



ADB Project Document

TA–9036: Strategy for Liaoning North Yellow Sea Regional
Cooperation and Development

RCI Needs Assessment, Development Strategy, and Implementation Action Plan for Liaoning Province

February 2018

This report was prepared by David Roland-Holst,
under the direction of Ying Qian and Philip Chang.

Primary contributors to the report were Jean
Francois Gautrin, LI Shantong, WANG Weiguang,
and YANG Song.

We are grateful to Wang Jin and Zhang Bingnan
for implementation support.

Special thanks to Edith Joan Nacpil and Zhuang
Jian, for comments and insights.

Dahlia Peterson, Wang Shan, Wang Zhifeng
provided indispensable research assistance.

ASIAN DEVELOPMENT BANK

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org
© 2015 by Asian Development Bank
April 2015

ISSN 2313-6537 (Print), 2313-6545 (e-ISSN)

Publication Stock No. WPSXXXXXX-X

The views expressed in this paper are those of the authors and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent.

ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use.

By making any designation of or reference to a particular territory or geographic area, or by using the term “country” in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

Note: In this publication, the symbol “\$” refers to US dollars.

 Printed on recycled paper

CONTENTS

Executive Summary	10
I. Introduction	1
II. Baseline Assessment	3
A. Macroeconomic Management and Performance	3
1. Understanding the Macroeconomic Challenge facing Liaoning	6
2. Attracting Foreign Trade and Investment	8
3. Relatively Small Scale of Foreign Trade	11
4. Too Many Low Value-Added Commodities for Export/Import	12
5. Imbalanced Volume Among Cities	12
6. Imbalanced Foreign Investment Among Industries and Source Countries.....	12
B. Transport Infrastructure development and financing	13
C. Industrial development for manufacturing exports	20
1. Background	20
2. Internationalization of Liaoning's equipment manufacturing industry	26
3. Problems in the Development of Liaoning's Equipment Manufacturing Industry.....	29
D. Sea- Rail Multimodal Transportation	38
1. Policies and mechanisms	41
2. Infrastructures and natural conditions	42
3. Potential of sea-rail multimodal in transportation system	44
4. SWOT analysis.....	45
5. Current Development of Liaoning's Sea-Railway Multimodal	48
6. Operational Models	57
7. Foreign and Domestic Growth Patterns and Impacts of Supporting Policies	61
E. Port Management	70
1. The Layout and Development Plan of Ports in Liaoning Province	70
2. Status of the Management of Port Resources in Liaoning Province	72
3. Management Problems	76
4. DEA Method of the Comprehensive Evaluation of Port Resources in Liaoning Province ...	79
5. Basic Concept of DEA	81
6. The Basic Idea of DEA.....	82
7. The Efficiency Evaluation Model of DEA	83
8. Input-output Indicator Selection based on the Variable Model of Economies of Scale	85
9. Input and output indicators of DMU data sample	86
III. Development Strategy	87
A. Macroeconomic management and performance	87
1. International Level	87
2. Inter-provincial Dimension	91
3. Intra-provincial Dimension.....	92
4. General Conclusions	92
B. Transport infrastructure development and financing	97
1. Definition of PPP	97
2. Types of PPP Schemes.....	99
3. PPP Projects: Stages and Process.....	104
4. PPP Projects: Growth and Trends	108
5. PPP Projects in China (CPPPC).....	111
C. Industrial development for manufacturing exports	116
1. International expansion has become an inevitable choice.....	116
2. National policies have provided strong support	118

D.	Sea-Rail Multimodal Transportation.....	123
1.	National Initiatives and Policies	123
2.	Internet Plus and Technological Development	127
3.	Policy context.....	132
4.	Case studies of the integration of Internet Plus and technological development.....	133
5.	Influence of Internet Plus and technological development.....	135
6.	The Role of Private Capital.....	138
7.	Transport service industry	139
8.	Emerging transport industry.....	140
9.	Case studies of private investment in transportation.....	143
10.	Bottlenecks and Challenges.....	148
11.	Incomprehensive Network	153
12.	Resources Shortage in Transit Stations	154
E.	Port Management.....	156
1.	SWOT Analysis	156
2.	The Operational Efficiency Evaluation of Dalian Port	158
3.	Analysis of Pure Technology Efficiency and Scale Efficiency of Dalian Port Operation	161
4.	The Redundancy Analysis of Dalian Port Operational Efficiency	162
5.	Operational Efficiency Evaluation of Yingkou Port	163
6.	Analysis of Operational Efficiency of Yingkou Port	165
7.	Analysis of Efficiency of Yingkou Port	167
8.	Analysis of Yingkou Port Operational Efficiency	168
9.	Operational Efficiency Evaluation of Jinzhou Port	170
10.	Factors Affecting Port of Jinzhou Efficiency.....	173
11.	Technical and Scale Efficiency of the Port of Jinzhou	176
12.	Factors Affecting the Operation Efficiency of the Port of Jinzhou.....	181
13.	SWOT Analysis of the Port of Dandong	182
14.	SWOT Analysis of the Port of Huludao	184
15.	SWOT Analysis of the Port of Panjin.....	186
16.	SWOT Analysis of the Port of Suizhong	191
17.	Comparison of Bohai Bay, the Yangtze Delta and Pan-Pearl Delta.....	195
IV.	Implementation Plan	209
A.	Macroeconomic management and performance	209
1.	Rebalancing economic structure	209
2.	Increasing Foreign Direct Investment into Strategic Sectors	209
3.	Promote open, competitive, and transparent commerce and investment climate	210
4.	Demographic Initiative.....	211
5.	Additional Macroeconomic Recommendations.....	211
B.	Transport infrastructure development and financing	212
1.	Select good potential PPP projects	213
2.	Enable proactive and fiscally responsible government support	213
3.	Prepare adequately project and make use of available capacity building assistance	214
4.	Achieve appropriate risk allocation among partners.....	216
5.	Make use of available project financing alternatives	220
6.	Ensure adequate generation of project revenues	221
7.	Conclusions for PPP Projects in Liaoning	223
C.	Industrial development for manufacturing exports	226
1.	Enhance policies supporting local, private sector innovation.....	226
2.	Support mergers and reorganization of enterprises.....	227
3.	Expand service value added in manufacturing	229
4.	Improve equipment manufacturing industry clusters	230

5.	Accelerate the upgrading of enterprise capacity	231
6.	Seize the " Belt and Road Initiative" and speed up "going global"	234
7.	Promote efficient supply chains and resolve excess capacity.....	238
8.	Upgrade global value chain participation and enhance profitability	239
9.	Accelerate development of priority areas for international expansion.....	244
10.	Change outdated concepts, deepening the reform and opening.....	247
11.	Enhance organization and leadership.....	248
12.	Building information resources	248
13.	Implementation of fiscal, taxing and financial support policy.....	249
14.	Cultivating talents for International expansion	250
D.	Sea-Rail Multimodal Transportation.....	250
1.	Develop both bulk cargo and container multimodal transport	250
2.	Determinants – the economic and product structures of Liaoning	251
3.	Determinants–development of speed and level.....	261
4.	Further Integration of Internet Plus.....	262
5.	Management Reform Proposals given Multiple Supporting Policies.....	263
6.	Expand Market Goods Supply and Step up Service Quality	266
7.	More Investment in Infrastructure	266
8.	Marketization of Domestic Sea-Rail Multimodal Transport System	267
9.	Encourage and Guide the Participation of More Private Capital	268
E.	Port Management.....	271
1.	Integrate with Belt and Road and Promote RCI	271
2.	Innovate to Improve Operating Efficiency of Ports in Liaoning	272
3.	Optimize port resource allocation for scale and technical efficiency	274
4.	Learning from international best practices in port service efficiency.....	276
5.	Accelerate industrial and IT upgrading of port enterprises	277
V.	References.....	279

Table 43: Analysis and Adjustment of the Port’s Financial Slack (Unit: 10,000 RMB)	181
Table 44: Input-Output Efficiency Indicators for Port Enterprises	198
Table 45: Average Original Indicators Data for 18 Port Logistics Enterprises by Region from 2006 to2015	200
Table 46: Average Efficiency for Port Logistics Enterprises, 2006-2015	201
Table 47: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Bohai Rim Region (RMB10,000)	204
Table 48: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Yangtze Delta (RMB10,000).....	204
Table 49: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Pan-Pearl Delta Region (RMB10,000).....	207
Table 50: PPP Project Risk Allocation Matrix.....	218
Table 51: Annual GDP of Liaoning Province.....	251
Table 52:Liaoning’s Main Agricultural and Industrial Product Output	254
Table 53: Liaoning Trade by Country and Region, 2016	258
Table 54: Liaoning’s Imports of Major Commodities	259
Table 55: Export Quantity of Main Commodities in Liaoning Province	260

Index of Figures

Figure 1: Lowest Economic Growth Rate in Modern History	4
Figure 2: A Significant Decline in Government Revenue	5
Figure 3: A Sharp Decline in Fixed Asset Investment.....	6
Figure 4: Foreign Trade Dependence in Liaoning versus National Average	8
Figure 5: A Precipitous Drop - FDI into Liaoning, 2006 - 2015	11
Figure 6: Number of enterprises above designated size in equipment manufacturing industry in Liaoning Province.....	21
Figure 7: Assets of enterprises above designated size in equipment manufacturing industry in Liaoning Province.....	21
Figure 8: Prime operating revenue of enterprises above designated size in equipment manufacturing industry in Liaoning Province	22
Figure 9: Total profit of enterprises above designated size in equipment manufacturing industry in Liaoning Province.....	22
Figure 10: GDP Comparatives between Liaoning and other Major Coastal Provinces	40
Figure 11: Work Flow of Sea-Rail Models	58
Figure 12: Intermodal Operation Schedules	60
Figure 13: Multimodal Opearation Schedules	61
Figure 14: DEA Efficiency Evaluation Schematic.....	80
Figure 15: Input and Output Indicators	86
Figure 16: Public Private Partnership Spectrum	100
Figure 17: SWOT Analysis Schematic.....	158
Figure 18: Efficiency Differences of State-owned Logistics Companies by Region from 2006 to 2015	202
Figure 19: Schematic of Alternative Revenue Schemes	222

Abbreviations

ADB – Asian Development Bank
ASEAN – Association of Southeast Asian Nations
BRI – Belt and Road Initiative
DOF – Department of Finance
EA – Executing Agency
FTZ – Free Trade Zone
GHG – greenhouse gas
IA – Implementing Agency
ICT – information and communication technology
ICTI – Internet Content, Technology, and Infrastructure
JMEPA - Japan–Mongolia Economic Partnership Agreement
LCEBDP - Liaoning Coastal Economic Belt Development Plan
LPDF – Liaoning Province Department of Finance
MDGs – Millennium Development Goals
MOC - Ministry of Commerce
MOFA - Ministry of Foreign Affairs
NDRC - National Development and Reform Commission
NEA – Northeast Asia
NSCP – North-South Corridor Plan
NSR – New Silk Road
OBOR – One Belt One Road (see also BRI above)
PFRIL - Provincial Financial Research Institute in Liaoning
PRC – People’s Republic of China
RCI – Regional Cooperation and Integration
SDGS – Sustainable Development Goals
SME – small and medium-sized enterprise
SOE – State Owned Enterprise
TA – Technical Assistance Plan
TIRC - Transports Internationaux Routiers Convention
WTO – World Trade Organization

Executive Summary

1. This advisory document is a distillation of five detailed Technical Reports commissioned by ADB to support a proactive agenda of economic renewal for Liaoning Province. The assessment and recommendations below are based on an extensive review of policy experience, evidence, and research on the potential for Regional Cooperation Initiative (RCI's) to contribute to inclusive and sustainable economic growth. Based on this analysis, and a detailed assessment of the past, present, and future experience and challenges facing Liaoning province, this document presents specific and actionable recommendations for Liaoning policy makers to leverage RCI for economic revitalization.¹ Regional cooperation and integration on all levels, including international, inter-provincial, and intra-provincial level, offer enormous potential for Liaoning to achieve dynamic and inclusive long-term growth for its economy.
2. At the national level, the PRC's accession to the World Trade Organization (WTO) opened new horizons for technical and managerial innovation across China's economy. In the same way, RCI can be a potent catalyst for economic renewal in Liaoning. What we see in today's global economy is a process of supply chain decomposition, where RCI distributes market opportunities, production tasks, technologies, and new skills across an international matrix of intermediate suppliers. Liaoning province can be said to have benefitted from linkages like this during China's heavy industrial development phase, but our review of evidence suggests Liaoning needs to redouble its commitments to external engagement to sustain innovation and overcome its present economic and demographic difficulties.
3. The recommendations presented below are the product of an extended research effort by international and PRC experts, ADB's Technical Assistance program 9036: Strategy for Liaoning North Yellow Sea Regional Cooperation and Development. Based on relevant experiences of other regions' in the PRC and elsewhere, the main finding of this work is that more determined RCI will be essential for Liaoning and the surrounding area to achieve greater economic growth through proactive economic restructuring, diversification, and commitments to higher productivity and human capital development. As is emphasized below, Liaoning retains many important advantages in terms of geography and resource endowments, and these can support a variety of ambitious existing and potential RCI initiatives. There are already many opportunities that Liaoning can seize to participate in and promote RCI, including existing national policies/strategies and established mechanisms for

¹ More detailed recommendations will be presented in a strategic report that synthesizes the lessons of all five Technical Reports in this series.

coordination on all levels of RCI. These are discussed in more detail below, but what is needed generally is more institutional commitment to external partnership in the following five areas:

- A. Macroeconomic management and performance
 - B. Transport infrastructure development and financing
 - C. Industrial development for manufacturing exports
 - D. Sea- Rail Multimodal Transportation
 - E. Port Management
4. Events the last decade clearly show that going it alone, or resisting larger forces of economic change, will only further isolate Liaoning's economy and deny opportunities to its people. A single province of China cannot really ignore the forces of national and global economic modernization without losing its primary growth drivers – investment and talent. The economic adversity of recent years demonstrates that the provincial and local governments themselves cannot replace the financial and human capital lost in an exodus of investors and skilled workers. The more realistic approach is to create conditions that will attract such assets back. Doing that in a credible way will require a disciplined examination and far reaching reform of current practices, weeding out policies that undermine competitiveness, innovation, and institutional adaptation in both the public and private domains.
5. This Technical Assistance project has conducted precisely such a baseline assessment with respect Liaoning's experience and RCI's potential for economic revitalization, and the present document makes a series of concrete recommendations for reform, renewal, and a more dynamic economic future. For the five policy contexts considered, Table 1 summarizes baseline challenges, opportunities, and recommendations discussed in greater detail throghot the document. Judging from the magnitude of recent declines in investment and other economic prospects, it is clear that very ambitious and sustained reforms will be needed to return Liaoning to its former economic strength, realize its great economic potential, and secure sustained prosperity for all its people.

Table 1: Summary of Baseline Assessment and Recommendations²

	Policy Context	Baseline Challenges	Baseline Opportunities	Policy Recommendations
A.	Macroeconomic management and performance	<ul style="list-style-type: none"> • Unbalanced economic structure • Unfavorable Foreign Trade and Investment Climate • Low Value-Added Trade • Declining rates of innovation and labor productivity growth • Unbalanced Structure Across Cities • Unbalanced Foreign Investment across Industries and Sources 	<ul style="list-style-type: none"> • Silk Road Economic Belt and 21st Century Maritime Silk Road • Liaoning’s engagement and achievements • China-Northeast Asia Expo • Greater Tumen Initiative • Northeastern Provinces Executive Consultation Mechanism • Bohai Economic Rim • Cooperation Between East and Northeast Provinces • Liaoning Coastal City Economic Belt 	<ul style="list-style-type: none"> • Rebalancing economic structure • Increasing Foreign Direct Investment into Strategic Sectors • Promote a more open, competitive, and transparent business environment in the Liaoning FTZ • Infrastructure mega-projects to establish inter-regional transportation, energy, water resources and information networks • Collaboration towards decreasing air pollution and improving the nearshore marine environment • Greater role of the market in determining resource allocation • Urban-rural integration

² The full report below contains details on all these entries and many more individual assessment findings and recommendations. Here we provide only the titles of leading issues.

<p>B.</p>	<p>Transport infrastructure development and financing</p>	<ul style="list-style-type: none"> • Infrastructure investment stagnant • More goods moving by road than rail • Port throughput relatively stagnant • Heavy concentration of SOEs in infrastructure investment • Very low private and international partnership • Significant redundancy and design inconsistencies across local capacity, especially transport • Lack of integrated support for diversified enterprise community development 	<ul style="list-style-type: none"> • As wide array of PPP frameworks available • Very large Asian regional private capital resources available for PPP in infrastructure • Integrating with regional and global supply chains will attract international investment partners • National PPP and other policies are providing strong support and expanding rapidly, including OBOR, etc. • Six PPP currently ongoing in Liaoning, a basis for expansion 	<ul style="list-style-type: none"> • Select good potential PPP projects • Enable proactive and fiscally responsible government support • Prepare adequately project and make use of available capacity building assistance • Achieve appropriate risk allocation among partners • Make use of available project financing alternatives • Ensure adequate generation of project revenues • Conclusions for PPP Projects in Liaoning
-----------	---	--	---	---

C.	<p>Industrial development for manufacturing exports</p>	<ul style="list-style-type: none"> • Relatively low efficiency and effectiveness • The system of specialized labor division and cooperation is unsound, and the system integration capability is relatively low • Crucial techniques and high-end equipment are highly dependent on foreign countries • The state-owned economy is high in proportion, and the system and mechanism are not flexible • Internationalization level needs to be further improved • The level of technological innovation is low • The degree of informatization is not high enough 	<ul style="list-style-type: none"> • International expansion has become an inevitable choice • "The Belt and Road Initiative" brings opportunities • National policies have provided strong support • Unfavorable Environment for International expansion of Equipment Manufacturing Industry in Liaoning Province • The demand of the international market and the increasing pressure of competition in the international market • The continuous accelerating of transnational operation and improvement in competitive power of other provinces 	<ul style="list-style-type: none"> • Enhance policies supporting local, private sector innovation • Enhance the policy support of acceleration to push forward the process of important technological equipment to become homegrown • Upgrade technological level of enterprises through various means • Accelerate the strategic restructuring of SOEs • Focus on promoting several enterprises to reach world-class level • Expand service value added in manufacturing • Enhance the ability of enterprises to adapt to international operations • Promote efficient supply chains and resolve excess capacity • Acquire overseas enterprises • Upgrade global value chain participation and enhance profitability
----	---	---	---	---

D. Sea- Rail
Multimodal
Transportation

- Bottlenecks and Challenges
- Insufficient Freight Supply
- Higher Freight Rate
- Infrastructure Issues
- Institutional Problems: Insufficient Sea-Rail Coordination System
- Incomprehensive Network
- Lack of systematic facilities design
- Insufficient Information sharing
- Resources Shortage in Transit Stations

- National initiatives
- Northeast China Revitalization Plan
- OBOR
- Liaoning's FTZ Planning
- Internet Plus and Technological Development
- SOE reform and asset disposal
- Modern and extended logistics support
- Case studies of best modernization practices
- Qingdao port – transformation and upgrading with Internet Plus
- Humen port
- Shanghai port
- Lianyungang port
- Ningbo port
- Rizhao port

- Develop both bulk cargo and container multimodal transport
- Determinants – the economic and product structures of Liaoning
- Determinants–development of speed and level
- Macroeconomic development
- Analysis of the economic and industrial structure
- Further Integration of Internet Plus
- Management Reform Proposals given Multiple Supporting Policies
- Expand Market Goods Supply and Step up Service Quality
- More Investment in Infrastructure
- Marketization of Domestic Sea-Rail Multimodal Transport System
- Marketization
- Promote “two points with one line” transport mode
- Encourage and Guide the Participation of More Private Capital
- Improve investment climate

E.	Port Management	<ul style="list-style-type: none"> • Port management inefficiency • Unproductive competition and redundancy across ports • Local protectionism • Unreasonable positioning of the ports • Port resources and structural capacities • Internal management of the ports • The ports' capacity to support port-centered industries 	<ul style="list-style-type: none"> • Establishing a Port Logistics System with Clear Division of Labor • Cutting the Logistics Cost of the Port • Building Logistics Facilities • Establishing the Logistics Chain for the Main Cargo • Building an Information Network for the Port Logist • Improve the Quality of Logistics Services • Establishing the Port- vicinity Industrial Cluster 	<ul style="list-style-type: none"> • Integrate with Belt and Road and Promote RCI • Innovate to Improve Operating Efficiency of Ports in Liaoning • Optimize port resource allocation for scale and technical efficiency • Learning from international best practices in port service efficiency • Accelerate industrial and IT upgrading of port enterprises
----	-----------------	---	---	--

I. Introduction

6. Regional integration has been a potent catalyst for economic growth across the Asian region, particularly when more advanced economies are linked through supply chains to lower and middle-income neighbors. In the East Asian region, supply chains have proliferated to an extent and at a rate unimagined decades ago. The role of private capital flows in this process has been essential, and we shall see that investment behavior has exerted a decisive influence on patterns of regional production and trade. An important implication of the resulting supply chain decomposition is that the global network of value creation and income linkages is much more extensive and complex, than would be suggested by bilateral trade statistics alone. For this reason, the significance of existing multilateral ties, as well as the gains from a more liberal trading environment, may be seriously underestimated.
7. These developments contrast with manufacturing intensive, individual export platforms in the early stages of Asian post-war emergence. In recent years, intra-Asian trade has come to dominate across a remarkably diverse and dynamic mosaic of private commercial linkages that link the region's economies. These linkages are generally incorporated in global networks or supply chains, where tens, hundreds, even thousands of intermediate product linkages are realized through bilateral deliveries across provincial, national, and regional boundaries. The result is a remarkably diffuse network of economic activity, coexisting with and often transcending official domestic planning, as well as bilateral and multilateral diplomacy and trade negotiation. As this system has grown in scope and complexity, well beyond the administrative capacity of individual enterprises, local and national governments, it relies for its existence on price mediated market interactions and a liberal trade and investment climate. With better understanding of this complex web of linkages, policy makers can see both the rewards of Regional Cooperation and Integration (RCI) and the importance of policies that facilitate it.
8. In Asia, RCI has advanced very rapidly and pervasively as more advanced Asian economies re-allocate production to less advanced ones. A primary mechanism for this process is distributing supply chains, where foreign trade partners and investors in the region create or promote new modes of production in different localities, with local firms beginning as intermediate contractors and eventually producing and marketing their own brands. The result has been replication of industries and technology transfer around the region at an unprecedented rate. Policy makers at all levels should not isolate themselves from this process, but

strive to understand and embrace the many opportunities it presents for technical and economic progress.

9. The present study is a synthesis of a series of more detailed technical reports delivered as part of the ADB's Technical Assistance program 9036: Strategy for Liaoning North Yellow Sea Regional Cooperation and Development. In this document, we evaluate five dimensions of the RCI policy challenge facing Liaoning province:
 - A. Macroeconomic management and performance
 - B. Transport infrastructure development and financing
 - C. Industrial development for manufacturing exports
 - D. Sea- Rail Multimodal Transportation
 - E. Port Management

With respect to each of these five leading areas, we present a baseline needs assessment, a forward-looking and proactive development strategy, and detailed recommendations for importance of regional supply chains for more sustained and inclusive economic growth in Liaoning province. In particular, we identify opportunities for Liaoning to leverage regional economic integration and share the benefits of productivity and innovation among its trading partners.

10. It is well known that the PRC's accession to the WTO opened new horizons for technical and managerial innovation across China's economy. In the same way, RCI can sustain economic renewal in Liaoning. What we see in today's global economy is a process of supply chain decomposition, where RCI distributes market opportunities, production tasks, technology, and skill development across an international matrix of intermediate suppliers. Liaoning province can be said to have benefitted from linkages like this during China's heavy industrial development phase, but our review of evidence suggest that it needs to redouble its commitments to external engagement if it is to sustain innovation and offer a new generation of economic opportunity to its people. The Technical Reports in this series are intended to support this proactive agenda for policy renewal.

II. Baseline Assessment

11. This section evaluates initial conditions in Liaoning as they are relevant to the opportunities and challenges of more determined commitments to growth through RCI. The leading issues in this area relate to the macroeconomy and its structure, the Manufacturing Export sector, Sea and Rail Transport unbalanced economic structure, redundant construction, overcapacity, SOE and port management deficiencies, and adverse trends in trade, FDI, and provincial demographics.

A. Macroeconomic Management and Performance

12. Dominated by legacy heavy industries such as machinery and mining, Liaoning province has long struggled to keep up with rapidly growing provinces in the coastal area. Although the central government has been helping Liaoning to make the transition from state-owned heavy industries to light industries and services, Liaoning is finding it difficult to harness employment opportunities and economic growth.

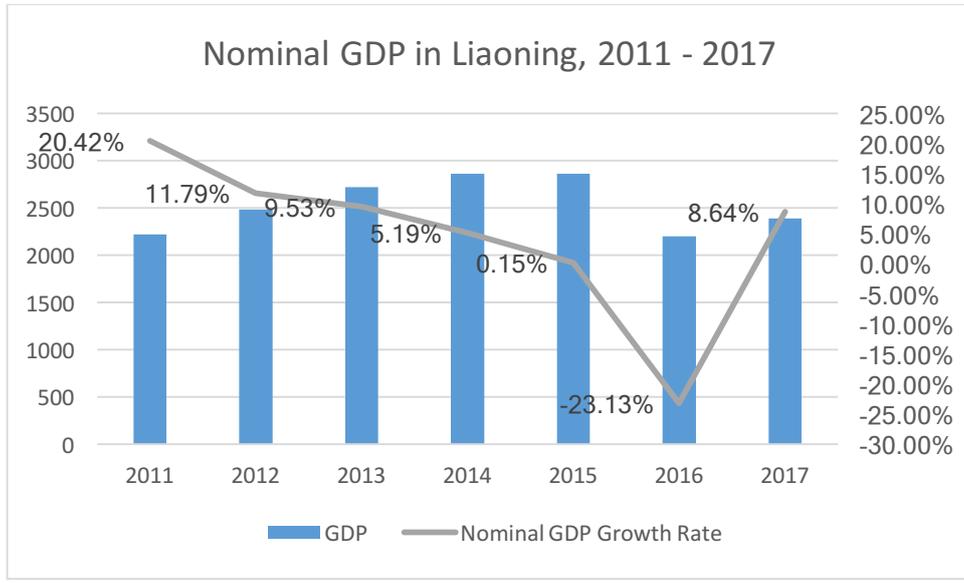
13. The recent collapse in Liaoning's economic indicator makes its future more dimmed. Liaoning province, once the leading economy of China, registered a -2.5% real GDP growth rate in 2016, with its economic output shrinking 23% in nominal terms, according to National Statistics Bureau. This made Liaoning the only province that experienced a negative growth in 2016. Meanwhile, Liaoning's government fiscal revenue has also declined by as much as 33.4 percent in 2015. At the same time, its government fiscal expenditure was 9.1% less.

Table 2: Gross Domestic Product in Liaoning Province
(RMB Billions, 2011-2017)

Year	2011	2012	2013	2014	2015	2016	2017
GDP	2,223	2,485	2,721	2,863	2,867	2,204	2,394

Source: National Statistics Bureau

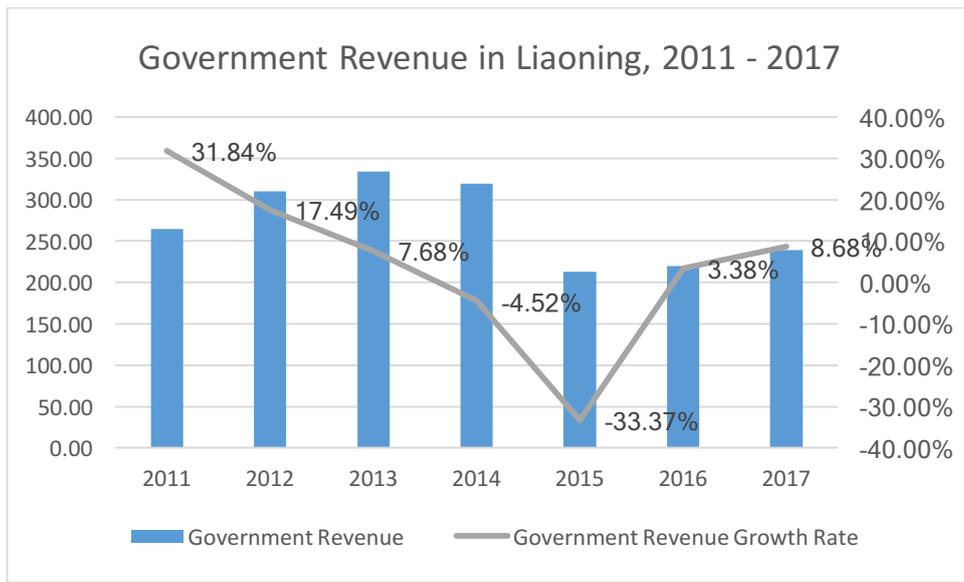
Figure 1: Lowest Economic Growth Rate in Modern History



Source: National Bureau of Statistics
Unit: Billion Yuan

14. According to official statistics, from 2008 to 2012, Liaoning's economic growth was higher than the national average by around 3.3%. Although its growth slowed down from 2012 to 2014, it was still higher than the national average level. Entering 2014, Liaoning's economic growth started to turn below the national average. In 2016, things became worse for Liaoning as its GDP growth rate turned negative to -2.5%, far below the national average level of 6.7%, which ranked bottom among all the provinces and autonomous regions in the country. Last year, it appeared that Liaoning's economy may be warming up again. Recently published data shows that Liaoning's real GDP increased only 4.2% in 2017, still 2.7% lower than the national average.

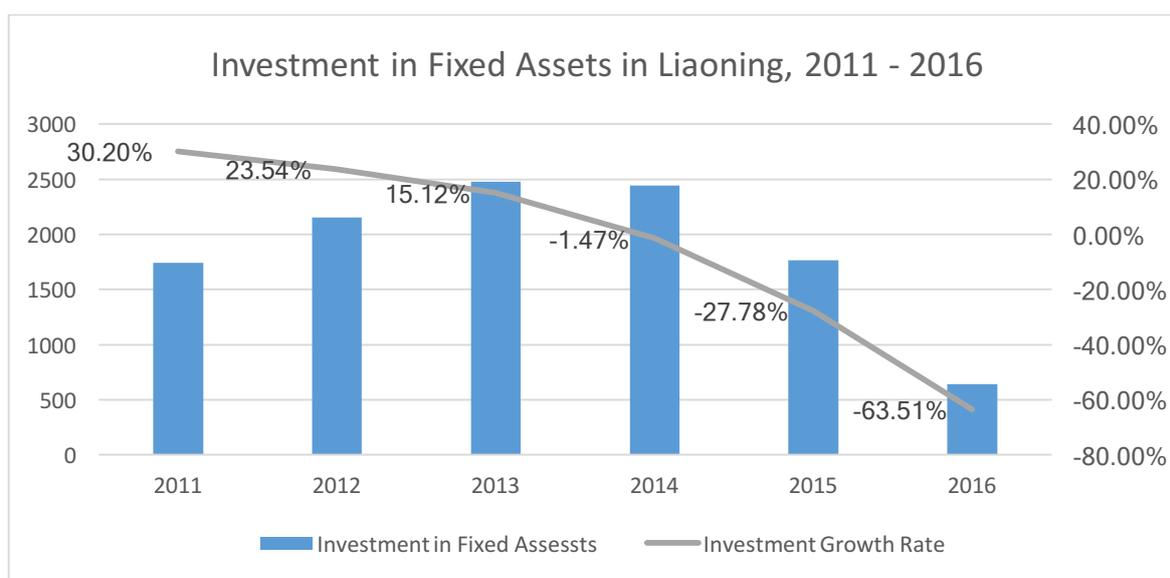
Figure 2: A Significant Decline in Government Revenue



Source: National Bureau of Statistics
Unit: Billion Yuan

15. Macroeconomic data suggest that 2014 was an unusual year for Liaoning in terms of its economic development. In this year, Liaoning's aggregate economic growth trended below the national average and its government revenue actually began to fall. In 2013, Liaoning's fiscal revenue reached an apparent peak of 334 billion yuan. By 2014, however, revenue had fallen to 319 billion yuan, nearly 5% lower than the previous year. By 2015, the speed of the revenue decline was accelerating. With total provincial fiscal revenue of 213 billion yuan, Liaoning experienced a 33.4% annual drop in public income, unprecedented in modern times. Although revenue recovered slightly in the last two years (2016) to 220 billion yuan, it remains well below the trend that had been established before 2014.

Figure 3: A Sharp Decline in Fixed Asset Investment



Source: National Bureau of Statistics
Unit: Billion Yuan

16. In part because of budgetary constraints, but also driven by more systemic institutional problems, the adverse fiscal revenue cycle is mirrored in Liaoning's fixed asset investment. In 2014, fixed assets investment in Liaoning showed a significant slowdown and begun to fall, modestly at first (-1.5%), but accelerating rapidly. In 2015 and 2016, aggregate fixed asset investment in Liaoning Province dropped -27.8% and -63.5%, respectively. From 2014 to 2016, in just three years, investment in fixed assets in Liaoning dropped by a startling total of 74%, from 2443 billion yuan to 644 billion yuan.

1. Understanding the Macroeconomic Challenge facing Liaoning

17. The primary reason for the sudden and significant drop of Liaoning's economy in 2016 was official attempts to undo the effects of previous over-reporting growth for the period from 2011 to 2014. However, the root cause for the region's current predicament lies in more fundamental structure problems with its economy.

18. Since the beginning of the economy-wide reform and opening up, China's industrialization progressed rapidly, especially in the early stages with heavy industry. This contributed to dramatic early growth for the province's economy, but has also imparted a legacy of structural imbalance because of over-reliance on capital-intensive heavy industry. Today, manufacturing still has the highest share of Gross Provincial Product (GPP), while the proportion of tertiary industry remains far below that of more dynamic provinces.

Table 3: Industrial Structure of Liaoning, 2011-2015 (percentage shares)

Year	Primary Industry	Secondary Industry	Tertiary Industry
2011	8.6	54.7	36.7
2012	8.7	53.2	38.1
2013	8.1	51.3	40.6
2014	8.0	50.2	41.8
2015	8.3	45.5	46.2

Source: National Bureau of Statistics

- 19.** Known as the “Eldest Son of the Republic” and the “Eastern Ruhr”, Liaoning was one of the first provinces in China to industrialize, with substantial external investments starting in the so-called Manchukuo Period. Despite wartime damage, Liaoning retained significant infrastructure and a skilled labor force. As a focal point of investment in the early Five Year Plans, industrial development accelerated in the decades after liberation, facilitated by the presence of iron and energy deposits in the province. This combination of historical advantages made Liaoning the leading province for heavy industry. The proportion of heavy industry in the province’s economic activity rose as high as 80%, while the scale of emerging industry has been relatively small. In Shenyang, for example, the 2015 proportion of heavy industry among all medium to large industrial enterprises was still 80% in Shenyang, 10 percentage points higher than the national average. In addition, 90% of the biggest enterprises in the city were traditional industries, while the number of companies that belonged to the more innovative emerging categories (such as electronic products, aerospace equipment, etc.) accounted for less than 5%.
- 20.** For the first decade of the new millennium, the traditional enterprises in Liaoning rode the tides of a WTO-induced national manufacturing and infrastructure development boom. The scale of domestic and foreign demand expanded very rapidly across the PRC economy, absorbing industrial capacity of all kinds. This dramatic and broad-based aggregate expansion concealed the structural imbalance and lack of diversification within the provincial economy. However, moderating aggregate growth since 2010 has not been as uniform, as demand patterns have shifted toward higher technology products and services. In place of fast and relatively uniform expansion fifteen years ago, we now see more moderate growth comprised of fast growing demand for tech and services, falling demand for primary industry, and average growth for the rest. Meanwhile, high investment on fixed assets does not necessarily increase employment when they investments are in labor saving technologies. Although Liaoning government is on its way to perform a major structure transformation, more effort will be needed to promote economic diversification toward more labor-intensive industries and higher value, skill-intensive services.

2. Attracting Foreign Trade and Investment

21. Liaoning's foreign trade is mainly conducted through the Port of Dalian. Major export items included primary products such as agricultural and fisheries products, raw materials (metals, minerals, oil), automobiles, auto-parts and machine tools. Major import items in Liaoning included steel, electronic parts, rubber and tubes.

Table 4: Liaoning Province's Foreign Trade, China 2006-2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Value of Export	283.2	353.3	420.5	334.4	431.2	510.4	579.5	645.4	587.6	508.4
Value of Import	200.7	241.5	303.8	294.8	375.5	449.2	460.4	497.4	552.0	452.5
Total Export-Import Volume	483.9	594.8	724.3	629.2	806.7	959.6	1039.9	1142.8	1139.6	960.9
Balance of Trade (Export - Import)	82.5	111.8	116.7	39.6	55.7	61.2	119.1	148.0	35.6	55.9
GDP (Liaoning)	1167	1468	1968	2227	2726	3441	3936	4394	4660	4615
Foreign Trade Dependence (Liaoning)	41.5%	40.5%	36.8%	28.3%	29.6%	27.9%	26.4%	26.0%	24.5%	20.8%
Foreign Trade Dependence (National)	64.0%	61.2%	55.7%	43.2%	48.7%	48.1%	45.2%	43.3%	41.0%	35.7%

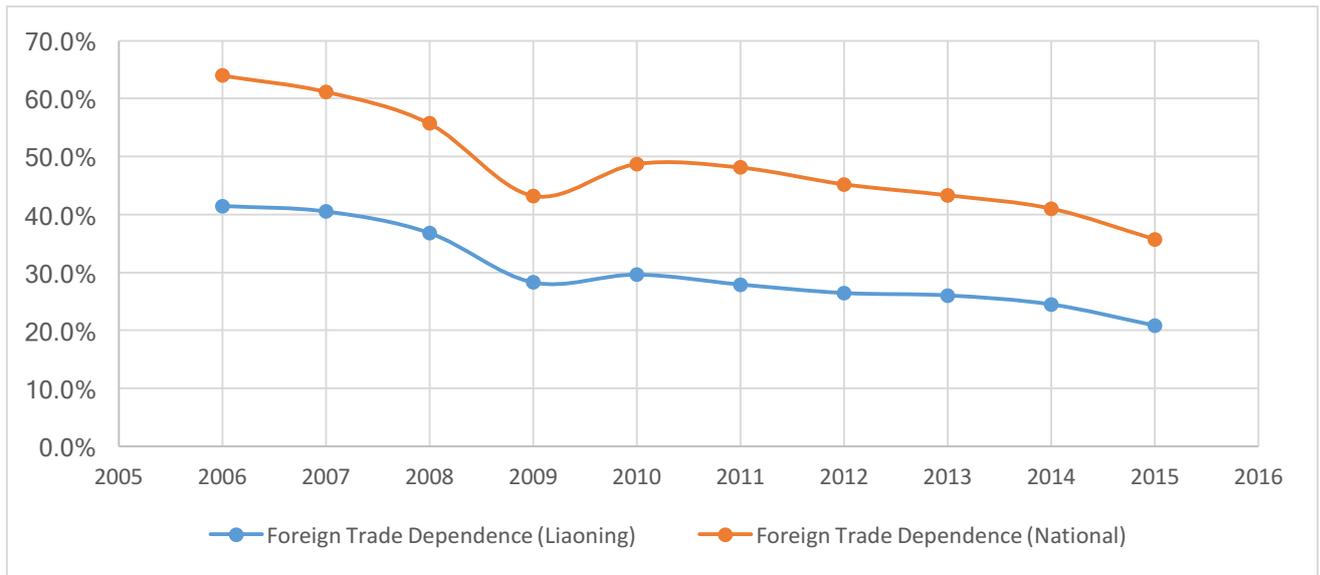
Source: Liaoning Province Yearbook 2016
Unit: 100 Million Dollars

22. From the above data, we can see that Liaoning has maintained a trade surplus in the past ten years, and its import and export volumes have been increasing in general. In 2013, Liaoning's total export-import volume and trading difference both reached their peak. However, we can also find two years with declining data, 2009 and 2015.

23. In 2009, Liaoning's import dropped 3.0% while its export dropped 20.5%, comparing with the former year. Meanwhile, its total export-import volume decreased 13.1%. Decline in this period was mostly caused by global financial crisis.

24. In 2015, Liaoning's import dropped 18.0% while its export dropped 13.5%, and its total export-import volume experienced a 15.7% decrease. Reasons for the decline in this year is more complex. Market slowdown of the electromechanical industry, rising labor costs, overcapacity in the steel industry, falling oil prices and falling prices of other commodities (such as iron ore and coal) all contributed to the problem, which created a huge negative impact to the electromechanical industry, steel industry and oil industry in Liaoning.

Figure 4: Foreign Trade Dependence in Liaoning versus National Average



Source: Liaoning Province Yearbook 2016, National Statistics Bureau

25. As shown in the figure above, the foreign trade dependence in Liaoning has been decreasing in the recent ten years, dropping from 41.5% in 2006 to 20.7% in 2015. Besides, its foreign trade dependence rate has always been 15% to 20% lower than the national rate. This shows that the importance of foreign trade in Liaoning's overall economy has been gradually decreasing, and the dependence of Liaoning on the international market is weakening. The main reason for this phenomenon is that after the global financial crisis in 2008 and the European debt crisis in 2010, the external demand was not strong. And most of the enterprises in Liaoning shifted their focus from the international market to the domestic market.

26. In 2015, the top export commodities in Liaoning were electromechanical products, steels, agricultural products, high-tech products, clothing and accessories, refined oil, aluminum, crude oil, auto parts, textile products, etc. Among them, electromechanical products accounted for 38.5% of all the exports, steel exports accounted for 11.4%; agricultural exports accounted for 9.4%, and high-tech exports accounted for 9.1%.

27. Meanwhile, the top import commodities in Liaoning were electromechanical products, crude oil, agricultural products, high-tech products, auto parts, xylene, natural gas, iron ore, coal and lignite, etc. Among them, electromechanical products accounted for 29.3% of all the imports, crude oil accounted for 22.5%, agricultural products accounted for 12.1%, and high-tech products accounted for 10.3%.

28. Because of geographical proximity, Liaoning province maintains very close trade ties with Japan, South Korea and Russia. In 2016, Liaoning exports to Japan, South Korea and Russia stood at 83.5 billion yuan, accounting for 29.4% of the

total exports. At the same time, imports from Japan, South Korea and Russia stood at 75.0 billion yuan, accounting for 26.1% of the total imports.

Table 5: Value of Imports and Exports between Liaoning Province and Japan, Korea, Russia (2014-2016)

Year	Export			Import			Total		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Japan	592.72	524.84	516.01	325.96	260.70	324.50	918.67	785.55	840.51
Korea	330.65	281.14	266.21	256.73	259.89	262.71	587.38	541.03	528.92
Russia	72.44	57.88	52.45	76.82	130.05	162.56	149.26	187.93	215.02

Unit: 100 Million Yuan

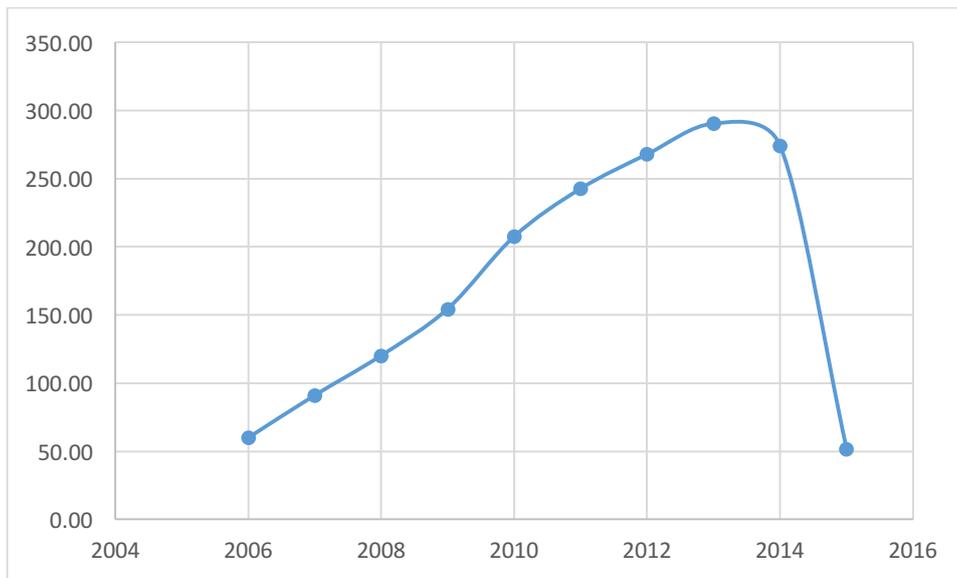
Source: Dalian Customs District People's Republic of China

29. From the table below, we can see that in the last decade, inbound FDI to Liaoning has registered a dramatic decline. From 2006 to 2013, it grew steadily with an average annual growth rate of around 20%. In 2006, the FDI in Liaoning was only \$6.0 billion, while it peaked at \$29.4 billion in 2013, experienced an almost fivefold increase in seven years. And during these eight years, the FDI dependence rate remained relatively stable, ranged from 5.13% to 7.61%. However, in 2014 and 2015, Liaoning experienced a huge drop on its FDI. Especially in 2015, the FDI dropped from \$27.4 billion dollars directly to \$5.2 billion dollars, even less than the amount ten years before. And the FDI dependence rate also dropped to 1.12% in the same year. How to attract FDI becomes a very important task.

Table 6: FDI in Liaoning Province, China 2006-2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FDI	59.85	90.97	120.19	154.44	207.50	242.67	267.93	290.40	274.23	51.85
GDP	1167	1468	1968	2227	2726	3441	3936	4394	4660	4615
FDI Dependence	5.13%	6.20%	6.11%	6.93%	7.61%	7.05%	6.81%	6.61%	5.88%	1.12%

Figure 5: A Precipitous Drop - FDI into Liaoning, 2006 - 2015



Source: Liaoning Province Yearbook 2016
Unit: 100 Million Dollars

- 30.** In terms of distribution of FDI among different industries, the utilization of FDI in Liaoning is concentrated in the second and the third industry. The industry that uses the most foreign capital is manufacturing, followed by real estate. In 2014, for example, the second industry used 51.7% of the FDI while the third industry used 46.8%. To be more specific, the proportions of FDI used in different industries are as follows: manufacturing industry accounted for 47.5%; real estate accounted for 18.2%; transportation, storage and postal industry accounted for 7.7%; information technology and software industry accounted for 4.9%; leasing and business the service accounted for 3.8%.
- 31.** In terms of the source of foreign investment, Asia takes up the largest share and Hong Kong has been in the first place for years. In recent years, the investment from Hong Kong takes up about 50% of the total foreign investment in Liaoning, followed by Japan and South Korea, takes up about 15% - 20% in total. Then the United States, Singapore and Taiwan account for about 10% of the total foreign investment.

3. Relatively Small Scale of Foreign Trade

- 32.** Comparing with the total volume of its economy, Liaoning's scale of foreign trade is relatively small. And the foreign trade dependence in Liaoning has always been lower than the national level. For nearly 10 years, foreign trade dependence in Liaoning has been 15% to 20% less than the national average. In 2015, among all the 31 provinces and autonomous regions around the country, export volume of Liaoning ranked tenth, while its import volume ranked

ninth, far less than coastal provinces like Guangdong, Jiangsu, Zhejiang, etc. Its import and export volume is only around 1/10 of Guangdong's, according to the statistics from China's Ministry of Commerce. To sum up, Liaoning has a relatively small scale of foreign trade with limited contribution its economic growth.

4. Too Many Low Value-Added Commodities for Export/Import

33. Among Liaoning's import and export commodities, the proportion of high technology and new technology products is low. Liaoning's export commodities are mainly steels, simple mechanical and electrical products and other labor-intensive products, while its import commodities are mainly mechanical and electrical products, crude oil, agricultural products and other natural resources. Most of Liaoning's foreign trade relies on simple products with little technology and low value-added. Only 10% of the commodities Liaoning imports and exports belong to high-tech products. Therefore, the structure of import and export commodities in Liaoning needs to be optimized.

5. Imbalanced Volume Among Cities

34. Most of Liaoning's import and export volume and foreign investments are concentrated in two cities, Dalian and Shenyang. Foreign trade and foreign investments in other regions is much less, especially in the northwest part of Liaoning Province. In 2014, the total value of import and export for Dalian was 64.5 billion US dollars, while the total value of import and export for Shenyang was 15.8 billion US dollars. 67.5% of the total foreign investments to Liaoning was also used up by these two cities. In comparison, the value of import and export for Fuxin was only \$361 million in the same year, which is only about 0.5% of Dalian. Only \$250 million foreign investment was directed to Fuxin and Chaoyang, which only accounts for 2% of Dalian's foreign investment. It can be seen that the gap of foreign trade between different cities in Liaoning province is very wide, and the regional development is quite unbalanced.

6. Imbalanced Foreign Investment Among Industries and Source Countries

35. Distribution of foreign investment among industries is also quite unbalanced in Liaoning. The foreign investment in Liaoning is mostly concentrated in the second industry and the third industry, while investment in the first industry is very small. Among all the foreign investment, nearly 70% is in the area of manufacturing and real estate. Little money is invested in technology intensive industries like information technology and computer software. The proportion of investment in agriculture, forestry and animal husbandry is the smallest, which

is only about 1.5%. As a result, foreign investment in Liaoning has a relatively large social cost. Many of the projects invested caused much pollution and consumed a lot of energy, while others belonged to the end of the industrial chain. Capital invested in the local real estate industry also helped create the real estate bubble. This was extremely detrimental for upgrading the industrial structure in Liaoning.

B. Transport Infrastructure development and financing

36. Putting in place high quality transport infrastructures has and is still a key component of the Chinese growth model. And this applies truly to Liaoning. Liaoning is proud to say that the first expressway in China was built between Shenyang and Dalian and to claim that overall, they have the best transport infrastructures. There is currently 4,200 km of expressways in the province with 1/3 of the network being with 6 or 8 lanes. The last expressway was built in 2014 between Dandong and Dalian. Below some broad indicators describing the transport sector are providing below.

Table 7: Liaoning Province Basic Statistics (Transport)

Item	2005	2010	2014	2015	2016
Infrastructure Investment (RMB Mi)		383900		339806	
Transport Investment (RMB Mi)		87778		92032	
- Financed by Central Gvt (RMB Mi)		4058		8660	
Total Railway network (1,000 km)		43	51	58	
Total Highway network (1,000 km)		102	115	120	
Expressway network (1,000 km)		3.1	4.2	4.2	
Highway 1st class (1,000 km)		2.9	3.5	3.6	
Total port throughput (M T)		679			1048
Throughput domestic (M T)		463			809
Throughput international (M T)		216			239
Total container (M TEUs)		9.68			18.79
Transported Freight (10,000 T)	95558	158484	222138	208562.7	
CAGR (%)		10.6	8.8	-6	
National Railway Freight (10,000 T)	15029	18628	16520	14540.7	
CAGR (%)		4.4	-3	-12	
Highway Freight (10,000 T)	74799	127361	189174	172000	177000
CAGR (%)		11.2	10.4	-9	3
Railway t-km (100 million TKm)	1195	1403	1177	893.6	
CAGR (%)		3.3	-4.3	-2.4	
Highway t-km (100 million Tkm)	416	1930	3074	2850.7	2936.8
CAGR (%)		36	12.3	-7	3
New Truck Registration (10,000)	3.55	10.3	5.87	4.52	
New car Registration (10,000)	14.06	50.2	44.12	62.6	
Passengers (10,000)	60400	101525	94172	75039	
CAGR (%)		11.1	-2	-20	
Passengers railway (10,000)	9533	13336	12841	12911.8	
CAGR (%)		6.9	-1	0.6	
Passengers highway (10,000)	49917	87699	80789	60000	59000
CAGR (%)		11.9	-2	-26	-1.7
Tourist arrivals (million)	1.3	3.6	2.6	2.64	
CAGR (%)		22.6	-8	0	
Tourism revenues (\$ million)	738	2259	1618	1683	
CAGR (%)		25	-8	4	

Note: CAGR: compound annual growth rate
Source: China National Bureau of Statistics (website), Liaoning Statistical Bureau
Liaoning Province and Hong Kong Trade Development Council (Feb 2017)

- 37.** Surprisingly total infrastructure investments were lower in 2015 than in 2010 but this was not the case for transport infrastructure investments accounting for approximately 30% of the total. And the vast majority of the transport investments were locally financed with central government only contributing 10% of the total.
- 38.** The railway network has been expanding since 2010. Liaoning has 5 High Speed lines with dedicated passenger tracks: Beijing-Shenyang (808 km), Shenyang – Dalian (377-400 km), Shenyang – Dandong (149 – 208 km) and Shenyang – Fushun (45 – 65 km) and Shenyang – Changchun (300 km). The Shenyang-Dandong line was completed in 2015. The Shenyang – Dalian was completed in 2012 at a cost of RMB 92 300 million (\$ 13 billion). There is, in addition, new Super High-Speed Train rail line under construction between Beijing and Shenyang, avoiding Tianjin and costing RMB 124.5 billion expected to be completed in 2019. Despite all these investments passenger traffic has not increased since 2010. Most of the rail traffic is busy moving the 145 million tonnes recorded in 2015 (mostly minerals) but in reality, rail freight volumes have been decreasing since 2010 at an average of 8.5% per year when weighted by distance. The rail traffic in 2015 is less than what it was in 2005.
- 39.** More freight is moving by road instead of rail accounting for 82.5% of the total. Highway freight has been growing at 6 to 7% per year, roughly along national GDP growth rates. Ownership of private vehicles has increased drastically since 2010 and the road network has been expanding. But, somewhat as a contradiction, passenger traffic has been declining, being now 23% lower than in 2010.
- 40.** Port activities have been growing on average at 7.5% per year from 2010 to 2015. Growth has been largely due to the container traffic which has been growing at 11.7% per year and come more from the domestic side than the international. In fact, the growth of international traffic has been a bit sluggish with throughput growing at only 1.7% per year. The table below provide details information on the four key sea ports: Dalian, Yingkou, Dandong and Jinzhou. These 4 ports alone account for 94% of the total provincial port throughput.
- 41.** Dalian Port history goes back to 1898. It has traditionally been the regional hub and the gateway for exports and imports to the whole of Northeast China. There is strong competition to Dalian from Yingkou Port and Dandong port, though Yingkou Port traffic is clearly more domestic. There is a lot of expansion projects and ambition development for Dandong Port. Its geographic location, it is claimed, makes it the most favourable port for Shenyang and the Jilin Province when trading with Japan and the Korean Peninsula.
- 42.** Dalian Port and Jinzhou Port are listed companies while Yingkou Port belongs to the municipal government. Dalian Port more than the others has been affected by

the recent slow-down in the economy. Nevertheless, port managers are all optimistic for the future and all have big expansion programmes that they already have started to implement.

Table 8: Ports

	Dalian Port	Yingkou Port	Port of Dandong	Jinzhou Port
Location	At the entrance of Bohai Bay	On the west side of Liaodong Bay, 210 km from Shenyang, 180 km from Dalian	At the mouth of Yalu River, facing Huanghai Sea, including three ports: Dandong Port, Langtou Port and Haiyanghong Port.	On the east side of Liaodong Bay, 240 km from Shenyang
Rank	7 th in China (tonnage and TEUs), 9 th in the world for tonnage, 14 th for TEUs	10 th largest in China for TEUs, 8 th for total tonnage		
Ownership Status	PDA is a listed company established in 2005 with foreign shareholders: China Merchants Holding (HK KG) 27% (2016),	Yingkou Port Company Ltd (2003) is owned by Yingkou Municipal Government; COSCO has shares in terminal	Sino-foreign joint venture	is a listed company established in 1998 and 1999 with domestic shareholders: Dalian Port Group 27% (2017)
Number of berths	80	78	42	24
Terminals	2 container terminals, crude oil terminal, ore terminal, automobile terminal, Ro/Ro terminal for passengers and vehicles, cruise terminal	9 dedicated terminals: container, steel, ores, crude-refined oil, grain, coal, vehicles;	container terminals, crude oil terminal, ore terminal, coal terminal and grain terminal	container terminals, crude oil terminal, coal terminal and grain terminal
Shipping lines connections	88 shipping routes, 13 direct, linked with 160 countries and 300 ports	Linked to 140 ports and 40 countries; 4 direct lines (Japan, ROK), 4 feeders: Tianjin, Dalian, Ningbo, Shanghai	linked with Japan, Korea and most domestic ports	Its shipping routes connect to all domestic ports and more than 100 countries over Asia, Europe, Africa, America and Australia.

Main Function	Major port serving the whole of Northeast China, 70% of imported crude oil, 100% of imported vehicles and 90% of international trade	Sea-rail connections with dry ports: Changchun, Jilin, Harbin; bonded logistic centre (650,000m ²)	Excellent Sea-rail connections to link Mongolia, Korea and Japan	It Is the easiest access to sea for Northeast China, Mongolia and Siberia region of Russia.
Land transport connections	80% of goods are moved by railway (513,000 wagons in 2015)	Road and rail connections (Shenyang, Dalian, Harbin)	Expressway and rail connections (Shenyang, Dalian, Harbin, Changchun and cities of Inner-Mongolia)	Good rail and road connection to Shenyang, Fuxin, Inner Mongolia, Tianjin and Beijing
Total Throughput	350 MT but with other small ports in area: 430 MT	338 MT	200 MT	100 MT
Detailed Throughput	10 M TEUs (200 MT) Auto: 480,000 (1 MT) General Cargo: 30 MT Ore: 15.5 MT Grain: 4 MT Ro/Ro veh: 10 MT Oil related: 52.5 MT	5.9 M TEU (100 MT)	Grain: 10 MT	Coal:23 MT
Total Revenues	8.9 Billion RMB (7.9 in 2014)	2.9 Billion RMB (2011)		0.6Billion RMB (2016)
Detailed Revenues	TEUs: 1.7 Billion Auto: 1.9 Billion General Cargo: 374 Mi Ore: 349 Mi Grain: 1.36 Bi Ro/Ro: 129 Mi			Anchored3.97% Storage5.06% Load and unload84.29% Others6.68%
Ro/RO activities	3.5 million passengers and 1.07 million of vehicles through Ro/Ro operations	Ro/Ro with Busan		

Past growth	From 2014 throughput fell: 6% (TEU), 12% (ore), 8% (general cargo), 34% (grain), 5% Ro/Ro; railway movements down by 18%; only import of vehicles & crude oil increasing	From 2014, throughput rises by 2.3%, TEUs by 5.5%; YETDZ (1992) has 24km ² and 150,000 of population.		
Prospects	Port expansion of Dalian Taipingwan with a capacity of 300 MT to become a regional hub; China Merchant Holding from HK KG became shareholder in 2016;	MOU between Yingkou Port Group Corporation and OJSC (Russia RZD) where Yingkou takes 29% share in Bely Rast Trade Logistics Centre in Moscow	The berths will reach 102, and the total throughput will reach 400 MT in the future of 3-5 years, being the Logistics hub of the Northeast Asia.	

C. Industrial development for manufacturing exports

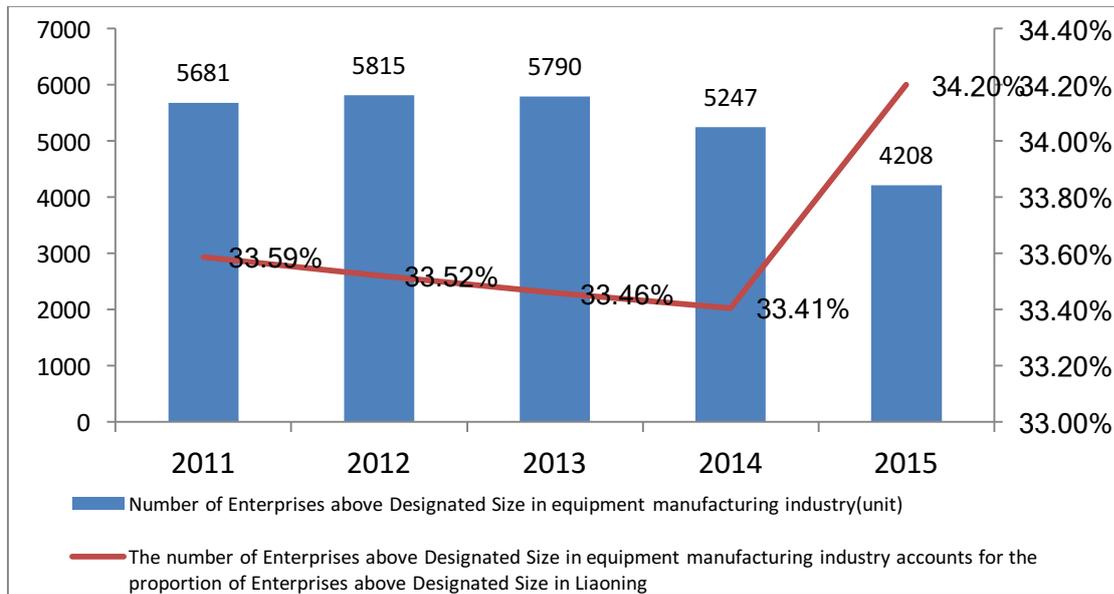
1. Background

43. Liaoning equipment manufacturing industry has a long history. In the long course of development, it has formed an industrial base with complete categories and some categories with comparative and competitive advantages.

a) The scale of the industry is growing steadily

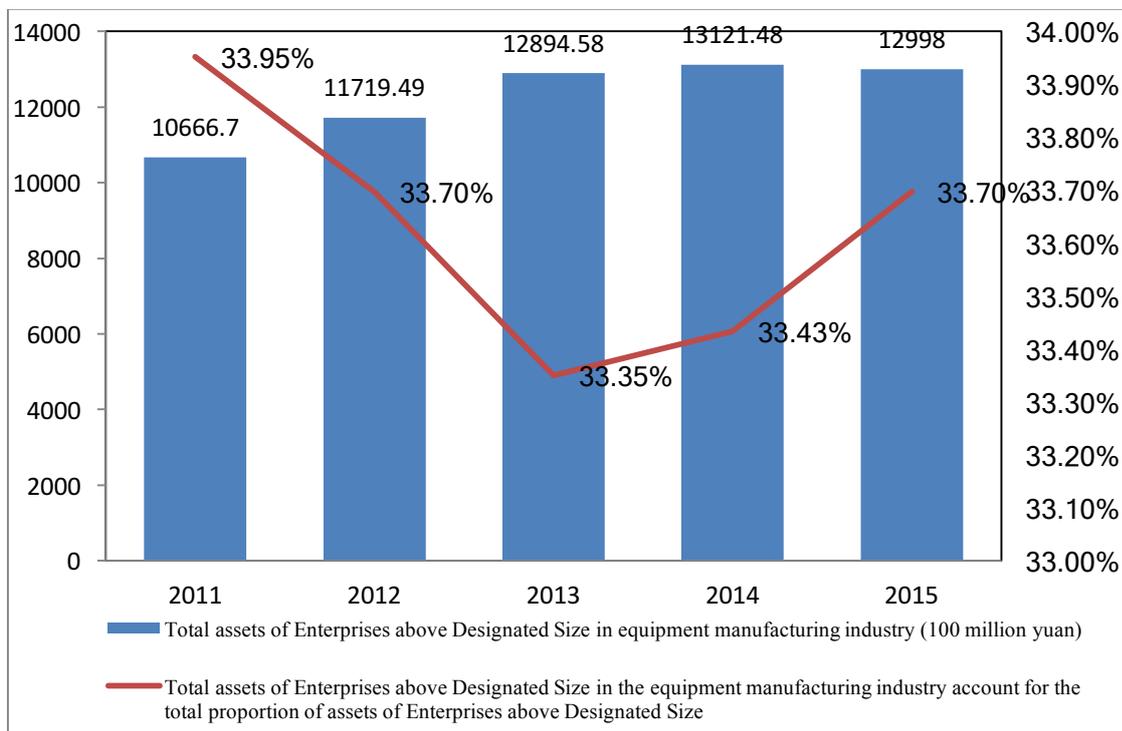
44. In recent years, equipment manufacturing industry as the most prominent pillar industry in Liaoning's industry has further strengthened its status. In 2015, in Liaoning Province, there are 4208 enterprises above-designated size in equipment manufacturing industry, accounting for 34.2% of the total of industrial enterprises above-designated size; their assets are 12,998 CNY, accounting 33.7% of the total of industrial enterprises above-designated size; their prime operating revenue is 10,809 CNY, accounting for 32.52% of the total of industrial enterprises above-designated size. The industrial added value of equipment manufacturing accounts for 32.3% of the Province's whole industry, ranking first in all sectors, 0.8 percentage points higher than that in 2010. The enterprises above designated size in equipment manufacturing industry have realized profits of 53 billion CNY, accounting for 49.54% of the Province's whole industry, 13 percentage points higher than that in 2011.

Figure 6: Number of enterprises above designated size in equipment manufacturing industry in Liaoning Province



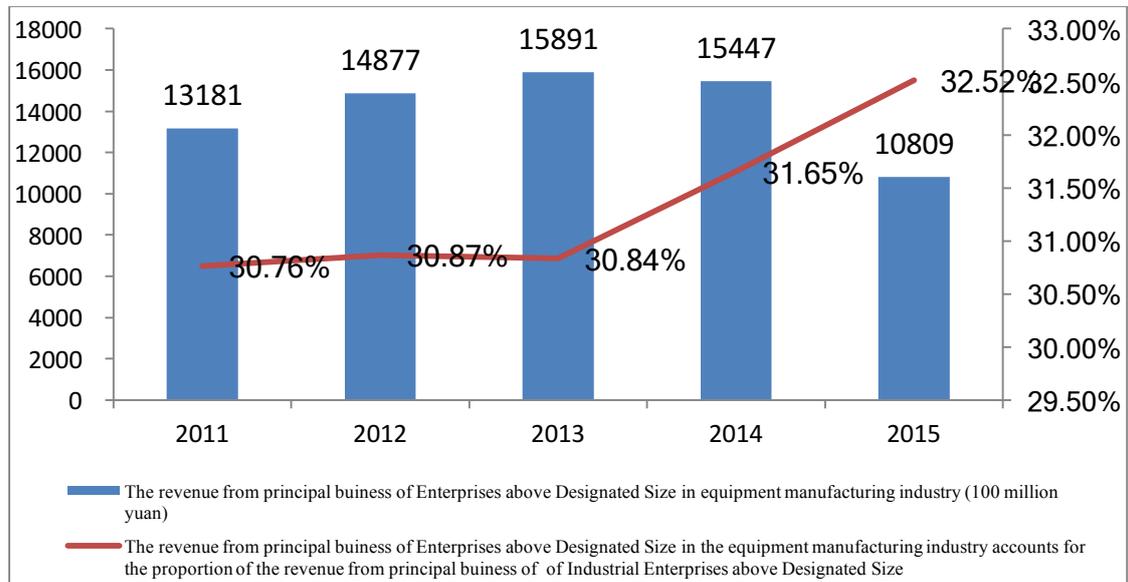
Source: Liaoning statistical yearbook (2016).

Figure 7: Assets of enterprises above designated size in equipment manufacturing industry in Liaoning Province



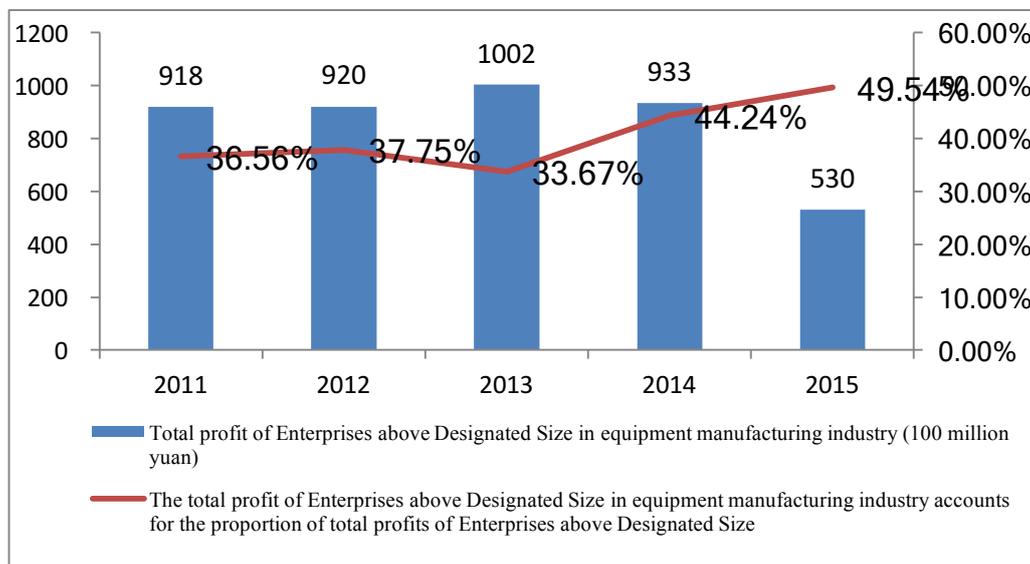
Source: Liaoning statistical yearbook (2016).

Figure 8: Prime operating revenue of enterprises above designated size in equipment manufacturing industry in Liaoning Province



Source: Liaoning statistical yearbook (2016).

Figure 9: Total profit of enterprises above designated size in equipment manufacturing industry in Liaoning Province



Source: Liaoning statistical yearbook (2016).

b) There are a large number of leading enterprises in the industry

45. Liaoning's equipment manufacturing industry has a large number of leading enterprises in similar industries in China, which are mainly located in Shenyang and Dalian and thus form a competitive industrial cluster. Shenyang Aircraft Corporation (SAC) is the research and production base of China's military fighters. Since its foundation, many types of China's military fighters are developed in SAC, which supports the construction of China's modern national

defense. CRRC Shenyang Co., Ltd., as the leading enterprise of domestic railway rolling stock industry, is mainly engaged in goods wagons manufacturing as well as overhaul diesel rolling stocks inspection and maintenance. The goods wagons produced there are the most in Asia. Shenyang Machine Tool (Group) Limited, with 1 state-level technical center and 3 industry research institutes, is mainly engaged in the developing and manufacturing of machine tools. It is one of the national priority high-tech development enterprises. Shenyang Blower Works Group Corporation (SBW) has been a leading enterprise in the blower industry. Its products are sold well in China and the market share is over 50%. The National Blower Research Institute and Fan Quality Supervision and Inspection Center are in SBW. The performance indicators of compressors developed and manufactured by SBW using imported foreign technology are far ahead of the world. Shenyang Transformer Research Institute is a state-level transformer testing center. Dalian Heavy Industry Group Co., Ltd., restructured with the merger of 2 large groups having great influence, is one of the 520 key enterprises in China. After several years of development, Dalian Heavy Industry Group has occupied a leading position in China. It is the most competitive enterprise in China's heavy machinery industry, with the highest operating efficiency and the largest operating scale. Dalian Machine Tool Group Corporation is good in overall operating efficiency; especially in the modular machine tool and automatic production line industry, it is in the top row in China both in the aspects of production efficiency and ability of research and development. It's important to emphasize that the sales modular machine tool has been in the vanguard in the whole machine tool industry in China.

c) *The industrial structure is constantly optimized*

46. In recent years, with a good equipment manufacturing base, Liaoning has been focusing on the development of a number of high-end equipment products, the proportion of high-end equipment manufacturing accounting for the equipment manufacturing industry increases from 10% in 2010 to 16.2% in 2015, and the industrial structure has been further optimized and upgraded. The aerospace equipment industry has made progress in the field of civil aircraft development, general purpose whole aircraft manufacturing, subcontract production of aero-engine parts, aviation parts production, gas turbine development, aerospace technology application and other fields, and the industrial chain has been extended. The new energy automotive industry, covering battery electric vehicles, plug-in hybrid electric vehicles and other whole vehicle series as well as batteries, motors, electronic control systems and other core components, has formed a system of university-industry cooperation and industrialization; The marine engineering equipment products cover a wide range, including jack-up drilling platform, semi-submersible drilling platform, floating production storage and offloading (FPSO), marine engineering ship and other major products, and

industrial technology level has been further improved; The intelligent equipment industry, showing a good development momentum in the aspects of high-end CNC machine tools, flexible manufacturing systems, automation equipment, industrial robots, intelligent instruments and systems and smart grid equipment, ranks among the best in China.

d) Innovation capability continues to strengthen

47. The independent innovation system of equipment manufacturing industry taking enterprises as the main players, aiming at the market and combining industry, university and research institution has been further improved. By 2015, among the equipment manufacturing industry of Liaoning Province, there are 22 state-level and 294 provincial-level enterprise technical centers, with an increase of 155 compared with 2010. The successful development of large number of new products at international advanced level has broken the long-term technical monopoly of foreign enterprises. A lot of new products, such as the 20MW electric-drive long-distance natural gas pipeline compressor unit of SBW, ZZDFPZ-250000/500-800 converter transformer of TBEA Shenyang Transformer Group, 1725mm hot rolled/1650mm cold rolled high performance magnesium alloy plate rolling equipment of Northern Heavy Industries Group and engine cylinder block and head flexible processing automatic production line of Dalian Machine Tool Group Corporation have filled the blankness in China and reached the international advanced level. By 2015, a total of 60 sets of major technical equipment projects in the Province have obtained provincial financial support and effectively promote the industry's innovation and development. 70 national major science and technology projects of high-end CNC machine tools and basic equipment undertaken in the Province have led the industry's development.

e) Agglomeration effect emerges increasingly

48. Liaoning Province, a transportation junction and core area of economic development in Northeast China will become an important growth pole of the new round of national economic development with the strong support of the State. Liaoning has unique geographical features and advantages of natural environment. It is close to South Korea and Japan; and its coastal port cities are also gradually established; the basic and investment environment of core cities have been further improved; the Province's economic and environmental policies and public service environment continue to improve; the development

strategy of “Five Points & One Line”³ and “Two zones and One belt”⁴ gives Liaoning's equipment manufacturing industry new advantages. The development of a number of industrial bases has led to the improvement of industrial concentration of Liaoning's equipment manufacturing industry. Tiexi District of Shenyang becomes the first development demonstration zone of equipment manufacturing industry in China, Panjin's petroleum equipment industry and Chaoyang's new energy industry electrical appliance industry as the characteristic industry bases are included in the China Torch Plan, and Dalian Jinzhou District is listed as one of the national intelligent equipment manufacturing industry demonstration bases in China. The industry clusters of bearing in Wafangdian and auto parts in Dadong, Shenyang are included in the Province's key industrial clusters. In 2015, the equipment manufacturing industry cluster has achieved a total sales revenue of 1088.5 billion CNY, with an average growth rate of 12.6%. The development and expansion of a number of pacesetter enterprises have led to the rapid development and overall upgrading of the industry. In 2015, there are 11 enterprises with a prime operating revenue of more than 10 billion CNY, including Brilliance Auto Group, SAC, DSIC, Shenyang Machine Tool Group, Dalian Machine Tool Group, Northern Heavy Industries Group and CRRC Dalian Company, and that of Brilliance Auto Group is more than 150 billion CNY.

f) *There is a decline in growth of economic efficiency indicators of key industries*

49. In 2016, the industrial value added of enterprises above designated size in Liaoning's equipment manufacturing industry falls by 11.7%, the prime operating revenue is 745.73 billion CNY, with a year-on-year decrease of 26.3%; in 2016, the industrial profit of enterprises above designated size in Liaoning is 31.92 billion CNY, with a year-on-year decrease of 35.2%; the profits and taxes are 59.72 billion CNY, with a year-on-year decrease of 27.7%. In 2016, the prime operating revenue of Liaoning's metal cutting machine tool industry is 33.33 billion CNY, with a year-on-year decrease of 17.7%, and the industry loss is 1.15 billion CNY. The output of metal cutting tools is 92,492 units, with a year-on-year

³ "Five Points & One Line" is the coastal development strategy of Liaoning. Hereinto, "Five Points" means five key areas, that is, port-centered industrial zone in Dalian Changxing Island, Coastal Industrial Base of Liaoning (Yingkou), Coastal Economic Zone of Jinzhou Bay in Western Liaoning (including Jinhai Western Industrial Park and North Port Industrial Zone of Huludao), port-centered industrial park of Dandong, and Dalian Huayuankou Industrial Park. "One Line" means the coastal road of a total length of 1443 kilometers from Dandong to Suizhong Huludao.

⁴ "Two Zones & One Belt" refers to two accumulation zones of equipment manufacturing industry and one industrial belt of ship and marine engineering and supporting. Hereinto, one "Zone" relies on Dayaowan Port and bonded functions and focuses on the development of overall vehicle support; another "Zone" relies on the resources of the deep water coastline along the north shore of Dalian Bay and focuses on the large-scale equipment and components. "One Belt" relies on the deep-sea coastline of Bohai Sea and focuses on the development of shipbuilding industry

decrease of 3%, of which the output of CNC machine tools is 6,8197 units, with a year-on-year increase of 10.5, and the product CNC rate is 73.7%, 10.5 percentage points higher than the same period last year. The industrial added value of automobile manufacturing industry declines slightly and the passenger car production increases significantly. Throughout the year, the industrial added value of automobile manufacturing industry drops by 0.2% year on year. The automobile output is 1.132 million units, dropped by 3% year on year, of which the passenger car production is 675 thousand units, increased by 11.2% year on year. The sales revenue of the automotive industry is 270.67 billion CNY, dropped by 0.8% compared with the same period last year, with a total profit of 19.16 billion CNY, dropped by 20.2% compared with the same period last year. The production of shipbuilding industry is stable and the industry continues to suffer losses. In 2016, the shipbuilding completion is 5.373 million tons, with a year-on-year increase of 15.2%, maintaining a positive growth for 7 consecutive months; the holding order is 13.63 million deadweight tons, dropped by 7.1% compared with the same period last year. The prime operating revenue of the Province's 8 key enterprises is 46.56 billion CNY, dropped by 11.2% compared with the same period last year, with a loss of 2.2 billion CNY.

2. Internationalization of Liaoning's equipment manufacturing industry

a) Export of equipment manufacturing industry

- 50.** The equipment manufacturing industry is not only an important support and source of Liaoning's economic growth, fiscal revenue and employment opportunities, but also the main force in creating exports. In 2014, the export value of Liaoning's equipment manufacturing products amounted to 11.8 billion US dollars, accounting for 20% of the Province's total exports. In recent years, the export delivery value of Liaoning's equipment manufacturing industry is relatively stable and accounts for 40%-50% of the total export delivery value of all industrial enterprises above designated size. However, what can't be ignored is that the growth rate of the export delivery value of equipment manufacturing industry in Liaoning has shown a downward trend. In 2015 and 2014, the export delivery value of Liaoning's equipment manufacturing industry dropped by 3.7% and 4.2% year on year respectively.
- 51.** In the process of Liaoning's equipment manufacturing industry participating in the international market, the situation of each subdivision industry is quite different. In recent years, the transportation equipment manufacturing industry, large in foreign trade scale and high in growth rate, accounts for a large proportion of the export delivery value of the equipment manufacturing industry, followed by communication equipment, computer and other electronic equipment manufacturing industry.

Table 9: Export delivery value of all sectors of equipment manufacturing industry in Liaoning (2015)

Sectors	Sales value (100 million yuan)	Export (100 million yuan)	Proportion of export delivered to Sales value
Electrical, mechanical and equipment manufacturing industry	1301.50	111.06	8.53%
Transportation equipment manufacturing industry	1012.43	255.00	25.19%
Metal products manufacturing industry	1132.26	65.64	5.80%
Computer, communications and other electronic equipment manufacturing industry	573.34	218.74	38.15%
General equipment manufacturing industry	2302.20	157.38	6.84%
Instrumentation and culture, office machinery manufacturing industry	160.21	21.87	13.65%
Special equipment manufacturing industry	1514.03	87.76	5.80%

Source: China Industrial Statistics Yearbook(2016).

b) Foreign trade structure of equipment manufacturing industry

52. The foreign trade structure of Liaoning's equipment manufacturing industry includes commodity structure, regional structure, trade mode structure, trade participant structure and so on. In different periods, the foreign trade structure presents different characteristics. Take 2014 as an example. In terms of exports structure of equipment manufacturing industry, ship products takes a large part according to the statistics of Shenyang Customs. The ship exports is 5.15 billion USD, with a year-on-year increase of 21.4%, accounting for 36% of the entire equipment manufacturing industry exports. In terms of the regional structure of exports, it mainly exports to Hong Kong, Japan, ASEAN, EU and the United States, which accounts for 66% of the total exports of Liaoning's equipment manufacturing products in 2014. In terms of the trade mode structure, the export of equipment manufacturing industry products in Liaoning by way of processing trade is 9.28 billion USD, with a year-on-year increase of 21.7%, accounting for 64.8% of the total, and that by way of general trade is 3.81 billion USD, with a year-on-year increase of 26.8%. In terms of the exporter structure of equipment manufacturing industry, the exports of foreign-invested enterprises is 7.03 billion USD, with a year-on-year increase of 18.3%, accounting for 49.1% of the total, that of state-owned enterprises is 4.96 billion USD, with a year-on-year increase of 31.3%, and that of private enterprises is 2.07 billion USD, with a year-on-year increase of 25.6%.

c) Overseas investment of Liaoning's equipment manufacturing industry

53. By the end of 2015, the overseas direct investment of Liaoning's equipment manufacturing industry amounts to 4.3 billion USD, accounting for 21.7% of the provincial total; there are a total of 451 approved and registered projects, accounting for 22.3% of the provincial total. In the first half of 2016, the overseas investment of equipment manufacturing industry reaches 0.93 billion USD,

accounting for 38.3% of the provincial total; there are a total of 26 approved and registered projects, accounting for 23.6% of the provincial total. The investment concentrates in the mining, manufacturing and metallurgical industries, mainly in ASEAN, Central Asia, Europe and North America as well as Africa.

d) *Enterprises' participation in international competition*

54. During the "12th Five-Year Plan" period, Liaoning has made full use of "both the domestic and international markets and resources" and accelerated the implementation of "going global" strategy in its equipment manufacturing industry, some strength-based enterprises are active in the international market competition. For example, TBEA Shenyang Transformer Group has made full use of international and domestic markets in recent years to actively carry out international strategy while working on China's electric power construction. Currently, it has 27 overseas offices in the world, and its products are sold to more than 30 countries and regions. It has launched factory construction in India, completed the high-end products export to the United States, Canada and Russia, and achieved a huge leap forward from "providing equipment to China" to "providing equipment to the World". At present, some equipment manufacturing enterprises in various areas in Liaoning have been accepted by the international market. With improving reputation, these enterprises already have a strong strength and favorable conditions to "going global".

e) *Foreign investment projects*

55. Northern Heavy Industries Group acquired the Robbins Company at the price of 156 million USD to develop tunneling equipment and ancillary equipment project. Upon its completion, it is expected to drive exports of 2 billion USD within 10 years. Based on the overseas development model of "product + service + technology + investment", CRRC Dalian Company got an order of 232 diesel rolling stocks in South Africa with a total amount of 904 million USD, creating the record of China's highest value in single order of diesel rolling stocks. Shenyang Yuanda Group and Stone India, India's largest rail transportation manufacturing company, entered into a joint venture agreement, planning to invest 200 million CNY for the establishment of India's largest elevator manufacturing enterprise. Shenyang Lianli Copper Company and Ordabasy Group of Kazakhstan entered into a cooperation framework agreement, planning to invest a total investment of 800 million USD for the copper resources comprehensive development and smelting project. Anshan Haicheng Petroleum Machinery Group and the government of Republic of Bashkortostan entered into a cooperation agreement, planning to invest a total investment of a total of 300 million USD for the construction of petroleum equipment manufacturing industrial park. At present, the planning of 2 sq. km zone (Phase 1) has completed. Brilliance Automobile Group has set up a whole vehicle

production base in Egypt. Shenyang Wellhope Agri-Tech Group has established 3 production plants in Russia and Nepal. The key overseas investment projects of these manufacturing enterprises have explored new ways, accumulated new experiences and provided typical demonstrations for manufacturing enterprises in Liaoning Province foreign in overseas investment and participation in international development and broadened the space of international cooperation in capacity and equipment manufacturing.

3. Problems in the Development of Liaoning's Equipment Manufacturing Industry

56. The development of equipment manufacturing industry in Liaoning faces with slow growth, insufficient investment in innovation, low industry levels, a large proportion of middle and low-end equipment products and other problems. Compared with the advanced level of the world, as for the equipment manufacturing industry, there is a great gap in the aspects of organizational structure, innovation ability, product quality and brand and there is an urgent demand for industrial transformation and upgrading. The related infrastructure and service system construction for the equipment manufacturing industry development are to be strengthened and improved.

a) Relatively low efficiency and effectiveness

57. Although Liaoning equipment manufacturing industry occupies a dominant position in China and has unique geographical advantages and adequate human and material resources, judging from efficiency and effectiveness, the gap between Liaoning and other provinces and municipalities remains relatively large, and there are still many areas that need to be further improved. By the end of 2014, there are 4,823 enterprises above designated size in equipment manufacturing industry in Liaoning, and the major economic indicators are as follows: the total industrial output value, sales income and total profits are respectively 1248.36 billion CNY, 358.268 billion CNY and 62.503 billion CNY, and the average enterprise industrial value added, sales income and total profits are respectively 263 million CNY, 74 million CNY and 4.93 million CNY. While in the same period, there are 19,113 enterprises above designated size in equipment manufacturing industry in Jiangsu, the total industrial output value, sales income and total profits are respectively 6,008.954 billion CNY, 5,937.853 billion CNY and 383.815 billion CNY, and the average enterprise industrial added value, sales income and total profits are respectively 314million CNY, 311 million CNY and 6.46 million CNY, which is respectively 1.19 times, 4.2 times and 1.31 times of that of Liaoning. Judging from the main statistical indicators, Liaoning accounts for a considerable proportion in China (see Table 2), especially in the two major industries of special equipment manufacturing and

general equipment manufacturing. The industry sales value, prime operating revenue and total profit of Liaoning's general equipment manufacturing ranks No.3 in the whole country; as for its special equipment manufacturing industry, the total product assets ranks the fourth, the industry sales value and total profit rank the fifth. As for the computer, communications and other electronic equipment manufacturing industry, the overall scale and efficiency are inferior, with the industry sales value, prime operating revenue and total profit ranking the fifteenth in China.

Table 10: Indicators and rankings of Liaoning's equipment manufacturing industry Unit: 100 million RMB

Index		Metal products manufacturing industry	General equipment manufacturing industry	Special equipment manufacturing industry	Transportation equipment manufacturing industry	Electrical, mechanical and equipment manufacturing industry	Computer, communications and other electronic equipment manufacturing industry	Instrumentation and culture, office machinery manufacturing industry
Sales Value of Industry (100 million yuan)	Liaoning	1899.25	3968.53	2238.24	1080.75	2101.92	889.77	224.03
	China	36612.45	47159.91	35039.02	18655.82	66921.57	85274.75	8286.27
	Ranking	6	4	5	6	9	17	9
Export Value (100 million yuan)	Liaoning	79.97	209.01	265.54	260.05	126.99	259.5	17.9
	China	3836.85	5173.75	3228.73	3511.07	9885.05	46165.14	1240.52
	Ranking	9	6	5	6	10	16	7
Total Assets (100 million yuan)	Liaoning	1106.7	2756.72	2208.96	2210.82	1372.52	829.76	208.54
	China	26013.06	39798.84	33724.19	21112.58	52333.16	59973.73	7309.82
	Ranking	6	5	5	2	9	15	9
Revenue from Principal Business (100 million yuan)	Liaoning	1894.04	3332.34	2193.76	1080.17	2127.93	915.55	222.27
	China	36396.44	39522.45	34826.39	18158.64	66977.77	85486.3	8347.58
	Ranking	6	4	5	5	9	17	9
Selling Expenses (100 million yuan)	Liaoning	35.93	103.75	48.15	11.02	49.77	19.59	7.16
	China	726.2	1329.17	1024.32	317.38	2355.86	1862.26	306.32
	Ranking	8	5	8	11	10	14	10
Total Profits (100 million yuan)	Liaoning	82.63	215.19	95.71	52.62	91.44	66.1	21.54
	China	2160.8	3149.34	2261.53	1079.27	4162.98	4282.57	720.76
	Ranking	8	5	8	7	10	15	8
Number of Unprofitable Enterprises(unit)	Liaoning	4.6	20.87	10.53	6.23	7.26	3.51	1.54
	China	87.77	173.16	219.92	115.09	316.5	315.81	21.51
	Ranking	7	2	8	7	9	14	5
Annual Average Employees(10000 persons)	Liaoning	16.97	38.65	17.64	11.29	16	8.15	2.64
	China	380.12	489.62	355.02	193.32	637.82	906.59	106.93
	Ranking	7	5	6	7	11	19	11

Source: China Industrial Statistics Yearbook (2016).

b) The system of specialized labor division and cooperation is unsound, and the system integration capability is relatively low

58. The industrial ecology of equipment manufacturing in Liaoning is unsound; the upstream and downstream of the industrial chain has not yet been got through completely, leading that the role of enterprises and market allocation of resources can't be brought into play better. The equipment manufacturing industry faces the problems of uneven development in the industrial chain and lack of resource sharing, which restricts the industry from upgrading to the high-end. The current situation of major subdivision industry chains is that there are

some leading enterprises, many of which are of tens of billions CNY and some even have world-class brand and discourse rights. However, the small and medium-sized enterprises are at the bottom of the industry chain, with relatively small scale, weak technology and poor equipment and lack of self-upgrading capability, and it is difficult to support the breakthroughs of the industry evolving to the high-end. Thus, the local basic materials, parts and components industry is undeveloped, and a large number of key materials and basic components need to be outsourced or imported. At the same time, it is difficult for specialized service enterprises to get in the supply chain of manufacturing enterprises, and can't form the pattern of integrative development of producer services and equipment manufacturing.

c) Crucial techniques and high-end equipment are highly dependent on foreign countries

59. The equipment manufacturing industry has problems such as high dependence on foreign products and techniques, inadequate development of high-end equipment manufacturing and low value added of products. The comparative advantage of equipment manufacturing industry value chain is mainly in the final assembly link, and on the whole, it is in the stage of equipment processing base rather than equipment manufacturing base. Some techniques of the equipment manufacturing industry are world-leading, but the complete equipment is at the middle and low-end level. There is a lack of joint research and development and results sharing in materials, machinery, electrical, hydraulic and other basic and generic technology of equipment manufacturing due to the division of labor for a long time. Foreign countries control key components – most supporting key components of high added value are purchased from European and American enterprises, becoming a bottleneck for industry evolving to the high-end. The lack of core components, materials and manufacturing processes, system design, etc. eventually results in inadequateness of product performance and reliability.

d) The state-owned economy is high in proportion, and the system and mechanism are not flexible

60. In the process of the development of Liaoning's equipment manufacturing industry, a lot of large and small state-owned equipment manufacturing enterprises have been established. In the early stage of its development, the state-owned enterprises did play a leading role, e.g. SAC, Shenyang Machine Tool Group and other large ones, and had made great contributions to China's socialist construction. However, with the deepening of China's socialist market economic system reform, it shows a great incompatibility between the traditional state-owned enterprises and the market economy; therefore, the upsurge of state-owned enterprise reform has been raised all over the country. In this

regard, the reform of state-owned enterprises in Liaoning's equipment manufacturing industry is relatively slow.

61. In 2015, the state-owned capital accounts for 34.5% of the paid-in capital of Liaoning equipment manufacturing industry, while Hong Kong, Macao and Taiwan capital and foreign capital together account for 14.5%. The state-owned capital accounts for 8.6% of the paid-in capital of national equipment manufacturing industry, while Hong Kong, Macao and Taiwan capital and foreign capital together account for 26.9%. The state-owned capital accounts for less than 5% of the paid-in capital of equipment manufacturing industry in Guangdong, Jiangsu, Zhejiang and other south-east coastal provinces, while Hong Kong, Macao and Taiwan capital and foreign capital together account for more than 40%. Thus, the state-owned proportion of equipment manufacturing industry in Liaoning is obviously higher than the national average, and much higher than that of China's south-east coastal provinces. As to large-scale joint-stock equipment manufacturing enterprises in Liaoning, the proportion of state-owned holding is even surprisingly high. For example, the state-owned shareholding ratio of Shenyang Machine Tool Group is more than 90%, that of SBW is more than 75%, that of Brilliance Automotive Group is more than 50%, and that of Dalian Shipbuilding Industry Corporation is close to 45%. The high proportion of the state-owned economy in Liaoning's equipment manufacturing industry leads to the slow development of market economy and restricts the vitality of equipment manufacturing enterprises. Especially compared with coastal cities and economically developed areas, there is a big gap in the awareness of opening-up and the sense of competition. It also leads to the lack of scientific management of enterprises, which can't provide advanced technology and equipment applications with ideal supporting conditions, making research and development, production, marketing and after-sales service can't have a coordinated development.

Table 11: Paid-in capital structure of the equipment manufacturing industry in China (2015)

Sectors	paid-in capital	Proportion (%)					
		State capital	Collective capital	Corporate capital	Personal capital	Capital of Hong Kong, Macao and Taiwan	Foreign capital
Special equipment manufacturing industry	6958	14.9	1.4	32.0	32.3	5.4	13.9
Electrical, mechanical and equipment manufacturing industry	12242	5.5	1.8	36.0	38.9	6.4	11.3
Transportation equipment manufacturing industry	343	60.8	0.3	30.4	3.8	0.4	4.4
Metal products manufacturing industry	6610	6.5	1.6	27.6	46.5	7.9	9.9
Computer, communications and other electronic equipment manufacturing industry	13990	8.0	2.3	31.8	11.5	16.8	29.2
General equipment manufacturing industry	8140	8.5	1.4	33.2	33.9	5.4	17.6
Instrumentation and culture, office machinery manufacturing industry	1525	8.5	1.3	30.4	36.4	9.3	15.0
Equipment manufacturing industry	49808	8.6	1.8	32.5	30.2	9.3	17.6

Source: China Industrial Statistics Yearbook (2016).

Table 12: Paid-in capital structure of the equipment manufacturing industry in Liaoning (2015)

Sectors	paid-in capital	Proportion (%)					
		State capital	Collective capital	Corporate capital	Personal capital	Capital of Hong Kong, Macao and Taiwan	Foreign capital
Special equipment manufacturing industry	345	27.5	0.3	34.1	18.1	0.1	19.9
Electrical, mechanical and equipment manufacturing industry	247	4.4	3.3	39.7	31.4	2.4	18.9
Transportation equipment manufacturing industry	3822	42.8	1.0	28.8	17.1	2.2	8.1
Metal products manufacturing industry	224	6.8	2.5	34.2	28.5	13.3	14.8
Computer, communications and other electronic equipment manufacturing industry	245	8.0	0.4	47.8	6.0	19.9	16.2
General equipment manufacturing industry	481	18.7	1.4	30.1	27.6	1.9	20.3
Instrumentation and culture, office machinery manufacturing industry	42	4.2	1.3	28.4	43.7	1.5	20.9
Equipment manufacturing industry	5407	34.5	1.1	30.9	19.0	3.3	11.2

Source: China Industrial Statistics Yearbook (2016).

e) Internationalization level needs to be further improved

62. Although the equipment manufacturing industry in Liaoning has made remarkable achievements in the process of outward foreign direct investment

with its unique regional characteristics, economic conditions and trade characteristics, there are also many problems. In 2011, the net growth rate of outward foreign direct investment of the equipment manufacturing industry in the Province was 33.8%, which slowed down year after year and dropped to a negative growth range. In the recent five years, the net outward FDI of equipment manufacturing industry accounted for 6.8%, 9.4%, 9.9%, 6.7% and 7.8% respectively of the total net outward FDI in the province. The proportion picks up after the drop, but shows a slow recovery trend. The "going global" of Liaoning equipment manufacturing industry encountered a bottleneck.

63. Enterprises engaged in outward foreign direct investment is short of vitality. The enterprises engaged in outward foreign direct investment in Liaoning are mostly strong state-owned large enterprises, the proportion of overseas investment of which is 65%. Relatively speaking, the proportion of private enterprises in outward foreign investment and cooperation is relatively low - 30% only. The inefficient allocation of a large number of state-owned assets and the aging state of production equipment lead to lower production efficiency, and the enterprises are at a disadvantage in the market competition.

64. The value added of key links in the industrial chain is not high enough. The industry chain is made up of different interlocking chains. Enterprises do not only provide products but also involve R&D, design, service and so on. These are the factors that improve the level of product specialization and value added of products. The value added of production links in Liaoning's equipment manufacturing industry is low, which is at the low end of the "smiling curve". The R&D innovation needs to be improved, and the high-end service such as R&D and planning is still in its infancy.

65. The foundation of international cooperation remains to be consolidated. The "going global" of Liaoning's equipment manufacturing industry and cooperation with international enterprises are still at the initial stage, and it also faces obstacles and challenges from the environment, institution, technology, culture and so on. The state-owned enterprises account for a large proportion of Liaoning, their operation system becomes rigid seriously, and they are short of experience in the international market competition.

f) *The level of technological innovation is low*

66. Technological innovation plays a key role in the development of equipment manufacturing industry. R&D expenditure is a core indicator used to evaluate technological innovation capability and the level of the technological innovation input in China's R&D spending. In 2014, the research spending of Liaoning's equipment manufacturing industry is 26.34 billion CNY, accounting for 7.3% of

the national total, only about 30% of that of the top provinces. In 2014, there are 31,032 scientific research projects in the manufacturing industry of Liaoning Province, with an expenditure of 17.536 billion CNY. These two indicators are 17.2% and 6% of the national total and in the middle of the national rankings, but it is far from enough. In 2014, the enterprise technology import expenditure in China is 49.631 billion CNY and the expenditure for technology absorption is 17.65 billion CNY, which falls behind of developed countries. It can be seen that there is still deficiency in technology innovation in Liaoning's equipment manufacturing industry. The number of patent applications is also an important indicator of technological innovation. In 2014, the large and medium-sized industrial enterprises in Liaoning have applied for 4,468 patents, including 1,596 invention patents and 2,761 available patents, accounting for 2.3%, 1.9% and 1.77% in China respectively. This also shows Liaoning's lack of independent innovation capability in the field of equipment manufacturing, which is mainly attributable to the lack of technological innovation factors.

g) *The degree of informatization is not high enough*

67. In January 2016, the Machinery Industry Information Research Institute issued the *China (Fully-covered Range) Equipment Manufacturing Industry Regional Competitiveness Evaluation Report (2014)*. The report gives an evaluation of the regional competitiveness of the equipment manufacturing industry, including four important aspects, namely scale & strength, economic efficiency, internationalization level and innovation ability. In the range of equipment manufacturing industry, the full-covered range used in the report is beyond the traditional division. According to the traditional division, the equipment manufacturing industry includes metal products industry, general equipment manufacturing industry, special equipment manufacturing industry, automobile manufacturing industry, railway, marine, aerospace and other transportation equipment manufacturing industry, manufacture of electrical machinery and apparatus, manufacture of measuring instruments and machinery, as well as investment products and some products with dual attributes of consumption and investment in the metal products, machinery and equipment repair industry. While in the full-covered range, it includes not only the traditional division of equipment manufacturing industry, but also the investment products in the computer, communications and other electronic equipment manufacturing industry. Therefore, expanding to the full-covered range makes the evaluation better reflect the regional development of the information equipment manufacturing industry and the level of information, digital, intelligent and high value-added technology integration of the equipment manufacturing industry. However, the development of information equipment manufacturing industry and the capability of equipment manufacturing industry carrying information

technology in Liaoning are not enough, and the deep integration of informatization and industrialization needs to be improved.

Table 13: Evaluation ranking of Liaoning and other provinces (municipalities) in the full-covered range of equipment manufacturing industry

Ranking	Scale strength		Economic efficiency		Innovation ability		International Competitiveness	
	Full aperture statistics	Traditional aperture statistics	Full aperture statistics	Traditional aperture statistics	Full aperture statistics	Traditional aperture statistics	Full aperture statistics	Traditional aperture statistics
1	Jiangsu	Jiangsu	Jilin	Jilin	Beijing	Beijing	Guangdong	Guangdong
2	Guangdong	Shandong	Shandong	Shandong	Jiangsu	Jiangsu	Jiangsu	Jiangsu
3	Shandong	Guangdong	Shanghai	Shanghai	Zhejiang	Zhejiang	Shanghai	Zhejiang
4	Zhejiang	Zhejiang	Jiangsu	Jiangsu	Anhui	Guangdong	Zhejiang	Shanghai
5	Henan	Liaoning	Tianjin	Henan	Guangdong	Anhui	Shandong	Fujian
6	Shanghai	Henan	Henan	Beijing	Shanghai	Shanghai	Fujian	Shandong
7	Hubei	Anhui	Beijing	Jiangxi	Shandong	Shandong	Sichuan	Liaoning
8	Liaoning	Shanghai	Liaoning	Hubei	Sichuan	Sichuan	Tianjin	Anhui
9	Anhui	Hubei	Anhui	Chongqing	Shanxi	Shanxi	Chongqing	Tianjin
10	Sichuan	Hebei	Hubei	Liaoning	Liaoning	Liaoning	Henan	Jiangxi

Source: Evaluation report on regional competitiveness of China (Full aperture statistics) equipment manufacturing industry (2014).

D. Sea- Rail Multimodal Transportation

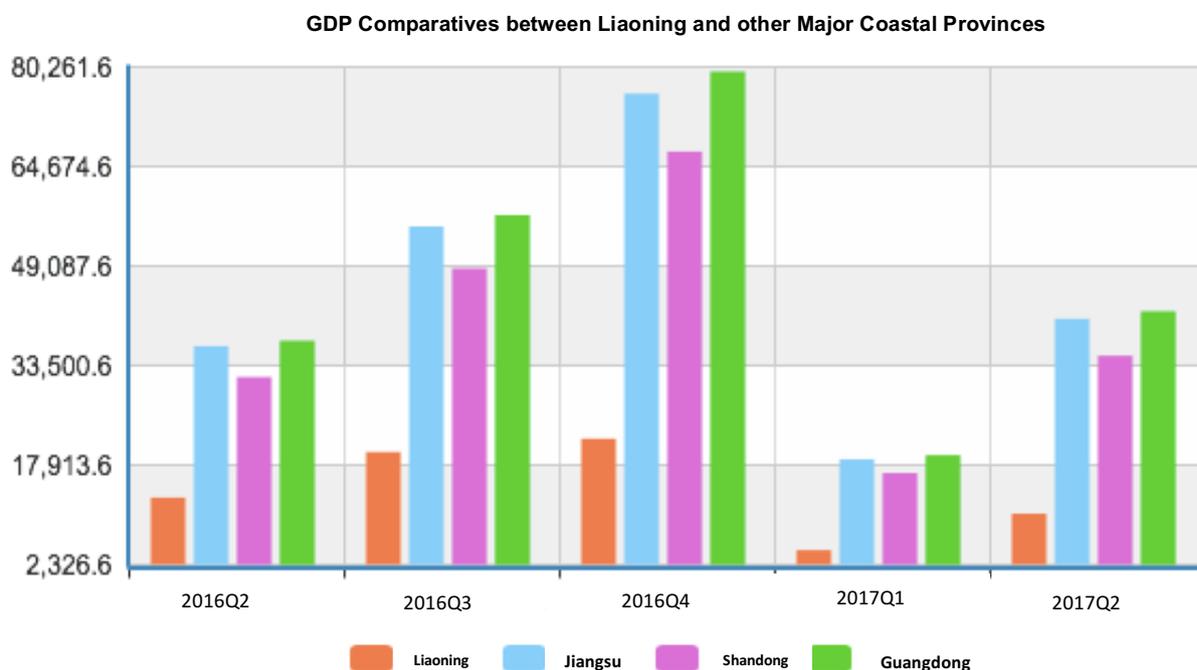
- 68.** China has entered a period of “new normal” where its economic growth rates have gradually moderated (annual GDP growth of 7%) from the previous high speed (annual GDP growth higher than 10%), now driven by innovations in production factors, investments and structural reforms. It’s a safe assumption that the “new normal” of China’s economy has become a major feature of China’s economic development, thus, a macroeconomic context to review Liaoning’s economic development. The revitalization of Liaoning is not only of high relevance to the regional development of NEA but also a vital part of China’s economic growth.
- 69.** Given the global economic meltdown and China’s economic slowdown, Liaoning’s development is facing an even steeper downward spiral, featuring drastic drop of economic growth rate, and insufficient supply. Deeply-rooted constraints that have long hindered the province’s development, institutional defects, under-served market, undesired environment for innovations and startups, no concrete reforms for SOEs, a fixed mindset, poor private sector, persisting economic structural conflicts, traditional industries becoming less competitiveness, under-developed emerging and modern service industries that are strategically important, stressed national resources supply, lack of R&Ds and talents, insufficient scientific transformations, lack of good governance and capacity building, etc., to just name a few.
- 70.** Data from national and provincial bureau of statistics clearly indicates an economic downturn in Liaoning, turning to a negative growth by 2016. GDP growth stood at 2.6%, 6.1% and 5.1% for Liaoning, Jilin and Heilongjiang respectively, all lower than the national average level with Liaoning ranking as the tail ender. The figure turned to a negative 1% for Liaoning in the first half year of 2016 and further slide into -2.5% by year end. The province’s economic growth rate still ranked at the very bottom till Q2 of 2016, and finally turned around to a positive 2017Q1.

Table 14: GDP Growth Rates 2016 to 2017Q1 for 31 Provinces and Cities

GDP Growth Rates 2016 to 2017Q1 for 31 Provinces and Cities					
Provinces and Cities	Rank	2017Q1 GDP growth rate	2017Q1 GDP (100 million RMB)	2016Q1 GDP growth rate	Annual GDP growth of 2016
Tibet	1	11.0%	27.135	10.7%	10.0%
Chongqing	2	10.5%	430.674	10.7%	10.7%
Guizhou	3	10.2%	250.483	10.3%	10.5%
Yunnan	4	9.9%	311.566	6.6%	8.7%
Jiangxi	5	9.0%	431.860	9.1%	9.0%
Hainan	6	8.9%	105.639	9.7%	7.5%
Fujian	7	8.6%	653.519	8.3%	8.4%
Ningxia	8	8.6%	58.810	6.9%	8.1%
Anhui	9	8.4%	582.680	8.6%	8.7%
Sichuan	10	8.2%	755.200	7.4%	7.7%
Shaanxi	11	8.1%	414.722	7.6%	7.6%
Tianjin	12	8.0%	466.718	9.15	9.0%
Henan	13	8.0%	939.222	8.2%	8.1%
Zhejiang	14	8.0%	1055.200	7.2%	7.5%
Guangdong	15	7.8%	1943.805	7.3%	7.5%
Shandong	16	7.7%	1665.330	7.3%	7.6%
Qinghai	17	7.6%	52.401	8.3%	8.0%
Hubei	18	7.6%	725.406	8.1%	8.1%
Xinjiang	19	7.6%	179.185	6.9%	7.6%
Hunan	20	7.4%	705.110	7.3%	7.9%
Inner Mongolia	21	7.2%	374.220	7.2%	7.2%
Jiangsu	22	7.1%	1882.260	8.3%	7.8%
Beijing	23	6.9%	604.050	6.9%	6.7%
Shanghai	24	6.8%	692.284	6.7%	6.8%
Hebei	25	6.5%	751.240	6.5%	6.8%
Guangxi	26	6.3%	390.953	7.0%	7.3%
Gansu	27	6.1%	138.875	7.3%	7.6%
Heilongjiang	28	6.1%	279.800	5.1%	6.1%
Shanxi	29	6.1%	280.940	3.0%	4.5%
Jilin	30	5.9%	268.343	6.2%	6.9%
Liaoning	31	2.4%	457.470	-1.3%	-2.5%

Source: Reports from NPC & CPPCC issued by local governments and local Bureau of Statistics

Figure 10: GDP Comparatives between Liaoning and other Major Coastal Provinces



*Source: National Bureau of Statistics
Unit: 100 Million RMB*

71. Although challenged by many difficulties and drastic difference in economic scale from the other coastal provinces, there are still potentials given the province’s economic foundations and conditions. Growth is observed in the province’s emerging and service industry benefiting from a sound industrial and equipment foundation. Therefore, Liaoning shall transform from the traditional development mindset based on its structural reforms in order to display its full potentials and materialize economic recovery. Standing at the key juncture of transformation, an improved transport system is crucial to the growth of emerging industries and reforms of traditional industries. It’s expected that a well-coordinated and seamlessly connected multi-modal transport system will provide high efficiency and overall advantage in integration. Therefore, to develop Liaoning’s transport system and establish a multi-modal transport becomes a necessary choice for boosting it economic growth.

1. Policies and mechanisms

- 72.** There are quite a number of supporting policies from national and provincial levels, ranging from the strategy of “Revitalization of NEA” , “Shenyang-Dalian Economic Belt” , the “Five Points, One Line” , “Plan on Adjustment and Revitalization of Logistics Industry” and the establishment of Liaoning FTZ, all of which have included the construction and development of transport systems in Liaoning and provided policy guarantee for both the economic and transport development of Liaoning and revitalization of NEA. The NEA Revitalization strategy entails preferential policies to promote transport development in Liaoning, and tax and fiscal policy support to NEA regions. The “Shenyang-Dalian Economic Belt” and “Five Points, One Line” strategy are set to form an economic powerhouse, connecting the economies and social activities of neighboring regions along the Shenyang-Dalian belt. These ambitious schemes shall provide policy guarantee for the economic development in North East China and Bohai Economic Rims. In order to improve sea-rail multi-modal transport and logistical throughput of transport hubs for international commodities, policy emphasis was given to step up infrastructural constructions of multi-modal logistics to serve as transport hubs connecting major ports, international transfer stations that accommodates both containerized maritime shipment and freight, multi-functional international freight stations, international airports, etc.
- 73.** The *Medium and Long-term Railway Network Plan* released by NDRC, Ministry of Transport and China Railway in July, 2016 has clearly outlined priorities to develop a well-connected and modern railway lines and extensions that provide effective supports to the logistics of resource-intensive regions, key ports and logistics parks so as to promote multi-modal transport and a seamless railway connection for the “first and last-mile”. The plan is set to build an international corridor that links inlands with sea-railway multi-modal transport supported by comprehensive railway networks and distribution system connecting coastal cities and key ports in Dalian, Qinhuangdao, Tianjin, Lianyungang, Shanghai, Ningbo, Zhoushan and Shenzhen, etc. Meanwhile, to realize multi-modal transport requires a seamless connection and one-stop service featuring highly efficient transport hubs for freights, container shipments, distributions and international multi-modal transport. In December of the same year, the Ministry of Transport along with 17 other relevant authorities have co-issued the *Circular of Further Encouraging Multi-Modal Transport*, which highlights an orderly transformation of medium and long distance freights from highways to transport modals such as railways and maritime shipments; further reforms to privatize railway freights, innovations on the management and organizational models of railway freights; establishing and improving a pricing mechanism that fully reflects market demand and supply, competitiveness and quality services.

74. The circular gave clear directions for the development of Liaoning's multi-modal transport. In its *Development Plans for National Economy and Social Development* in 2015 and 2016, Liaoning strategized to live its obligations under "OBOR" by fully utilizing the China-Europe container trains and speeding up the construction of Maritime and Overland Logistical Channel. Meanwhile, it will push forward projects along the railway lines of China-Europe container networks to facilitate sea-rail multimodal transport. Enterprises are encouraged to set up product sales centers and industrial parks with international businesses partners to facilitate trade with Russia and Mongolia. Liaoning will actively participate in building Sino-Korea FTZ so as to expand business opportunities with Russia, ASEAN, Africa, South America and Pacific Islands.
75. In terms of regional cooperation, Liaoning strengthens economic ties with nations along the China-Mongolia- Russia Economic Corridor. It will actively engage in cross-border logistics to stimulate transit trades by relying on key harbor cities such as Dalian, Yingkou, Jinzhou, Dandong and Panjin. Moreover, Liaoning is committed to promoting cooperation in transport, energy, industries and public services with Bohai Economic Rims in order to play a more active role in RCI. Therefore, to develop sea-rail multi-modal transportation is in compliance with national policies but also the development priority of the province itself as well as Bohai Economic Rims.

2. Infrastructures and natural conditions

76. There are quite a few ports and airports in Liaoning providing plentiful port resources to the province; however, what Liaoning urgently needs is to integrate all these resources. It's challenging to build up a NEA Shipping Center without being equipped with a certain level of scale to accommodate large volumes of freights and shipments. Therefore, Liaoning shall integrate all kinds of resources such as ports, airports and railways so the whole competitiveness of Liaoning's transport can be stepped up and the full potentials of Liaoning's multi-modal transport can be unleashed.

Table 15: Overview on Liaoning's Transportation 2009 to 2015

Overview on Liaoning's Transportation 2009 to 2015								
Indicator		2009	2010	2011	2012	2013	2014	2015
Length of Transportation Routes (km)	Railway mileage	3962	3988	4035	4757	4875	4899	5328
	Highway mileage	101117	101545	104026	104679	110072	114504	119362
	Inner river mileage	813	813	813	813	813	813	813
Freight Volumes (10KT)	Railway	139541	163303	190329	212957	215375	231742	208562
	Highway	18262	18622	18716	17388	20484	19103	14541
	Waterway	105088	127361	151773	174355	172923	189174	172140
Throughput of major costal ports (10KT)		55513	67952	78374	88502	98354	103675	104859
<i>Source: Liaoning Statistical Yearbook 2016</i>								

77. Transport infrastructure was growing steadily given the growing routes' lengths for both railways and highways from 2009 to 2015, but the carrying volumes for railways, highways and waterways are declining from 2014 to 2015 affected by Liaoning's economic downturn (see Table 3). Meanwhile, investment in infrastructure dropped in 2015. However, indicators from January to May 2017 show that the decline in investment is narrowing down while transport and telecommunications sector are continuing a positive growth after a transitioning 2016. Total investment from January to May registered at 44.38 billion RMB, down by 30% year on year but the decline narrowed by 2.7% January to April, among which, investment in postal logistics accounted for 260 million RMB, up by 970%; pipeline 2.7 billion RMB, up by 270%; power and thermal energy production and supply industry 13.89 billion RMB, up by 28.9%, handling services and shipping agents 860 million RMB, up by 1%. It can be concluded that infrastructure construction and investment in Liaoning is steadily moving forward with decline continuing to narrow down for a consecutive 3 months till Aug. 2017.

78. Liaoning has equipped itself with a sound foundation for providing interconnected infrastructure. So far, interprovincial pathways connecting Liaoning with neighboring provinces (regions) have been fully accessible and there are 92 shipping routes supporting container shipment to facilitate trade with over 100 nations and regions. The multi-modal transport project connecting Yingkou, bypassing Manzhouli and reaching Russia and Europe through Eurasia Land Bridge, has been running 5-6 times of railway/shipment per week since its launching in 2008, ranking number 1 in the nation. Exponential growth has been observed in the shipment capacity of sea-rail multi-modal transport since 2012 with an annual growth rate over 50%, taking up 93% of the total container shipment in North East Ports, 50% of the national total, and topping the nation.

Launched in June, 2013, shipment through Dalian-Europe Cross Border Corridor increased by 300%. By the above means, Liaoning is actively building a seaport cluster in Bohai Economic Rims in order to serve as an international hub for logistics and trade in NEA regions.

3. Potential of sea-rail multimodal in transportation system

- 79.** Transport serves as fundamentals to support regional economic growth while developing cross-border multi-modal transport will be a pivotal driver to Liaoning's economic growth. Compared with developed countries, multi-modal transport is still at a developing stage, challenged by a singular development modal, insufficient traffic networks, and low level of professional organizational management, ill-integrated operations and lack of supporting policies, legislation, technical specifications and technologies. Given that and along with the OBOR initiative and China's middle and long-term logistical policies, multi-modal transport will surely embrace quite a number of important opportunities.
- 80.** There are many types of multi-modal transport, including land-bridge, sea-rail, air-bridge, connected by international multi-modal transport routes, such as shipment routes from inland China to Japan, United States, Africa, West Europe and Australia, and Siberia land-bridge routes bypassing Mongolia to Russia, Iran and finally reaching North Europe. Among these types of multi-modal transportation, management and operation of containerized railway transport have been undergoing drastic reforms with railway becoming a major approach of international transportation.
- 81.** As the most commonly applied means among multi-modal transports, sea-rail transport is obviously a more optimized combination of transportation models as both enjoys larger carrying capacity and lower rates compared with a land-air transport model. Besides, a sea-rail combination can fully play the advantage of the preferential shipment rates and higher efficiency of land transport. The sea-rail model's carrying capacity usually takes up 20-40% of TEU throughput in the cases of many developed countries. However, the share is lower in China because China is a late-comer in this regard, even though we have one of the highest TEU throughputs in the world. By 2014, TEU throughput by sea-rail transport has taken up 2% of the total 182 million TEU in China, reaching 4million TEU. Although enjoying a promising future, the slow development of sea-rail modal has not yet fully lived up to its potentials. There have been four key sea-rail routes in China, namely, Dalian-Yingkou port; Tianjin port; Lianyungang-Qingdao; Shanghai port.

82. Although encountering a slow economic recovery in recent years, there are noticeable increases in railway freight and maritime shipment, for example, TEU throughput carried by sea-rail transports in 2016 was up by 23%.

4. SWOT analysis

83. Both sea and rail transport feature large carrying capacity and low freight rates. As an optimized combination of the two ways of transportation, sea-rail multi-modal transportation integrates low cost of sea transport and high efficiency of overland transport. But compared with other countries, China is still at the infant stage. Based on its current development in China, we conduct a SWOT analysis to look into its strengths (S), weaknesses (W), opportunities (O) and threats (T). In the analysis, strengths (S) and weaknesses (W) are categorized as internal factors while opportunities (O) and threats (T) external factors.

a) Strengths

84. First, constantly-improving rail transport capability and network structure. In recent years, China's rail network structure has been constantly improved, which makes it possible to develop container rail-sea intermodal transportation. During the 12th five-year plan period, a total of 3.58 trillion RMB was invested in fixed assets of rail transport, extending rail lines by 30, 500 km. On the basis of the "Four Vertical and Four Horizontal" network and the major layout of rail lines in China, the *Development Plan of Railway during the 13th Five-year Plan Period* proposes to carry out a series of high-speed rail projects that are ready. Meanwhile, governments will continue to increase investments to build new rail lines and renovate old ones. For example, in Liaoning province, according to its 13th five-year plan, it would continue the construction of 15 rail projects, covering a total distance of 1386 km (with 715 km newly built and 671km renovated), with a total investment of 101.5 billion RMB (74.3 for newly built lines and 27.2 for renovated lines). By the end of 2015, 28.3 billion of investment had been made and 14 new projects are expected to commence, covering a total distance of 1589 km (437km newly built and 1152km renovated) with a total investment of 62.7 billion RMB (36.5 for newly built lines and 26.2 for renovated lines).

85. Second, growing importance attached by governments and enterprises. From the perspective of equity and efficiency, governments and enterprises attach more and more importance to rail-sea intermodal transportation and have adopted a series of measures to improve its share in freight carriage. On the basis of existing freight sources, efforts are being made to expand and develop new and non-hinterland sources of freight for leapfrog development of container multi-modal transportation.

b) Weaknesses

- 86.** First, inadequate carrying capability and structure of rail network. Though transport capacity has gradually improved in China, in terms of distribution, flow direction and flow volume of freight, railway container transport is mainly undertaken by the Railway Bureaus in Beijing, Shanghai, Guangzhou, Zhengzhou and Shenyang. The total container volume in these 5 major Railway Bureaus account for more than 70% of the national total, leading to almost full utilization of major rail lines like Beijing-Guangzhou, Beijing-Shanghai, Beijing-Kowloon, Zhejiang-Jiangxi, Beijing-Harbin and Longhai railway. Besides, there is competition over operation lines between container lines and passenger lines and parcel lines, greatly restricting the growth of container intermodal transportation.
- 87.** Second, poor connection between rail transport and sea transport. Currently, most harbor districts are not directly and conveniently connected with railway. Take Shanghai Luchaogang Rail Container Station as an example. It started operation on Dec 9th, 2005, the first among the 18 rail container terminals the country plans to build. However, due to various reasons, no rail line was put into Yangshan Port, where freight from Luchaogang station would be transferred. With 42 km in between, containers must be delivered by container trucks, which not only undermines the advantage of low cost of multimodal transport, but also causes extra times of loading and unloading of containers. Such poor connection between rail transport and sea transport increases costs and impairs display of advantages of rail-sea intermodal transportation in high efficiency and security.
- 88.** Third, lack of professionals. In practice, operation of rail-sea intermodal transportation relies on the application and development of information technology, thus requiring the establishment of an information-based transaction and operation platform. But now China is short of talents in this field, which is another challenge we need to tackle in the future.

c) Opportunities

- 89.** First, large room for development. At present, China's rail-container volume is just about 10 million TEU every year, only 2% of the total, a very small part in the whole picture. Therefore, it is fair to say rail-sea multi-modal transportation enjoys a large space to expand.
- 90.** Second, opportunities brought by transition from port logistics to integrated logistics. Current trend shows ports need to chart out a rail logistics network, apart from roads and waterway transportation, no matter for providing integrated logistics services or advancing stable integrated transport systems, in order to play a dominant role in the integration, improvement and optimization of the whole

logistics chain. Such transition from port logistics to integrated logistics brings great opportunities for intermodal transportation.

d) *Threats*

91. First, service market is yet to be completed. In current stage, market of ship agencies and freight forwarding in China has gradually come into shape. But relatively mature maritime transport service providers can often only be found in coastal cities while service market in inland cities is yet to be nurtured. What's more, lack of a good market climate and a sound competition mechanism also makes it difficult to deliver "door-to-door" service in rail-sea multi-modal transportation.
92. Second, information system is yet to be improved. At present, Cargo Management System and EDI have basically been popularized in China's shipping industry, which makes it possible to connect with information network of customs, trade companies, commodity inspectors, banks, insurance companies and other logistics service providers and enable efficient exchange of information. However, supporting information system is still insufficient for rail-sea multi-modal transportation and cannot realize efficient and effective information-sharing with shipping houses, ports and inspection authorities. Such lag of information exchange hinders efficient management and real-time tracing of containers, causing low efficiency in multi-modal transportation.

Table 16: SWOT Analysis on China's Sea-Rail Modals

	Strengths	Weaknesses
Internal Factors	<ul style="list-style-type: none"> ① Continuous improvement on the carrying capacity of railway and the network structure ② Growing importance attached by governments and enterprises ③ Broad prospects of sea-rail multi-modal transport 	<ul style="list-style-type: none"> ① Inadequate carrying capability and structure of rail network ② Transport risks and differences due to different containers ③ Inadequate services ④ Insufficient infrastructure ⑤ Lack of professional talents
	Opportunities	Threats
External Factors	<ul style="list-style-type: none"> ① A large room for development ② Opportunities brought by transition from port logistics to integrated logistics ③ Vigorous policy support ④ Opportunities brought by OBOR Initiatives 	<ul style="list-style-type: none"> ① Strong competition as opposed to railway ② Incompatible services from third party logistics ③ Underdeveloped information system

93. It's important that we shall develop containerized railway transport, strengthen infrastructure and create a sound clearance platform by fully displaying the advantages of the growing railway capacity and improving road networks in compliance of the OBOR Initiatives based on the SWOT analysis of Table 4. The development of sea-rail multi-model transport shall also seize the window of opportunities brought by strong policy support. Meanwhile, we also need to be aware that some of the weaknesses have cost us quite a few opportunities, which need to be overcome. Under the "threats" column, it's expected road transport enjoys a clear edge in short distance logistics, so the sea-rail model shall avoid a direct competition in this regard and focus on providing medium and long distance transport service considering its strong suits lies in large carry capacity and lower rates. We shall also draw upon the good lessons and avoid external risks by studying on international cases.

5. Current Development of Liaoning's Sea-Railway Multimodal

94. The study summarized on the built or initially completed sea-rail multimodal transport development through a series of analysis of the data and documentations acquired from the Ministry of Transport, statistical bureaus, governments of Liaoning, Dalian, Yingkou, Shenyang and Panjin.

a) Development of three key comprehensive transport channels

95. The development of three key comprehensive transport channels, namely, "Liaoning-Manzhouli-Europe", "Liaoning-Mongolia-Europe" and "Liaoning-Bering Straits-Europe", has achieved breakthroughs under strong support of transport department of Liaoning and built a sea-rail transport network connecting all territories in North East China with Europe. There are three corridors (West, Middle and East) to provide cross territorial container freights in Liaoning based on a categorization of goods supply and exit ports. The West corridor exits from Alataw Pass and attracts exports to Europe from Middle West China. The Middle Corridor exits from Erlian port and attracts exports to Europe from North and Middle of China. The East Corridor exits from Manzhouli and attracts exports to Europe from North East, North China, East China, South China and South West of China. There are 132 multi-modal routes for goods to reach Russia and Hamburg in Germany from 6 regions like Northeast, North China, East China, Middle China, South China and Southwest. The East Corridor can save up to 500-600 USD/carriage and cut the delivery time by half to 15-20 days compared with shipment by waterway only. So generally speaking, the East Corridor enjoys a clear advantage in terms of cost, efficiency and safety, and that's why the "Liaoning-Manzhouli-Europe" channel is growing the fastest.

- 96.** “Liaoning-Manzhouli-Europe” Channel is a sea-rail transport route starting from Dalian, Yingkou, Shenyang, Panjin, reaching the land-bridge in Europe bypassing Russia. Direct railway lines linking cities like Moscow, Warsaw, Minsk, Kaluga and Novosibirsk have been now accessible for container freights.
- 97.** 472 times of train transport for the “Liaoning-Manzhouli-Europe” Channel have accumulatively shouldered 39,000 TEU shipments from Dalian port and Yingkou port, up by 74.9% year on year in the first of 2017. Dalian port has now been linked with 7 cross-border railway lines along the “Liaoning-Manzhouli-Europe “ Channel after ties being established with railway companies in countries such as Russia and Germany. Among the three channels, the “Liaoning-Manzhouli-Europe” is the only route that connects trains to depart from ports, which truly realizes a seamless connection between sea and railway transport. There are 221 trains departing from Dalian port in 2016, which boosted cross-border TEU shipment by 150% and cut the total transportation cost by 46% and time of delivery by 40%. China-Europe freight trains set out from Dalian port have extended to a specialized category of trains like China-Belarus Industrial Park Trains and Samsung Trains, and fully refrigerated container trains, among which, 15% of the freights coming from Japan and South Korea, 3% from South East Asia, 80% from Guangdong, Shanghai, Tianjin and Beijing. Dalian enjoys a geological advantage in promoting sea-rail, air-road and sea-air multimodal transport in order to link with Japan, Korea, South East Asia and Europe. As the nearest port to Northeast China and East Inner Mongolia, Yingkou Port has equipped 11 China-Europe freight lines bypassing Manzhouli port. Setting out 7-8 times every week, this route covers a rail length of 6,500 km and can complete shipment within only 10 days, which has set up a new record for the China-Europe freight lines departing from Yingkou port. Meanwhile, Dalian Customs has been coming up with individualized services and supervision, like setting up timetable for China-Europe freight lines, 24-7 appointment services for clearance, one-stop clearance, hotlines for Q&As, They’ve also enhanced communication with local governments and relevant port authorities to streamline procedures and improve efficiency for clearance.
- 98.** The “Liaoning-Mongolia-Europe” Channel is a railway route connecting Jinzhou port, Panjin port with Choybalsan in Mongolia as its destination, passing through the port of Jengadab. Railways constructions within China have been completed and the 300 km railway lines within Inner Mongolia are still under construction. This channel is set out to be the most convenient passage to link the East inlands of Inner Mongolia with Jinzhou Port and Panjin port, and is destined to drive regional economic cooperation.
- 99.** The first China-Europe freight train has been set out from Panjin port along “Liaoning-Mongolia-Europe” Channel in Northeast China with its destination in Minsk Corrizic City in Belarus in May of 2017. Launching out once a week, the

train cut the delivery time to 16 days, only 1/3 of the delivery time for waterway shipment. It's the third China-Europe freight train line along "Liaoning-Mongolia-Europe" Channel, the first China-Europe freight line passing through Erenhot along "Liaoning-Mongolia-Europe" Channel. It's a new expansion to the Middle Corridor after its launching of trains along the east rail line of "Liaoning-Manzhouli-Europe" Channel linking Panjin Port with Russia. Therefore, the international containerized multi-modal transport in Panjin is supported by multiple route options and two logistic channels.

100. "Liaoning-Bering Straits-Europe" is a newly-opened sea route starting from Dalian port, bypassing Bering Straits and the Arctic Ocean to reach Europe. The merchant vessel "Yong Sheng" owned by COSCO Shipping has already returned from its maiden voyage from Dalian port to Rotterdam Port, passing Arctic routes and Europe's new economic and strategic channels. This route has cut the transport mileage for the original 13,000 km Asia-Europe sea route by 8000 km, down by 35% in mileage and 30% in transport cost.

101. After its first sail, the merchant vessel set out again from Dalian port in May, 2017, passing the North Pole, and returned through the same route. Transport department in Liaoning is working to materialize a regular operation of the sea route that's adaptive to seasonal changes.

102. The establishment of the three international multi-modal transport channels have further facilitated trade and integrations with NEA, Far East Asia such as Russia, European countries, Japan and Korea. In early 2017, over 97.5% of the container freights in North East China are shipped to Japan, Korea and South Asia via Dalian port. The construction of the three channels have not only facilitated Liaoning in becoming the hub for sea-rail transport in NEA, but will also promote the opening up of North East China to a new height and provide new thinking for the revitalization of North East China.

b) Ports Connectivity between Liaoning and Europe

103. Yingkou and Dalian ports have played the most key roles in enhancing connectivity between Liaoning and Europe by sea-rail multimodal transport. As an important port for Northeast China's opening up to the outside world, Dalian port has launched the Northeast No.1 train linking to Harbin as early as the year of 1996; it is the earliest to develop sea-rail transportation. Yingkou port caught up quickly and achieved remarkable progress both in waterway and railway by applying an innovative development modal.

104. Yingkou port spans from Yingkou, Panjin and Huludao and enjoys 5 harbor districts that cover 112 km² of land. It has recently injected investment in building

up Shenyang port and Municipal logistical platform in Liaoning, aiming to develop a comprehensive logistical platform that combines all means of transportation such as waterway, railway, highway and air. The platform will facilitate the logistic interconnectivity among cities as well as urbans and rural areas. Transport volumes by sea-rail model of Yingkou port has topped in China for many years, as the exported TEUs by the “Yingkou-Manzhouli-Europe” route have accounted for more than 90% of the total volumes in NE ports, 45% of the exported TEUs through Manzhouli port. Yingkou port has shipped a total of 526,000 TEUs in 2016, an 22% increase YOY; 33,000 TEU have been transported by “Yingkou-Manzhouli-Europe” freight lines departing from Yingkou port, that’s a 30.8% YOY increase, accounting for 51.3% of the total export volume of Manzhouli Port.

105. As the only port that is not covered by government policy, Yingkou has the busiest direct train schedules providing international shipment services; it carried the largest freight volume from Southeast China through the land-bridge route. There’s no doubt that it has become an important sea portal linking China and Europe, providing necessary routes along the Silk Road Economic Belt and Euro-Asia. China’s first multi-modal transport pilot program – “Container Shipment by Highway-Waterway-Railway Multimodal Transport Program in Liaoning” is based in Yingkou. The program has opened up two logistical access from two directions, namely, a land corridor Yingkou port – Russia – Europe linking east with west, and a sea route Yingkou port – East China and NEA – South China, extending networks to Southwest China and ASEANs linking south with north, the latter of which requires in-depth cooperation with ports along the coast of South China, Yangtze river, Southwest China and ASEAN. The program aims to build Yingkou into a transit hub closest to North China and Europe.

106. In terms of transport capacity, the sea-rail model of transport from Yingkou port is standing at 163, 000 TEU in Q1 2017, a 46.8% increase YOY; 8,300 TEU by China-Europe freight trains, a 59.9 % increase YOY. Yingkou has also tried some new development models. Enterprises led by Shen Ha Hong Yun Logistics Co., Ltd, have pooled in all possible resources and played very active roles in developing a sea-railway multi-model of development. The company has applied for a fixed train schedule with fixed rates and routes for two railway lines “Bayuquan – East of Shenyang” and “Bayuquan – Changchun” from Shenyang Railway Bureau. By relying on the strategic partnership with land ports such as Shenyang, Changchun and Harbin, it comes up with innovative transport model by combining railway lines with extensions, and shipment through multiple points, which has provided new ideas for the development of China Europe Freight Train routes. The company now provides direct lines setting out from Bayuquan to Manzhouli twice a week, which has become one of the efficient and stable logistic routes along the Silk Road Economic Belt. Besides, it extends logistic lines to

multiple train stations to support the development of a North-South logistic route. Thanks to the government support, its shipment lines now can reach train stations in Lishu County, Zhalantun and Laha, etc. After partnering up with COFCO, the company designed shipment lines for open-top containers to reach train stations of Xidong, North of Tongliao and Shulan and saw outstanding market returns from it. The operations of the China-Europe freight trains have followed through the strategic proposals made by Yingkou Port Group. The trains will not only carry passengers but also serve as a safe, convenient and low-cost multi-model logistics option for the Russia Overseas Warehouse Project of Gang Yun Company. They've already provided shipment from Gangyun's warehouse for e-commerce products ranging from electronics, shoes, toys and accessories, which saved logistic cost and delivery time for clients.

107. Dalian has 100 berths for production use, including 74 berths for 10,000-ton-class or above, and a series of mega-deep water berths. It started cooperation with COSCO and opened up access to the Europe market by travelling through the North Pole sea route, bypassing Bearing Strait and reaching the North of Norway. The route will cut the shipment time by 9 days and cost by 30% when compared to those of the traditional routes. It's indeed an express sea route across Artic Ocean.

108. Since 2016, Dalian port opened "Samsung Trains" and "Liaoning-Manzhouli-Europe Trains", which have been serving as multi-model transport options for shipping products like auto parts and components, mechanical equipment and daily commodities from Japan, Korea, South China, East China and North China to reach Europe. Now there are 50 container trains shipping out from Dalian port each week, forming up a distribution network for inland transportation reaching the 3 provinces in North East China and all borders of East Mongolia. Meanwhile, Dalian port is also moving forward with its transformation and upgrading. It attracted investment from FAW Group to become stockholders of the Dedicated Terminal for Automobiles in Dalian port. By doing so, it will become a key transit hub for shipping commercial vehicles of FAW by waterway, which will for sure stimulate another round throughput growth for the port. Dalian port has access to a number of international logistics routes such as "Liaoning-Manzhouli-Europe", "Liaoning-Bering Strait-Europe" and "Dalian-Harbin-Europe", accommodating to multiple ways of transportation such as by sea, railway and highway. Dalian port's annual transport capacity for sea-rail model has reached 406, 000 TEU, a 17% YOY increase. CRIntermodal is the only harbor station that can realize a seamless connection with the ports. Up till early 2017, Dalian Port Group has established nearly 80 international sea routes for container transport, connecting with more than 160 countries and 300 ports to facilitate trade. It has become one of the major transit and sea ports to carry out multi-modal transport.

c) Coordinated development of dry ports and sea ports

- 109.** Although the development of dry port has started since 2013 in Shenyang, it's mainly serving as container warehouses and providing services in logistics, handling of shipments, container loading and unloading, maintenance and cleaning, etc. Covered an acreage of 100,000km², it can handle 250,000 TEU every year, and is the most equipped, advanced and well-managed modern dry port in Liaoning. Since its establishment, the port has been seeking a coordinated development with sea ports in Liaoning to become a distribution center and key juncture to connect with container rail lines for a balanced development of sea-rail service networks.
- 110.** Given the context of the establishment of Liaoning FTZ and OBOR initiative, Shenyang municipal government has set up Shenyang Port Group Co. Ltd to better play the advantages of Shenyang's role as an international logistic center as well as Yingkou's geological location to form up a multi-modal transportation network that combines the land, sea and air. The land crossings will serve as the exit of "Liaoning-Manzhouli-Europe" route, and Shenyang port for sea route transport and Xiantao airport for air freight.
- 111.** The planning of Shenyang port has overcome regional constraints and incorporated more services into its business scope, which has provided a new model for inter-modal transport. It has shouldered more responsibilities from Yingkou port by providing freight forward services, direct contracts and orders and it plans to provide one-stop clearance services in the future. Enterprises can finish all procedures with one-stop services provided by Shenyang port and logistic companies can load all cargos directly from railways and highway, and then ship them to more than 100 ports in 50 countries. By doing so, some of the seaport functions have been shifted to inland and Shenyang will function like a coastal city that can offer all sea port services. Quite a few features will be included into the development of Shenyang port, for example, a customs center to oversee multi-modal transport will be set up to provide custom supervision, which is still under construction, a logistic system connecting Shenyang with Yingkou and Dalian is under development. Shenyang port is also trying to integrate its development with innovations of the FTZ mechanisms by combining all resources of airports, railways, highways and the bonded areas covered by FTZ. On one hand, it will realize a seamless connection by sea routes through the linkage with Yingkou and Dalian ports, on the other hand, connection with Europe and countries along OBOR through railway lines.
- 112.** Shenyang port is also speeding up constructions of 3 logistic platforms of inland ports in Shenbei, Liaozhong and Faku. Some of the business functions for container shipment will be shifted to the location of product sources and local

logistics companies so commodities will quickly be distributed. By doing so, commodities will move more quickly from source locations to seaports and Shenyang port will become a home base for providing international sea-rail multimodal transport. Once completed, it will become a logistic platform integrating maritime shipment, railway, highway and airway, which will boost trade flows among China, Russia and Europe. It aims to become a well-recognized international trading, logistic, information and pricing center to stimulate a new round of economic development of the traditional industrial base.

d) Development of Internet of things of sea railway model

113. The Internet of things (IoT) is the network of things based on internet technologies. Sea-rail multi-modal transport would require information sharing and operations not only between ports and railway stations but also quite a few entities such as shipping companies, cargo owners and supervision institutions. In 2011, Dalian along with the other 5 cities, Lianyungang, Qingdao, Tianjin, Shenzhen and Ningbo have co-applied for a pilot program of national Internet of things for sea-rail multi-modal transport. Both NDRC and MOF have approved the program to develop internet of things on demonstrative transport routes like Lianyungang-Alashan, Dalian-Harbin, Qingdao-Zhengzhou, Tianjin-Hohhot, Shenzhen-Chengdu, Ningbo-Wuhan etc. As one of the earliest port to develop sea-rail multi-modal transport in China, Dalian port is identified as one of the 6 national demonstrative ports by Ministry of Transport and China Railway. As a result, the TEU transport capacity by sea-rail multi-modal transport have been increasing and taking a leading position nationwide.

114. As the earliest starters in developing sea-rail multi-modal transport in China and the first to apply IoT to intermodal transport in North East China, Dalian port has more than 50 shifts of container freights each week, reaching out to traffic networks covering the “4 centers, 12 terminals and 31 stations” in NE, and its TEU transport capacity by sea-rail multi-modal transport has been increasing and in a leading position around the nation. The IoT program started construction in July, 2014 in Dalian and went on trial in May, 2016, and then was approved and completed inspections by experts from Ministry of Transport in April, 2017. The program entails development of application systems, information sharing platform for sea-rail transport, data center, data collection system, supporting platform for applications and infrastructure of CPUs and storages, network safety systems. It built up an intelligent IoT platform by integrating smart technologies such as satellite positioning, one-stop services for custom declaration, coordination with checking stations and multi-modal transport and the inclusion of a “big data storage house” that collects all information of shipping bills, cargos, dock operations, railway companies, inland depots, train operators, supervision authorities. The platform will greatly enhance the efficiency and quality of

information sharing between Dalian port and railway operators. As a result, more coordination and better services are expected in waterway and railway transports for TEU transports.

115. The IoT program greatly enhanced the efficiency and quality of sea-railway multi-modal transport, cut cost and improved customer services. Meanwhile, it provides services such as categorizing commodities, analyzing of goods flow and assessing assembly and evacuation efficiencies of the port so that the port can make timely adjustments based on the market supply, operation flow analysis and planning on inland logistics. It's recognized not only as a demonstration for applying IoTs in national container sea-rail transport but also greatly promotes the development of Dalian port in becoming an international logistic channel under OBOR initiative.

Table 17: Policies Listed in this Sub-Section

NO.	Policy	Time of Release	Publisher
1	<i>Development Plan of Liaoning Province on Coastal Economic Belt</i>	2009	State Council
2	<i>Plan on Adjustment and Revitalization of Logistics Industry</i>	2009	State Council
3	<i>Development Plan of a Modern and Integrated Transportation System in the 13th Five-year Plan Period</i>	2017	State Council
4	<i>Outline on Cooperation and Development of Bohai Economic Rims</i>	2015	National Development and Reform Commission
5	<i>Program of Liaoning Province in Participating the " Belt and Road " Initiative in the 13th Five-year Plan Period</i>	2016	People's Government of Liaoning Province
6	<i>Implementation Plan of Liaoning Province in Participating the " Belt and Road " Initiative</i>	2016	People's Government of Liaoning Province
7	<i>Development Plan of Liaoning Province on Integrated Transport Development</i>	2017	People's Government of Liaoning Province
8	<i>Medium and Long-term Railway Network Plan</i>	2004	National Development and Reform Commission; Ministry of Transport; China Railway
9	<i>Joint Notice of 18 Departments on Further Encouraging the Development of Multimodal Transport</i>	2017	Ministry of Transport ;Ministry of Foreign Affairs; National Development

			and Reform Commission, etc.
10	<i>Report on Implementation of Economic and Social Development Plan of Liaoning Province in 2015 and Draft of its Plan in 2016</i>	2016	Liaoning Provincial Development and Reform Commission
11	<i>Report on Implementation of Economic and Social Development Plan of Liaoning Province in 2016 and Draft of its Plan in 2017</i>	2017	Liaoning Provincial Development and Reform Commission
12	<i>Harbor Construction Plan on Yangtze River Delta, Pearl River Delta and Bohai Bay(2004-2010)</i>	2016	National Development and Reform Commission
13	<i>Outline on Development of China-Mongolia-Russia Economic Corridor</i>	2016	National Development and Reform Commission
14	<i>Opinions on Building Liaoning-Manzhouli-Europe Integrated Transport Route</i>	2015	Transportation Department of Liaoning Province
15	<i>Construction Plan of Dalian International Logistics Center(2016-2020)</i>	2016	Dalian Municipal People's Government

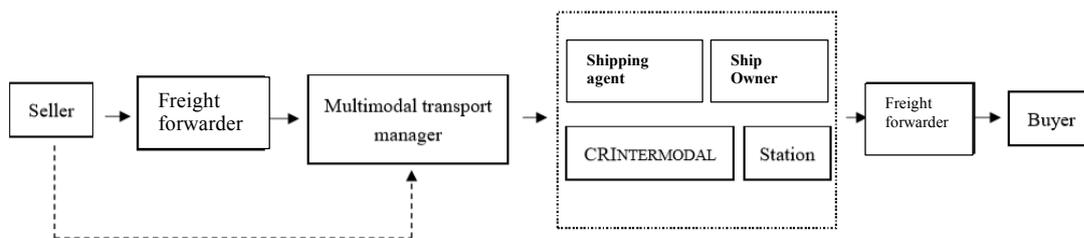
6. Operational Models

- 116.** As a new model of transportation started in the 1960s, international container multimodal transport is another new model of transportation along with the development of international container transport. It provides a door to door service to customers with better efficiency, safety and convenience. Unlike the conventional transportation means, it builds up an integrated transport system that effectively combines maritime, road, air and railway transport. It's defined in the *United Nations Convention on International Multimodal Transport of Goods* as “the carriage of goods by at least two different modes of transport on the basis of a multimodal transport contract from a place in one country at which the goods are taken in charge by multi modal transport operators to a place designated for delivery situated in a different country.”
- 117.** The combined model of sea with railway will allow the imports and exports directly shipped out by railway and then linking to merchant vessels, or a logistic flow vice versa. It would only require a onetime custom declaration, inspection and clearance if applying such a model of transportation. As a systematic project, the sea-rail multimodal transport would require a good coordination of hardware and software infrastructure, improved operation network, mature market players and a matching mechanism, etc. Especially for cross-border shipment, a multi-model transport posts high demands for container freight stations, traffic networks, a unified rating system and a developed organizational mechanism and a highly efficient port and distribution system.
- 118.** Given the fast growth of a global logistic network, many coastal industries have shifted their development to inlands, which have spurred higher demands for multi-modal transport. With increasing environmental concerns and calls to develop green transportation that can help with energy conservation and emission reduction, the sea-rail multi-modal transport has become one of the most important models in international shipment considering its unique advantages in safety, efficiency, environmental protection, large carrying capacity and low costs. Sea-rail multimodal transport cannot only provide cost-effective transport solutions to businesses, enhance corporate competitiveness, but also generates more cargo shipment to ports and increase throughputs, so in return, it will step up transport service industry itself. It will also facilitate industrial upgrading and transformation and thus, driving economic development. Therefore, to further develop sea-rail transport is a necessary path to realize industrial upgrading and economic transformation while invite competition and attract product supplies from inland areas. Key ports around the globe have all prioritized the development of a sea-rail multimodal transport as an important development strategy.

a) Work flow models

119. A freight forwarder accepts consignment from a cargo owner (Figure 11). Both parties will conclude contracts to identify shipping responsibilities, and a designated party will consign the freight forwarder when the cargo is ready for shipment.

Figure 11: Work Flow of Sea-Rail Models



120. When accepting the consignment for shipment in step 1), the freight forwarder will raise a written shipping request and forwarding order to the Multimodal Transport Operator (MTO), who will sign and stamp upon receiving verified approvals from both parties. MTO is entitled to designate a location for the forwarder to deliver cargos, inspect, verify and accept orders. A bill of loading (B/L) for multi-modal transport will then be raised by the MTO upon payment by freight forwarder. The B/L will be later passed to sellers as supporting documents to be presented to the bank and settle payment procedures. When no freight forwarders are consigned by sellers or buyers, both parties can consign the shipment directly to the MTO.

121. MTO shall perform the transportation and be held responsible for all contractual obligations related to transportation. It usually concludes subcontracts directly with railway transport companies and shipping companies themselves, and in some cases, with their agents. MTOs shall arrange and coordinate among all modes of transportation, and ensure safe and punctual arrivals of goods. When received a written shipping application for locomotives from the MTO, railway companies or authorities shall confirm the reception of the application and then request a designated location for delivery of goods, they shall confirm acceptance of the goods after completing all inspection and verification procedures. A railway B/L shall be passed to the MTO when all shipment costs are settled with the MTO and relevant railway subsidiaries have been assigned on the shipment task. When received a shipment order from the MTO, the shipping companies or authorities shall sign a contract with the MOT after verifying all information on the order. After delivering the goods to a storage yard designated by the shipping company and upon reception of a booking note receipt provided by the MTO, the shipping

companies shall sign on and issue the shipping B/L, which is an important documentation that can be used as the transfer of property rights. The goods will later be loaded to the carrying vessel for the destination port. Shipping companies will then start on relevant procedures such as custom clearance and delivery of goods.

122. MTOs shall arrange the entrance of goods into the destination port, including preparing for loading of the goods upon arrival, notice to the seller after tracking shipment status with shipping company and accurately determining the arrival hours to the port. MTOs shall complete clearance procedures upon arrivals of the goods and notify railway authorities to ensure timely delivery of the goods to the destination. Buyers shall also be kept on notice on shipment delivery before goods arrival.

123. Buyers shall complete the acceptance procedures upon goods arrival, including the provision of consignment notice and completion of the clearance procedures and then transportation of the goods to the designated location for delivery.

124. The above work flow reflects multi-modal transportation under common circumstances, it should not be taken as a universal procedure working for all cases.

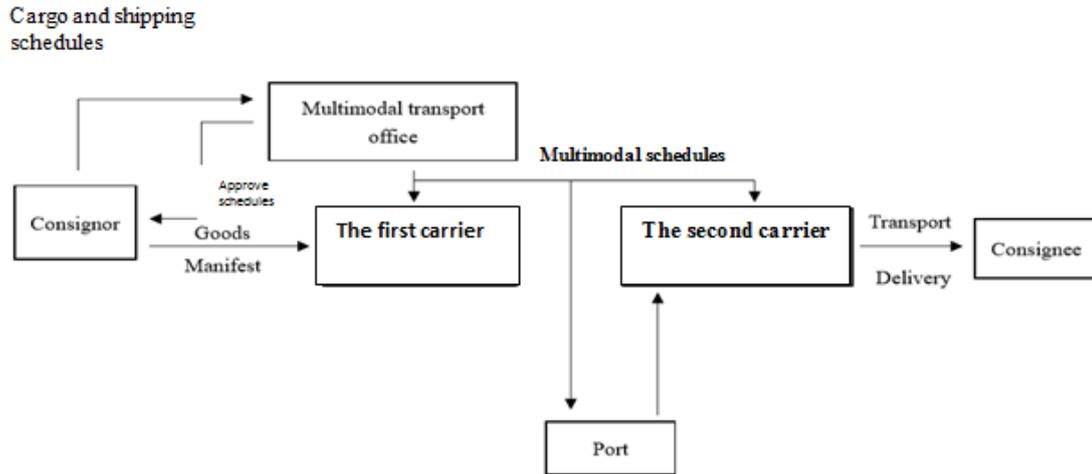
b) Operational Models

125. Generally speaking, there are two models to operate multi-modal transport – intermodal and multimodal. The former is defined as the movement of cargo from origin to destination by several modes of transport where each of these modes has a different transport carrier responsible in accordance of unified chapters or agreements. The latter is defined as the movement of cargo from origin to destination by several modes of transport by a single multi-modal company (MTO). In China, multimodal transport is usually referred as a combined way of transport and operators are usually referred as MTO companies.

126. Intermodal transport is widely applied in China (see Table 6). All participating carriers for multi-modal transport can receive applications from a consigner and sign on shipment bills covering whole legs of the transportation after receiving the cargos. Each carrier will be held responsible for their own leg of transportation and the carrier for the next leg needs to coordinate relevant procedures upon changing to different modes of transportation. The last carrier shall deliver the cargo and deal with the claims on cargo damages from the receiver. All participating carriers will be deemed as both the common carriers for shipper and stakeholders for each other. Any of the transport contracts signed by one of the carriers will also be binding to others, namely, each carrier is legally binding with shippers based on transport contracts. Together they are stakeholders who are not only obligated to

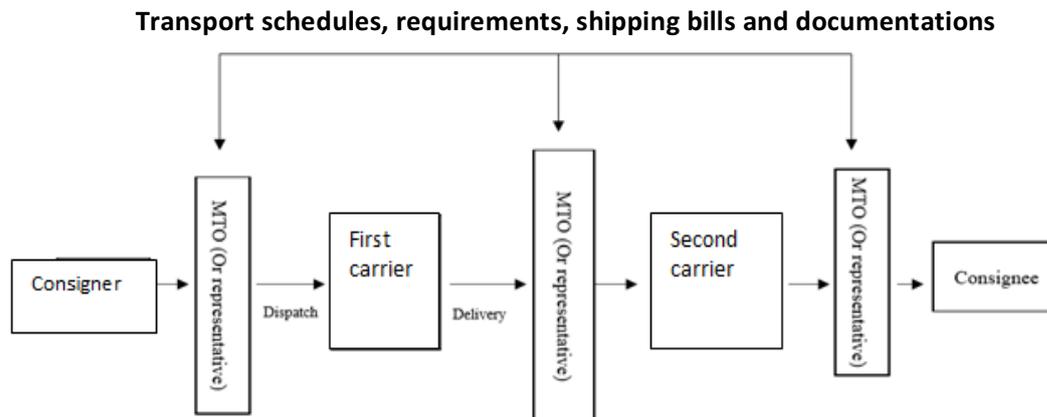
perform the transport and operation of goods of their own leg but also share the risks and interests.

Figure 12: Intermodal Operation Schedules



127. Organizations of different legs of transport models and the actual transportation are separated under multi-modal schedules. MTOs will be responsible for organizing the whole legs of transportation and each carrier shall carry out transportation of different legs. There are dual roles for MTOs under such model. On one hand, it acts as the consignee that concludes transport agreement with the consignor, collecting transport-related rates from the consignor, and on the other hand, it serves as a consignor to all actual carriers of each leg of transportation and signs up individual contracts with them and make all due payments relating to carrying out each leg of transportation. This schedule clearly separates organizational work from the actual transportation, which is more clearly fit for the business principles to specialize division of labor. With the MTO serving as an intermediary for the cargo owners and the actual carriers, different legs of transportation will be better facilitated and therefore, it's the commonly applied model when it comes to intermodality.

Figure 13: Multimodal Operation Schedules



128. In China, intermodal transport is more widely used, which means, each carrier will be responsible for its own leg of work and connecting with the next leg of carriers, and they will share the profits and risks based on contractual agreements. As another option, multimodal operation schedules are more suitable for carrying out multi-modal transport since it has separated the organization of different modes of transportation but also facilitated cargo owners and actual carriers, which will benefit the connection of different models of transport. It's more widely applied in carrying out international cargo shipment, including sea-rail models. Therefore, we shall upgrade our operational modals if we aim to develop sea-rail models to catch up with international trends.

7. Foreign and Domestic Growth Patterns and Impacts of Supporting Policies

129. Given the large capital input and long cycles of return required for constructing the infrastructure of the sea-railway transport projects, they are usually being categorized as public products and supported by fiscal policies along with national strategic initiatives. Recognized its economic and social bearings as accentuated in OBOR, China have come up with a number of supporting policies and preferential fiscal policies at national and local level. However, our analysis on policies and mechanisms of representative local cases has shown that there's still in lack of a top design as many of the practical policies are proposed by local governments. Many of the subsidy plans are generated with features of self-sectionalism, which have worsened the competition of sea-rail transport market amongst different regions, and thus, could compromise the upgraded and systematic development of multi-modal transport.

a) Supporting Policies and Development of Western Ports

130. Developed countries have started trials on sea-rail transport models along with the development of containerized shipment back in the 1940s and 1950s. For quite some time, the development of highway networks has spurred the development of sea-highway model into becoming a major choice for multi-transportations. It's not until the beginning of this century that people started to pay attention to environmental issues and high energy consumption caused by road transportation; therefore, many developed countries have put forward a number of supporting policies to promote the development of a more environmental friendly option such as sea-rail model. A few cases in points are New York - New Jersey Harbor, Port of Rotterdam in Holland and Port of Antwerp in Belgium.

(1) New York - New Jersey Harbor

131. The US government has outlined the development of sea-rail model at a strategic level, and announced an *Intermodal Surface Transportation Efficiency Act* in 1991. New York - New Jersey Harbor launched a 20-year 1 billion US dollar PIND initiative to provide viable solutions to tackle challenges such as traffic jam and environmental pollutions. Meanwhile, they've come up with very specific fiscal policies based on a thorough analysis of the current situation and systems of the harbor, including subsidies of 25 USD for each container cargo, 200,000 USD operation fund for newly-built routes, free warehouse service for empty containers of the depots, free shipment service to New York for empty containers. The project received strong support from the federal government as well. Some funding of building inland terminals is provided by the government, and it's subsidized through charges on traffic alleviation and air quality improvement.

132. Progress has already been seen in the first ten years of running the project; the total transport capacity has increased from 27,000 TEU to 230,000 TEU, with an annual growth of 7.1%, 4.8% higher than the total throughput. Meanwhile, service routes of sea-rail transport have extended to the south west and even the west coast of the country. The greatly-improved transportation speed by railway has also promoted container freight, which would enable the arrivals of goods to 1/3 of US and 1/2 of Canada within 24 hours.

133. PIDN is a systematic, comprehensive and long-term project which was supported by applicable laws such as *Intermodal Surface Transportation Efficiency Act 1991* and received capital and subsidies from the federal government. As the execution agency in this case, the port authorities have set up a long-term plan for 20 years. Fiscal policies and subsidies are provided and operated through joint-stock companies and funds, which have boosted infrastructure and subsidized some of operation costs.

(2) Port of Rotterdam

- 134.** With a geological location near Dover Strait, alongside the complex of Rhine River and Maashaven, the port of Rotterdam is well recognized as the gateway to Europe market and an important transportation hub for goods of Holland and Europe. It's also the largest port for cargo freight and container shipment. With an advanced collection and distribution system and vast hinterland, it has attracted 80% of shipments, mostly from or to Europe. In recent years, we've noticed that it has gradually opened up to a more diversified modes of container transport, connecting with barges, roads and railways, built up more modernized infrastructure and become highly automated in handling goods. The operations can be directly controlled by computerized system.
- 135.** However, 53% of its distribution and collection of goods had been by roads with only 10% taken by railway transport before any supporting polices coming into play. Seizing the opportunity of building Trans-European Transport Networks (TEN-T) proposed by EU, the Port of Rotterdam Authority has carried out incubator programs to coincide with the 5.5 million Euro infrastructure development plan, including ① Investment of supporting infrastructure. The port authority firstly electrified all railways lines within the territories of its administration, reconstructed single track railways into two-track ones, and built up railway bridges and tunnels. Moreover, it has actively developed a railway corridor connecting Germany, Poland and Scandinavia with South Europe, and subsidized up to 25% of construction of an inland industrial park. ② The port authority has provided subsidies at a proportionate amount. It estimated a return of profit within at least two years of operation of the sea-railway multi-model routes, hence, coming up with a comprehensive set of policies during the incubation period that attracted stakeholders to increase the railway transport. ③ They've set their eyes on expanding into global market to ensure sufficient supply of goods by setting up 7 overseas offices.
- 136.** The number of main travelled rail voyages setting out from the port has increased from 1,000 in Q1 of 2008 to 5,915 in Q2 of 2011. The shipment capacity of major railway lines has increased from 41% to 75% from 2009 to 2011. Train schedules have increased from four times a week to six times a week.
- 137.** The multi-modal transport in Holland is mainly subsidized by the port authority, which fully displayed the port's advantage in resource integration. It has also set up a company called Keyrail to specialize in carrying out all projects related to the promotion of sea-rail multimodal transport. Such commercialized subsidy has avoided direct intervention from government authorities to the market and provided targeted measures to achieve desired results.

(3) Port of Antwerp

- 138.** Located in the downstream of Scheldt River, 8,000 miles away from the North Sea, the port serves as a transit to reach the production and consumption regions of Europe, 50% of its throughput is for transit trade, and nearly all of them are for international shipment. Distinctive features of the port entail a well-connected road network, an extensive and advanced traffic network covering all modes of transportation, and thus, forming up perfect transportation networks. Meanwhile, the port itself is supported by sound infrastructure, including all kinds of specialized terminals ranging from containers, Ro/Ro vessels, irons, coals, fertilizers, grains, woods with some even further specialized as terminals for fruits and papers. The infrastructure construction is well supported by warehouses and specialized equipment. It further constructed networks that can exchange data with competent departments within Belgium government to step up a more modernized information service capability.
- 139.** As a nation with the largest share of multi-model transportation in the world and the most intensive railway network, Belgium has also paid high attention to the compliance of supporting policies so to ensure the sustainability and execution of policies. The federal government has come up with act of C-2009/14189 to especially facilitate the development of multi-modal transportation; including measures of ① case-by-case subsidies ranging from 60% to 80% for the terminals and all relevant infrastructure constructions. ② Subsidies for the construction of transit stations for multi-modal transportation. The construction of large size assembling and unloading infrastructure is subsidized by federal tax cuts or exemptions. ③ Federal government provides direct subsidies to containerized railway transportation at a fixed rate of 1.5385 Euro/ton. For goods that are transported over 51 miles by railway, each increased mileage will receive corresponding subsidies at a fixed amount of 0.00978 Euro/ton. Meanwhile, the Belgium government also subsidizes freight transfers that are using railway models, but the subsidy is half of that for containerized railway transportation.
- 140.** Policies are designed with accurate targets, on one hand, legislations have ensured the consistency and stability of fiscal policies, and on the other hand, the authority has taken full consideration of key factors for transportation, namely, distance, weight and destination, and formulated policies that combined capital subsidies with tax cuts and exemptions. These well-executed policies have boosted multi-modal transportation up to 34% of all modes of transport in 2011, a much larger share compared to other major ports in Europe.

b) Supporting Policies and Development of Domestic Ports

- 141.** Considering the severe traffic congestions and mounting pressure on environmental pollutions, along with the significance of sea-rail multimodal transportation strategized in OBOR, the Chinese government has come up with several guiding opinions to facilitate the development of multi-modal transport, meanwhile, the local governments have come up with corresponding stimulus measures to promote the multi-modal transport.
- 142.** As for the legal system construction, China, as a major transport country, has formulated relatively complete laws, regulations, and planning systems regarding highways, railways, waterways, aviation and inland waterways, including the Highway Law of the People's Republic of China , National Expressways Network Plan , the Medium- and Long-Term Railway Network Plan , and the National Plan for Inland Waterways and Ports. Meanwhile, relevant approaches and rules have also been introduced for integrated traffic transport. China has also put forward corresponding development plans to cope with new situations arising from the sea-rail multimodal transport development. The State Council issued the Concerning the Promotion of the Healthy Development of Marine Industry and the Medium and Long-Term Plan for the Development of the Logistics Industry (2014-2020) in 2014 and then the 13th Five-Year Plan in 2015, proposing to improve the modern integrated transport system and to open multimodal transport and cross-border multimodal transport routes. However, neither systematic legal laws and regulations nor nationwide supportive measures and implementing rules on sea-rail multimodal transport are available at this stage. In 2013, the Ministry of Railways merged with the Ministry of Transport. The new Ministry of Transport noted in the *Symposium On Integrated Transport Pilot Project* and then again in the press conference concerning the *Certain Opinions of the State Council Concerning the Promotion of the Healthy Development of Marine Industry* that it was necessary to actively promote sea-rail multimodal transport development and strengthen integrated traffic transport system, which has drawn increasing attention to sea-rail multimodal transport development.
- 143.** Due to the absence of a clear construction planning on sea-rail multimodal transport and relevant incentives from the Central Government, local governments in inland cities led by Zhengzhou and Xi'an and port cities represented by Ningbo and Qingdao have successively launched stimulating policies on sea-rail multimodal transport under the momentum of the "Belt and Road" initiative. This group takes Ningbo and Dalian, two typical port cities in the South and North, as an example to demonstrate the development of subsidies and supportive policies on China's sea-rail multimodal transport.

(1) Ningbo Port

- 144.** Ningbo Port is China's second largest port. It stands at the mid-point of China's mainland coastline and close to the south tip of the T-shaped junction of the Yangtze River Delta and the Yangtze River. It is a multifunctional and comprehensive modern deep-water port, integrating the inland port, estuarine port and seaport in one.
- 145.** Ningbo is the first domestic city which introduced supportive policies on sea-rail multimodal transport. The Ningbo Municipal Government issued the *Notice on the Issuance of Certain Opinions on Supportive Policies for Accelerating the Sea-rail Multimodal Transport Development for Ningbo Port (Revised)* in 2009, with an implementing term of three years. Its major subsidy policies are: the subsidy to de-facto operators of sea-rail multimodal transport are 200~ 800 yuan per TEU according to the actual railway mileage; the funding limit for the "five-fixed" trains (i.e. fixed loading site, route, train number, schedule, and pricing) is up to 25 million yuan; the standard subsidy to container shipping companies providing container terminal services between railway port stops and each terminal is 50 yuan per TEU; the subsidy to shipping companies providing container services for container sea-rail multimodal transport is 50 yuan per TEU, with an annual funding limit of 500,000 yuan and a cumulative funding limit of 1.5 million yuan. Eligible platforms with sea-rail multimodal public services (train operators) may be subsidized with up to 150,000 yuan. The construction of sea-rail multimodal transport project is supported so. After this, Ningbo implemented the policies after revision in 2012 and 2015. Since then, the sea-rail multimodal transport of Ningbo Port achieved considerable development. Ningbo sea-rail multimodal transport volume was merely 1,067 TEUs in 2009, and soared to 135,100 TEUs by 2014, increasing by 80 times (See Table 8). As of April 2012, there were nine train lines in regular operation for container sea-rail multimodal transport in Ningbo Port, of which there were two lines for "five-fixed" trains and the other seven for direct trains. Ningbo Port has established sea-rail multimodal transport with up to 20 cities and built 10 dry inland ports, establishing itself as the largest port with sea-rail multimodal transport in southern China.

Table 18: Container Throughput of Ningbo Ports by Multimodal Transport

Year	2009	2010	2011	2012	2013	2014
Volume (10,000 TEUs)	0.167	2.8	4.7	5.95	10.5	13.5
Year-over-year growth percentage			67.9%	26.6%	76.5%	28.6%

146. When compared with subsidy policies of sea-rail multimodal transport in other countries in respect of specific implementation measures, the subsidy program of Ningbo reflects the characteristics of China’s sea-rail multimodal transport market. However, there is still no systematic legal guarantee for the supportive policies put forward by local governments. Moreover, sea-rail multimodal transport has not adequately engaged the market during its operation. Direct subsidies from the government may cause vicious competition between different regions and so are not conducive to the overall stable development of the national sea-rail multimodal transport market.

147. In the meantime, without the extensive application of a scientific master plan, the cost of untapped shoreline investment is high. Consequently, there is a fair amount of waste and the overall utilization efficiency of the coastline is hampered. Terminal facilities are insufficient and imbalanced in layout, which results in the low utilization rate of the cargo owner’s terminal and a limited transport volume of the port. Therefore, it is unfavorable for the long-term sustainable development of the port.

(2) *Dalian Port*

148. The sea-rail multimodal transport market in the north is more mature and competitive than that in the south. Tianjin Binhai New Area introduced the *Method of Financial Support for Accelerating the Construction of the Northern International Shipping Centre* in Tianjin Binhai New Area in 2010, including a subsidy measure on sea-rail multimodal transport. However, the measure was implemented for but one year. Thereafter, subsidy policies on sea-rail multimodal transport were launched in Dalian, Yingkou, Zhengzhou, Xi’an, Gansu, and Harbin in succession. Among them, the subsidy policy by Dalian Municipal Government was the most transparent. Dalian Municipal Government issued *Implementing Regulations for the Dalian Port Container Development Subsidies (2014-2015)* in 2013, with an implementation term of 2 years. The subsidies related to sea-rail multimodal transport include: subsidies to container trains companies or logistics companies

in sea-rail multimodal transport between inland ports and Dalian port with an annual volume of no less than 5,000 TEUs; expressway toll subsidies to container trailers companies serving Dalian Port; subsidies of container terminal construction to port companies that invest in and construct dedicated container terminals in Dalian.

149. In 2015, Dalian ranked the first in terms of sea-rail multimodal transport volume in the country with a total of 349,000 TEUs, of which the cross-border container traffic volume increased by nearly half as compared with the same period of last year. In sharp contrast, the volume of cross-border containers traded in Tianjin Port dropped by 35% over the same period. Of course, Tianjin Port has its own disadvantages such as aging infrastructure construction, insufficient transport capacity and poor information exchange. However, it is clear that non-market competition plus regional policy support is not conducive to the sound development of sea-rail multimodal transport in the northern ports. Even Yingkou Port, which is also in Liaoning, competes with Dalian Port. Yingkou Port has the shortest route of sea-rail multimodal transport between China's southeast coast and countries including Japan, South Korea, Russia, Mongolia and Europe. Its transport volume increased from 5,702 TEUs in 2011 to 14,166 TEUs in 2013 with its port advantage, location advantage and policy support, with an increase rate over the three years of 50% or more, securing a dominant position in the northeast. Therefore, subsidy policies in some regions become one important factor that hinders the ports from competing for cross-border sea-rail source. This sort of direct government involvement with no overall planning has caused vicious competition to some extent.

150. Therefore, it is important not only to strengthen the infrastructure construction for sea-rail multimodal transport and improve soft ancillary facilities, but also to reinforce the establishment of a macro-management and coordination mechanism for sea-rail multimodal transport, including sea-rail intermodal transport development in Liaoning and elsewhere in the country. Meanwhile, it is necessary to coordinate the overall planning and management of governments, establish an integrated transport system, and enhance cooperation between ports. Excessive vicious competition causes losses to both sides, while cooperation brings about a win-win situation. Despite its geographical advantages, Yingkou Port is a shallow water port, where foreign trade ships cannot berth. Frozen sea surface in winter makes Yingkou Port available only to near-ocean routes and domestic secondary routes, which is a salient disadvantage in this regard. However, Dalian Port is an ice-free port all year round, with a number of near-ocean routes and ocean routes. It can act as a transit port for large vessels to Yingkou Port. Hence, scientific planning, policy support, and close cooperation among all ports, railway divisions

and related parties are the key to tap the potential of Liaoning sea-rail multimodal transport.

Table 19: Policies Listed in this Sub-section

No.	Name	Release time	Release agency
1	<i>United Nations Convention on International Multimodal Transport of Goods</i>	1980	<i>The United Nations</i>
2	<i>Intermodal Surface Transportation Efficiency Act</i>	1991	<i>The United States</i>
3	<i>Act of C-2009/14189</i>	2009	<i>Belgium</i>
4	<i>Highway Law of the People's Republic of China</i>	2017	<i>National People's Congress</i>
5	<i>National Expressways Network Plan</i>	2004	<i>The State Council</i>
6	<i>National Plan for Inland Waterways and Ports</i>	2007	<i>Ministry of Communications</i>
7	<i>Concerning the Promotion of the Healthy Development of Marine Industry</i>	2014	<i>The State Council</i>
8	<i>Medium and Long-Term Plan for the Development of the Logistics Industry (2014-2020)</i>	2015	<i>The State Council</i>
9	<i>Notice on the Issuance of Certain Opinions on Supportive Policies for Accelerating the Sea-rail Multimodal Transport Development in Ningbo Port (Revised)</i>	2009	<i>People's Government of Ningbo</i>
10	<i>Measures for Accelerating the Implementation of Financial Supportive Policies for the Sea-rail Multimodal Transport Development in Ningbo Port</i>	2015	<i>People's Government of Ningbo</i>
11	<i>Method of Financial Support for Accelerating the Construction of the Northern International Shipping Centre in Tianjin Binhai New Area</i>	2010	<i>People's Government of Tianjing</i>
12	<i>Implementing Regulations for the Dalian Port Container Development Subsidies (2014-2015)</i>	2013	<i>People's Government of Dalian</i>

E. Port Management

1. *The Layout and Development Plan of Ports in Liaoning Province*

- 151.** Liaoning province has planned a 1400 kilometers long, 30 to 50 kilometers wide, port-based Coastal Economic Belt, comprising 21 urban districts and 12 coastal counties under the jurisdiction of 6 coastal cities including Dalian, Dandong, Yingkou, etc. Liaoning provincial government has made a detailed plan for the layout of the ports along the coastline. There are 7 major ports in the province: Dalian, Yingkou, Jinzhou, Dandong, Huludao, Panjin and Suizhong Port, and 15 large-scale port areas – Dalian Port Area, Xianglujiao Port Area, Heizuizi Port Area, Dashihua Port Area, Ganjingzi Port Area, Heshangdao East Area, Heshangdao West Area, Sankuangzhongzhuan Port Area, Beiliang Port Area, Dayaowan Port Area and Nianyuwan Port Area of Dalian Port; Bayuquan Port Area of Yingkou Port; East Port Area of Jinzhou Port; Dadong Port Area of Dandong Port; Suizhong Port Area of Huludao Port. At Present, a general development layout has taken shape based on Dalian Port and Yingkou Port, supported by Jinzhou Port and Dandong Port and supplemented by Huludao Port, Panjin Port and Suizhong Port.
- 152.** The hinterland of Dalian Port includes the provinces of Heilongjiang, Jilin and Liaoning, and the east area of Inner Mongolia, for which Dalian Port serves as a major transshipment port for the transport of raw materials and energy. It is also an important port for Dalian Northeast Asia International Shipping Centre. Dalian Port, focusing on the port areas in the “One island and three bays” (namely Changxing Island, Taiping Bay, Daya Bay and Dalian Bayarea) and the Changxing Island Port Area, has established 7 specialized transport and transshipment systems for containers, petroleum, iron ore, grains, commercial vehicles, ro-pax and cruise ships, and built 4 port-centered coastal industrial bases featuring respectively petro-chemical industry, facility manufacturing, ship building and shipping commerce, which have formed a well-functioning modern port service system, laying a solid foundation for Dalian Northeast Asia International Shipping Center.
- 153.** Yingkou Port mainly takes Shenyang Economic Circle (Shenyang, Fushun, Anshan, Liaoyang, Benxi, Yingkou and Tieling) as its hinterland, and is an important transshipment port for the transport of raw materials and energy for Liaoning Province, as well as a key feeder port for containers. Centering on Bayuquan and Xianrendao Port Area and focusing on the transport of domestic trade containers, iron ore, petroleum, iron and steel, Yingkou Port has comprehensively developed its transport capacity for grains and groceries, expanded its modern port services, port functions and port-based industrial functions, gradually growing into a comprehensive port with advanced facilities, well-developed functions, efficient management and high level of safety and environmental friendliness.

- 154.** The hinterland of Dandong Port mainly covers the eastern part of Liaoning province. The construction of the supporting technological transport channels has enabled the port to expand its hinterland effectively to Jilin Province and east of Heilongjiang Province, thus becoming important strategic resources of Dandong city and eastern Liaoning area for promoting their economic competitiveness and pushing forward the process of economic globalization. Based on Dandong Port Area and Haiyanghong Port Area, Dandong Port aims to serve the eastern area of Northeast China by developing port-centred industries. Focusing on the transport of coal, metallic ores, grains, oil products and containers, the port has gradually developed into a comprehensive multifunction port that is capable of handling passengers and cargoes, serving domestic and foreign trade.
- 155.** Jinzhou Port has a hinterland covering the five cities of east Liaoning Province, the mid-western areas of Jilin and Heilongjiang Province and east of Inner Mongolia. It is a regional port of China as a key development area in the north and a key point for the development strategy of Liaoning Coastal Economic Belt. Based on Bijiashan Port Area and Longqiwan Port Area, Jinzhou Port focuses on the transport of bulk cargoes such as petroleum, coal and grain, as well as domestic trade containers. The port has gradually developed into a comprehensive multifunction port that is capable of handling passengers and cargoes and serving domestic and foreign trade, and concentrates on developing its logistics, trade, port and port-centred industrial functions, gradually growing into a comprehensive multifunction port.
- 156.** Mainly serving the city they are based, Huludao Port, Panjin Port and Suizhong Port, are important pillars for local economic and social development and gateways for opening up. Based on Rongxing Port Area, Panjin Port mainly develops petrochemical industry and transports bulk cargoes, and has developed step by step into a comprehensive multifunction port serving both domestic and foreign trade.
- 157.** With the implementation of the great strategy of revitalizing the old industrial base of the Northeast, ports in Liaoning have enjoyed a favorable environment for development. The advantages of the port cluster along the coast of Liaoning are further promoted, making it the most competitive port cluster in northeast Asia. In 2016, Dalian Port registered a cargo throughput of 355 million tons, representing a 5.5% growth year on year, and a container throughput of 9.441 million TEU, a year-on-year growth of 1.5%, making Dalian Port a modern, specialized and intensive port cluster with scientific layout, clear structure and precise distribution of work. In the same year, Yingkou Port registered a total throughput of 352 million tons, representing a 4% growth year on year, and a container throughput of 6.08 million TEU, a year-on-year growth of 2.8%. The throughput of other ports in Liaoning is also consistent with the economic growth trend of the province,

indicating that the ports at present have strong business capability and outstanding performance in the actual business operation.

2. Status of the Management of Port Resources in Liaoning Province

a) Integration, merger and restructuring of the port cluster

158. In December 2008, Jinzhou Port made Dalian Port Corporation as its domestic strategic investor through the issuance of 246 million non-public shares at 7.77 RMB per share, which were acquired by Dalian Port Corporation with 1.911 billion RMB in cash, making the Corporation the 2nd largest shareholder of Jinzhou Port with 18.9% of the total share capital. This marks a formal “marriage” between Dalian Port and Jinzhou Port. In May, 2012, Jinzhou Port State-owned Assets Operation and Management Co., Ltd, the 3rd biggest shareholder of Jinzhou Port, transferred its 78.5579 million shares of Jinzhou Port (5.03% of the total share capital) to Dalian Port Corporation, making Dalian Port Corporation the biggest shareholder with 24.47% of the total shares. Besides, before 2012, Dalian Port Corporation had been continuously enhancing its relationship and cooperation with Dandong Port and Huludao Port through merger, restructuring, joint venture and joint operation before retreating from the construction of Dandong Port and Huludao Port due to capital and other reasons and transferring the construction task to Yingkou Port.

159. In March 2007, Yingkou Port and Panjin Port jointly formed Panjin Port Co., Ltd, realizing the sharing of port resources on both sides of Liao River for common prosperity. In May 2012, Yingkou Port Corporation reached a framework cooperation agreement with Dalian and Dandong Municipal government on the construction of Dandong Haiyanghong Port Area. In June 2012, Yingkou Port Corporation respectively signed agreements with Huludao municipal government and Suizhong county government on the construction of Huludao Port’s Liutiaogou Port Area and Suizhong Shihe Port. Since then, Yingkou Port has been accelerating its development. It took over the construction projects of Dandong Haiyanghong Port Area and Huludao Port’s Suizhong Port Area so that it has port areas in Yingkou, Panjin, Huludao and Dandong city, 4 of the 6 cities in the Liaoning Coastal Economic Belt. In particular, Yingkou Port has built over 70 production wharfs for 9 types of goods – containers, vehicles, coal, grain, ores, steel, large facilities, crude oil, and refined oil and liquid chemical industrial products – at Yingkou, Bayuquan and Xianrendao Port Area in Yingkou city.

b) Status of the construction of port resources

- 160.** As the construction of ports has become a key sector in the economic and social development of China and many development policies have been rolled out, Liaoning Province has new opportunities for the development of its ports. The construction of ports in the province is developing rapidly and the total scale continuously growing. The province has invested 5.37 billion RMB for the construction, a 72% year-on-year growth, and Panjin and Jinzhou Port have received remarkable capital investment. Upon the completion of modern ports, many deep-water berths have been put into production, gradually optimizing the port structure of Liaoning Province. Although lots of advanced technologies have been gradually adopted, there are still problems: there lacks priority in the construction, leading to repetition and waste of resources; and as there is no coordinated planning; the structures and functions of the ports are similar, limiting the future development of the ports and cities of Liaoning Province.
- 161.** There are 196 production berths in Dalian Port, of which 78 are above 10-thousand-ton level and 78 are specialized, enabling the port to prevail among the 7 ports in the Liaoning Coastal Economic Belt and win a place worldwide. At present, there are over 150 km of designated railways, 1.8 million square meters of goods yard, 1000 sets of loading and unloading machinery, 557,300 square meters of production storage area, 56,317,000 cubic meters of oil storage capacity, 2,881,800 cubic meters of silo capacity, 3,699,300 square meters of stock yard of which 1.04 million square meters are for containers. There are 35 tugboats and 10 engineering and technical ships in operation, more than 80 specialized berths for containers, crude oil, refined oil, grain, coal, loose ore, chemical products, passenger and cargo ro-pax, of which more than 40 are 10-thousand-ton berths.
- 162.** Yingkou Port now has 61 berths for production, the biggest one being a 200,000-ton ore terminal. There are 4 million square meters of container yard, 3 million square meters of full-function Logistics Park with advanced facilities, and the port is equipped with thermostatic warehouses, steel warehouses, transaction warehouses for corn futures, bonded warehouses and export supervised warehouses capable of tax refunding upon entering.
- 163.** There are 42 existing productive berths in Dandong Port with a coastline of 886 meters. No. 1 floating anchorage of Zhongshuidao, No. 6 floating anchorage, No. 14 and No. 1 anchorage of Xindao are respectively located at the estuary of Yalu River and Xindao Island, which are all sand-bottomed. The departure channel of Langtou Port Area is the Yalu River, which is 2-4 meters deep and equipped with navigation assistance facilities. The departure channel of Dandong Port Area is 10 nautical miles long with an average water depth of 9.1 meters. This Port Area has 10,400 square meters of production warehouse and 162,000 square meters of storage yard. There are 94 sets of loading and unloading machinery, the biggest one having a lifting capacity of 36 tons. There are 9476 linear meters of designated

railways, 4 loading and unloading lines, adding up to a total of 4310 extension meters. In the next 3-5 years, Dandong Port will continue to improve its port functions and supporting facilities with the goal of building a logistics and transport hub in the eastern part of Northeast China and Northeast Asia. It will also enhance its automation, management and informatization level, and build mega-level specialized deep-water berths and ancillary facilities for oil, ore, containers, grain, car ro-ro, cruise ships and others. More than 60 large-scale deep-water berths will be built, with an annual throughput of 400 million tons. By 2020, the throughput of Dandong port will have reached 500 million tons, making it a major port for integrated logistics and transactions in Northeast Asia.

- 164.** The main channel of Jinzhou Port is 31 kilometres in length with a 320-meter-wide bottom and a -17.9-meter water depth, allowing the one-way navigation of load-shedding 250,000-ton oil tankers and the two-way navigation of 50,000-ton-and-below vessels. Jinzhou Port has set up three anchorages with an area of 32.31 million square meters and a water depth of -11 to -20 meters. The anchorages are all sand-bottomed, providing good anchoring force. The port has 24 berths, including a 250,000-ton oil berth, five 100,000-ton bulk cargo berths, four 100,000-ton container berths, with the largest one capable of docking 150,000-ton tankers and 100,000 tons of bulk cargo ships. The port is now using GPS system for piloting, which is capable of berthing operations around the clock. At present, Jinzhou Port is carrying out the expansion of No. 3 anchorage and the construction of No. 4 anchorage.
- 165.** Huludao Port currently has a considerable scale of production and operation capacity, with 4 existing production berths, of which 2 are million-ton berths and the other two 5,000-ton berths. The annual integrated throughput of the port is over one million tons. It is a bulk cargo port mainly for transporting petrochemical products, grain and building materials. By far, Huludao Port has completed its first phase expansion project, and in the second phase, three 70,000-ton berths will be built and the original channels and dock basins with a total amount of work of about 14 million cubic meters will be expanded so as to provide access to 70,000-ton ships. The project is an important part of Liaoning Province's strategy of building a "five point and one line" coastal economic zone. Upon completion, the project will substantially increase the cargo throughput of Huludao Port and play an active role in promoting the economic development of Liaoning Province.
- 166.** Yingkou Port has 9 types of specialized wharf for containers, automobiles, coal, grain, ore, steel, large equipment, refined oil, liquid chemicals and crude oil, of which the ore and crude oil wharfs are 300,000-ton ones, and the container wharfs are capable of docking the fifth-generation container ships. The main cargoes handled in the port include iron ore, steel, coal, grain, non-ore cargo, refined oil, chemical products, fertilizers, crude oil, commercial vehicles for domestic trade,

containers and so on. There are 4 existing direct foreign trade routes, namely Southeast Asia route, Japan Kanto route, South Korea Busan route and South Korea Incheon route (regular international route for passengers and cargoes). There are also 4 extended foreign trade routes bound for other cities around the world through Tianjin, Dalian, Ningbo and Shanghai. There are over 50 voyages monthly through the direct foreign trade routes and the extended domestic routes for foreign trade. The existing domestic container routes have covered 30 main ports along China's coast, and the frequency of the voyages has reached more than 420 per month, accounting for 2/3 of the traffic volume of the ports in the Northeast China. In particular, there are at least two ships to Guangzhou and Shanghai every day, and at least one to Ningbo, Fuzhou and Quanzhou.

167. The construction of Suizhong Port started in September 2012, and was planned to start with three 50,000-ton general berths of gravity block structure along 800 meters of coastline, covering a land area of 2.4 square kilometres with a designed annual throughput of 4.3 million tons. Since Suizhong Port was formally put into operation, it has greatly promoted the rapid development of port-centred industry in Huludao, and enhanced the strategic position of Huludao in Liao Ning Coastal Economic Zone and even in Bohai Economic Rim, optimized the strategic layout of ports in Liaoning province, improved the collection, distribution and transport system of ports in west Liaoning, and enhanced the overall service function of the port cluster, and provided important support and guarantee for the development and opening up of Liaoning Coastal Economic Belt.

168. The lack of coordination and cooperation between local governments and ports has caused duplication of ports and waste of resources. For example, Dalian Port has built a 300,000-ton ore wharf, yet Yingkou has also built a 200,000-ton one, and as Benxi Steel Group Corporation has been relocated to Dandong, Dandong also plans to build a 200,000-ton ore wharf. Similarly, both Dalian and Jinzhou have built oil wharfs, respectively of 300,000 tons and 250,000 tons, while Yingkou, Huludao and Dandong also plan to build oil wharfs.

c) The status of the internal management of ports

169. The internal management of Liaoning Port is chaotic with corruption problems. Separately, each port is scientifically planned and designed, but the whole picture is a total mess: the hinterlands of the ports overlap with each other; the cargo supplies are the same; the development plans are similar; they all have wharfs for bulk cargoes, containers and oil with little differentiation. At the same time, the internal management of the port enterprises is also chaotic. Since 2012, the main persons in charge of Dalian Port, Yingkou Port and Jinzhou Port have been prosecuted due to violation of laws and regulations, which also shows the weak

internal management of port enterprises and the urgent need to strengthen management.

d) *The status of the supporting external resources of the port*

170. At present, there is only *Port Law of the People's Republic of China* for the administration of ports in our country. The imperfect law system has led to many problems for the development of the ports in Liaoning Province. Although Liaoning Provincial Government has issued *Plans for the Layout of Coastal Ports in Liaoning Province*, yet on the whole, the province still has weakness in terms of its port management system and related documents. There are conflicts between ports and enterprises, the macro regulation of the government is not strong and there is no supervising administration. The "visible hand" of the government has weak control over port enterprises, and the macro regulation of the local governments, especially the provincial government, on the development of port enterprises needs to be strengthened, which can be seen from the following aspects: (1) all coastal cities have proposed "to develop the city by developing the port", and compete with each other with no dialogue mechanisms, while the provincial government has no unified administration over all the ports in the province; (2) some port enterprises in Liaoning Province are privately controlled, and private enterprises tend to pursue maximum profit. So the government is weak in coordinating these enterprises for port planning and construction.

3. Management Problems

a) *The planning and layout of ports and the port systems and mechanisms in Liaoning Province*

171. With the implementation of the Liaoning Coastal Economic Belt, it has become clear that the productive forces in Northeast China will become more concentrated in the coastal areas in the future. The port-centred industries will gradually agglomerate at multiple bases, putting forward new requirements for port transport services. At present, ports are intensively laid out along the transport channels, which will not be able to meet the needs of the coastal areas where industries tend to be scattered and the transport demand is fragmented. In addition, with the rapid construction of the railways in the eastern area of Northeast China and the channel to transport the coal in east Inner Mongolia through waterways, the sea passage in the northeast will no longer be confined to the Harbin-Dalian channel, but further diversified. In particular, the service areas of the ports on the east and west coast of Liaoning will be further expanded and their service function enhanced, and the role of the ports will change significantly. To this end, the layout of the ports needs to be adjusted accordingly and optimized. The development of new ports is an important measure to implement the Liaoning Coastal Economic Belt planning, but at present, there are still some problems such as too many in number and lack of

focus. In order to further promote the coordinated development of new ports and coastal industries, and to rationalize the inter-relationship between new ports and the existing ports as well as between the new ports, it is necessary to further clarify the layout and positioning of the new ports. It is one of the important tasks of the coastal ports in Liaoning Province to make full use of the opportunity presented by the rapid development of the key new ports, actively adjust themselves to the redistribution of productive forces in coastal areas, and give full play to the leading role of the ports in the adjustment of urban planning, especially the urbanization of port areas. For example, as Dalian International Shipping Centre has made some achievements, compared with the shipping centres in Shanghai and Tianjin, its development process is slower and the development level is lower. In particular, the shipping equipment and facilities are smaller in scale and less intensive, and the shipping, logistics and port and other ancillary service systems need to be improved in general. The layout of the port needs to be further adapted to changes in the distribution of productive forces along the coast and the integrated transportation system.

172. In addition, the internal ownership structure of port enterprises in the province is also complicated, and there are some differences between enterprises in their management systems. Meanwhile, for some of the ports, the cities where they are based have a certain weight of ownership by the SASAC. As a result, the port enterprises have great reliance on local governments, and even local governments may directly participate in the internal operation and management of the port enterprises through the port authority. In the process of effective integration and management of port resources, the local governments place more emphasis on long-term social and economic benefits. Therefore, they tend to realize rational development of port resources and the sharing of resources through coordination of port functions and scientific investment so as to promote the coordinated growth of regional economy. On the contrary, what the port enterprises pursue is the maximization of profit. Thus it can be seen that the diversification of participants in the management of port resources based on their respective economic interests will lead to dual failure of the market and government regulations. This will result in the government not being able to enhance social benefits by leveraging port resources, and the enterprises not being able to achieve optimal allocation of operational resources. In the course of port resources management, it involves the interests of many industries and sectors such as relevant regulatory departments, transportation and port-centred industries. As a result, the management of port resources will inevitably be overwhelmed by the interests of different parties or sectors. Therefore, it is an urgent problem to be solved for the port development of Liaoning Province as to how to strengthen the coordination between port authorities in different cities and break the barrier of administrative division.

b) Unreasonable positioning of the ports

173. At present, the positioning of the ports in Liaoning Province is unreasonable, and they are having more competition than cooperation with each other. As a result, there are some discordant factors in the process of development of the ports. The ports, driven by their own interests and divided by the administration system, have neither unified planning for their construction nor clear and reasonable cooperation relationship. Port enterprises continue to increase their investment, blindly enhancing the throughput of containers, and unreasonably expanding deep-water wharfs, leading to the similarity of port functions and causing serious waste of resources. In addition, types of goods in the major ports in Liaoning Province are similar: the main types of goods in Dalian Port are grain, steel, metal ore, petroleum and coal; in Yingkou Port they are metal ore, fertilizer, grains, coal and steel, and in Jinzhou Port, they are oil, minerals, coal and grains. It can be seen that similar port functions and a homogeneous business models cause harsh competition between ports, making it impossible to create scale merits or raise profits.

c) Port resources and structural capacities

174. When the transport authorities develop and utilize port coastlines, the wharfs are often developed in a continuous manner with a high utilization rate of the coastlines. However, the goods, materials and industries are scattered, the coastline occupied by the factories or wharfs is too long, and there are often phenomena of over-occupation, public-owned land used for private purposes, deep-water areas used as shallow ones, and vicious exploitation, holding the ports back from forming a mutually complementary and reasonably coordinated situation, neither in the hardware facilities nor in the software environment. As a result, the structural contradictions have become increasingly prominent-the major ports and specialized wharfs are stretching themselves, while the new small and medium-sized ports are underused. Due to the increasing of investment in infrastructure in the past few years, the impulse to make investment has led to a rapid increase in the overall capacity of ports. The ports competed for the expansion of port areas, waterways, wharfs and berths. In the case of insufficient cargo supply, the ports often reduce their charges for loading, unloading, storage yard and allow the customers to pay afterwards so as to attract more customers. Such vicious competition has severely hindered the overall development of the ports in Liaoning Province, and greatly weakened the competitive advantages of other ports at home and abroad.

d) Internal management of the ports

175. An analysis of the internal management of the major ports in Liaoning Province has revealed that there are common problems in the ports such as unreasonable organizational structure. The original longitudinally distributed organizational

structure of the ports has created independent systems according to the professional scopes, leading to the problem that many departments are responsible for one task at the same time. Although this seems meticulous and helpful to improve the speciality and level of business of the ports, it has led to the deeper problem of single management and too lengthy vertical structure, making it very difficult for senior managers to skip the low, middle and high administrative levels and directly find the problems that arise in the grass-root work, thus leading to failure to respond to new problems in time. Therefore, the coordination of the ports is seriously lagging behind. In the meantime, the ports also have the problems of complicated organizational structure and serious waste of human resources.

e) *The ports' capacity to support port-centred industries*

176. Among the seven major ports, port-centred industries in Yingkou Port, Jinzhou Port and Huludao Port are developing at the slowest speed. Although these three major ports have good resources conditions and industrial advantages for developing port-centred industries, there are still problems that cannot be ignored. First, the industrial layout is not reasonable, and the guiding role of the development plan has not fully come into play, which will hinder the introduction of future projects and the development of regional industries. Second, the industries are not quite linked to each other, and most of the industrial chains of the port-centred heavy and chemical industries are short, weakening its influence over other industries outside the area. As a result, no large-scale industrial clusters have been formed. Third, the core enterprises in each port-centred industrial area are small in size, and the existing small and medium-sized enterprises are small in scale and few in quantity, so the dominant industries have very limited driving force for regional industrial development; finally, the supporting capability of resources and the environment is weak, constraining the development of the port-centred industries.

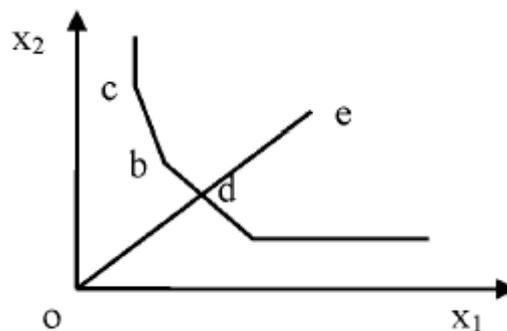
4. *DEA Method of the Comprehensive Evaluation of Port Resources in Liaoning Province*

a) *Data Envelopment Analysis (DEA)*

177. DEA refers to Data Envelopment Analysis, which is proposed by the famous operations research scientists A. Charnes and W. W. Cooper et al. It is a new research field in the intersection of operations research, management science and mathematical economics, and an effective non-parametric approach to measure the relative efficiency of multi-productive and non-productive sectors and units with the same type of multiple inputs and outputs. If a sector or unit is efficient, then it is called DEA efficient, and the efficiency value is 1. The basic idea of DEA method is to establish the efficiency evaluation model of mathematical programming

according to the input and output indicators of the system being evaluated. Then, the efficiency of each evaluation unit in the same system is analysed separately, and then the different efficiency value of each evaluation unit is obtained. And each DMU is sorted according to the efficiency evaluation value, and DMU with the highest relative efficiency is the most efficient DMU, and the inefficient programs of other inefficient DMU and the reasons for their inefficiency are analysed accordingly. In the meantime, within the scope of the definition of the productions possibility sets, we can fix the input of a certain DMU and increase its output, or fix the output of a certain DMU and decrease its input. For ease of understanding, we can illustrate the basic idea of data envelopment analysis by a simplified input-output relationship, as shown in **Error! Reference source not found.**

Figure 14: DEA Efficiency Evaluation Schematic



178. Assume that there are only two input factors (x_1, x_2) in one production activity, and one output y can be obtained. There are five evaluation units, namely a, b, c, d and e . As can be seen from the figure, the production frontier of the evaluation system consists of a series of segment lines of equal output lines. The evaluation units a, b, c and d are located on the surface of the production frontier, while point e is located above the frontier. This shows that under certain output, the two inputs (x_1, x_2) consumed by point e are much greater than the input of points on the surface of the production frontier, so the evaluation unit e is technically inefficient. Its production activity wastes too many resources, and the degree of inefficiency can be measured with de/oe . Similarly, the relative efficiency of all evaluation units in the whole evaluation system can be analysed in this way.

179. Based on the above idea, DEA method constructs the mathematical programming model through the distance ratio of the evaluation units and the linear combination of its corresponding production frontier, and evaluates the relative efficiency of each evaluation unit. Through the relative efficiency analysis, the

relative efficiency value of each evaluation unit can be obtained, and these efficiency values can reflect the input-output and resource redundancy status of these DMUs.

5. Basic Concept of DEA

180. In order to better extend the basic principles of DEA, now we introduce the DEA model and clarify the economic implications EDA efficiency, and illustrate the following concepts.

1) Input and output

181. Input and output in the production process are commonly referred to as production input and production output. As there are several inputs and outputs, we express them in the form of general vector. Input and output is free to handle and dimensional irrelevant. The former means that the factors are free to deal with in the production activities, namely, the increase of input does not result in the decrease of output. Meanwhile, input means the use and consumption of resources, which is negative; and output means the generation of value, which is positive. Dimensional irrelevancy means the resulting efficiency value is irrelevant with the dimensions of the input and output data, but the dimensions of the same input or output for different DMUs should be the same.

2) Decision-making unit (DMU)

182. DMUs are entity units, which describe the process of how the input is transformed into the output. DEA efficiency is the comparative value of the input-output ability of a DMU relative to the DMU on the surface of the production frontier. A selected set of DMUs must have the same objectives and tasks, namely they must be comparable and homogeneous. In this paper, the input and output values at different time points in the same port are used as a set of DMUs.

3) Production possibility set

183. Assume the input of a production activity is $X = (x_1, x_2, \dots, x_m)^T$, the output is $Y = (y_1, y_2, \dots, y_s)^T$, and point (X, Y) is the production activity. The production activity composed of the set $T = \{(X, Y) \text{ input } x \text{ and generate } y\}$ is the production possibility set.

4) Technically efficient, the production function and returns to scale

184. Assume that for any $(X, Y) \in T$, if $(X, Y_1) \in T$ does not exist and $Y \leq Y_1$, then $(X, Y) \in T$, is called technically efficient production activity. The curved surface $Y = f(X)$ composed of all efficient production activity points (X, Y) in the production possibility set T is the production function. The production function

means that under certain technical conditions, when the production is in an ideal state, the maximum output that can be obtained by the input X is Y, that is, the production activities in the production function are technically efficient.

6. The Basic Idea of DEA

185. Conduct linear combination of the known DMUs on the boundary of the production possibility set, and construct DMUs better than the non-boundary DMUs. Then, by combining with the linear planning, conduct comparative analysis for the relative efficiency of various DMUs.

Set the DMUs as follows: $DMU_1, DMU_2, \dots, DMU_n$

Input indicators: $X_j = (x_{1j}, x_{2j}, \dots, x_{mj})^T, j = 1, 2, \dots, n$, $j = 1, 2, \dots, n$, and x_{ij} represents the input of the J th DMU in the i th indicator;

Output indicator: $Y_j = (y_{1j}, y_{2j}, \dots, y_{sj}), j = 1, 2, \dots, n$, and y_{ij} represents the output of the J th DMU in the i th indicator;

For the DMU $j_0 (0 \leq j_0 \leq n)$, we can explore the idea of DEA method from the input and output perspectives:

① For DMU J , without adding more inputs than DMU J_0 , we can find a linear combination that can get the maximum possible output by changing the linear combination of various input factors. If this value is greater than the original output value, then original production combination is defined as inefficient. The model is as follows:

$$\begin{aligned} & \max \omega \\ \text{s.t.} & \left\{ \begin{array}{l} \sum_{j=1}^n \lambda_j x_{ij} \leq x_{ij_0}, i = 1, \dots, m \\ \sum_{j=1}^n \lambda_j y_{kj} \leq \omega y_{kj_0}, k = 1, \dots, s \\ \lambda_j \geq 0, \omega \geq 0, j = 1, \dots, n \end{array} \right. \quad (2.1) \end{aligned}$$

wherein: x_{ij} is the i th input of DMU_j , and x_{ij_0} is the i th input of DMU_{j_0} ;
 y_{kj} is the k th output of DMU_j , and y_{kj_0} is the k th output of DMU_{j_0} ;
 ω is the target value;

λ_j is the linear combination variable.

② For DMU J , under the precondition of ensuring at the least the same output for DMU J_0 , the input factor amount is reduced as much as possible and the minimum output amount is found, if this value is smaller than the original input amount, then DMU J_0 is inefficient. The model is as follows:

$$\begin{aligned} & \min \phi \\ & \left\{ \begin{array}{l} \sum_{j=1}^n \lambda_j x_{ij} \leq x_{ij_0} \phi, i=1, \dots, m \\ \text{s.t.} \quad \sum_{j=1}^n \lambda_j y_{kj} \leq y_{kj_0}, k=1, \dots, s \\ \lambda_j \geq 0, \phi \geq 0, j=1, \dots, n \end{array} \right. \quad (2.2) \end{aligned}$$

Wherein: x_{ij} is the i^{th} input of DMU_j , and x_{ij_0} is the i^{th} input of DMU_{j_0} ;
 y_{kj} is the k^{th} output of DMU_j , and y_{kj_0} is the k^{th} output of DMU_{j_0} ;
 ϕ is the target value;
 λ_j is the linear combination variable.

186. The basic idea of DEA method is to find out the eternal envelop surface based on the input and output of actual sample points by evaluating the relative efficiency of input and output of each DMU in the evaluation system. For the DMU that is not on the envelop surface, we can know the distance relative to the envelop surface.

7. The Efficiency Evaluation Model of DEA

187. CCR model and BCC model are the two most commonly used models of DEA. CCR model is a data envelop model with constant returns to scale, and BCC model is a data envelop model with variable returns to scale. The efficiency of solving BCC model is the pure technical efficiency (PTE) of the evaluation unit, which takes into account the situation where the returns to scale of the evaluation unit increase or decrease. In this paper, BCC model with variable returns to scale is adopted. Assuming there are m independent DMUs, and each DMU has n factor inputs and k outputs, then we build a model:

$$\begin{aligned}
& \min \theta \\
& s.t. \cdot \begin{cases} \sum_{j=1}^m \lambda_j x_{ij} + S_i^- = \theta x_{i0}, (i=1, 2, \dots, n) \\ \sum_{j=1}^m \lambda_j y_{hj} + S_h^- = y_{h0}, (h=1, 2, \dots, k) \\ \sum_{j=1}^m \lambda_j = 1 \\ \lambda_j, S_i^-, S_h^- \geq 0 \end{cases} \quad (2.3)
\end{aligned}$$

Based on the above model, we can calculate the optimal solution $\lambda^*, S_n^{-*}, S_m^{+*}, \theta^*$, in which case its efficiency can be analyzed:

When $\theta^* = 1$ and $S_n^{-*} = S_m^{+*} = 0$, DMU is DEA efficient in both technology and scale. This shows that DMUs are highly efficient and resources are optimally allocated. Operating points are on the surface of the production frontier, all input factors are given maximum play, and on this basis the obtained output will also reach the optimal level. At this point, the production scale is also relatively in the optimal state;

When $\theta^* = 1$ and $S_n^{-*} \neq S_m^{+*} \neq 0$, DMU is weak EDA efficient, which means that it is efficient in technology but inefficient in scale. If $S_n^{-*} > 0$, then the redundancy of the nth input factor is S_n^{-*} ; if $S_m^{+*} > 0$, then the deficit of the mth output factor is S_m^{+*} . In this case, if DMU wants to be DEA efficient, it needs to make the following adjustment: one is to keep the existing output unchanged and reduce the input amount of S_n^{-*} for the nth input factor; the other is to keep the input amount of the existing factor unchanged, and increase the output amount of S_m^{+*} for the mth output factor;

When $\theta^* < 1$ and $S_n^{-*} \neq S_m^{+*} \neq 0$, DMU is DEA inefficient in technology and scale. This means that under existing technology conditions, the current DMU has a problem of resource waste or insufficient output, that is, there are too many input factors and too few output factors. In addition, the smaller the efficiency evaluation indicator θ^* is, the lower the operation efficiency of DMU is. The larger S_n^{-*} and S_m^{+*} is, the larger the space to adjust the DMU to DEA efficient is.

Analysis on the economies of scale:

- If $\lambda^* / \theta^* < 1$, then the DMU efficiency increases;
- If $\lambda^* / \theta^* = 1$, then the DMU efficiency remains unchanged;
- If $\lambda^* / \theta^* > 1$, then the DMU efficiency decreases.

Thus, we can get:

(1)When the economies of scale are unchanged and DMU is technically efficient, the output has reached the maximum scale based on this input.

(2)When the economies of scale decrease and DMU is technically inefficient, it means that if the input is increased, then the increase in output is lower than the increase in input. In this case, we should not increase the input; instead, we should strengthen the management of the input resources, so as to improve the utilization efficiency of existing resources, and strive to achieve the maximum output level and effectively improve the DEA efficiency.

(3)When the economies of scale increase and DMU is technically inefficient, it means that we should increase the input of factors, and also strengthen the management of input resources, so as to improve the output efficiency.

(4)When the economies of scale increase and DMU is technically effective, it means that insufficient input is the most important reason for DEA inefficiency. In this case, we should increase the input of resources and achieve DEA efficiency [14].

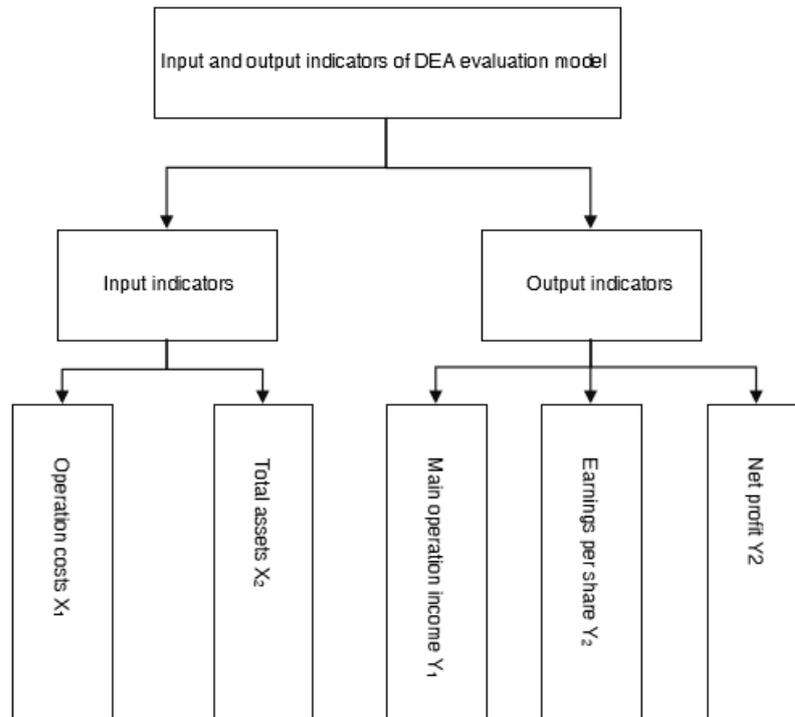
8. Input-output Indicator Selection based on the Variable Model of Economies of Scale

188. According to the economic principle of BCC-DEA, from the perspective of financial efficiency of various ports in Liaoning Province, input indicators are generally cost indicators, such as asset size indicators and operation costs. Output generally focuses on profitability indicators and debt-paying ability indicators, such as operation income, net profit and earnings per share. At the same time, according to the requirement of the variable model of economies of scale for the input and output indicators, the principle of input indicator is “the smaller, the better”; and the principle of output indicator is “the bigger, the better”. In selecting input indicators, this paper mainly selects the total assets and operation costs that can reflect the operation input of port enterprises, and operation costs refer to costs of goods or services provided by enterprises. In terms of output indicators, we choose the three indicators that can reflect the profitability of ports, namely, operation income, net profit and earnings per share. Operation income refers to the total inflow of economic benefits formed by an enterprise in the daily operation of the business, such as selling goods, providing labor services and transferring the right to use assets. These input and output indicators can fundamentally reflect the performance of the basic input and output in ports in Liaoning Province.

9. Input and output indicators of DMU data sample

189. The main principle of DEA is: from a certain point of view, each DMU must have the same inputs and outputs. Take the indicators selected by the Economic Efficiency Analysis of China's High-tech Industries from the Perspective of Technical System as reference (Li Xiaomei), and according to the indicator selection requirements, select output indicators from the profitability indicator and debt-paying ability indicator, and select input indicators from the cost indicator and asset scale indicator. The principle of selecting input indicators is "the smaller, the better"; while the principle of selecting output indicators is "the bigger, the better". So we select total assets and main operation costs as the input indicators, and net profit, main operation income and earnings per share as output indicators, as shown in Figure 15

Figure 15: Input and Output Indicators



III. Development Strategy

190. The above baseline assessment has identified many challenges facing policy makers in Liaoning province. Emphasis was on those areas where policy has either fallen short of its potential or where new and more determined policies can offer remedies to existing challenges. In this section, we use the same five-dimensional framework to discuss strategic opportunities for Liaoning to promote more inclusive and sustained development for all its citizens. Again, we emphasize the role that policy can play, directly and by leveraging private agency, as a catalyst for development. With respect to each of the five core areas, we give direct examples of how proactive policy can leverage existing opportunities for more dynamic and broad based provincial growth.

A. Macroeconomic management and performance

191. This section examines recent history of Liaoning's experience with RCI, including the role central government revitalization initiatives. From this basis, discussion will be extended forward to opportunities for participation in emerging initiatives, including national programs such as the "New Silk Road Economic Belt" and "21st Century Maritime Silk Road," as well as a variety of other PRC domestic, regional, and global commercial initiatives.

192. Three geographic perspectives on RCI are presented, reflecting different dimensions over which regional policy is promoted, namely the international, inter-provincial, and intra-provincial level. For each initiative discussed, an overview of the general cooperation mechanism and Liaoning's individual participation will be discussed.

1. International Level

a) Silk Road Economic Belt and 21st Century Maritime Silk Road

193. Silk Road Economic Belt and 21st Century Maritime Silk Road, or the One Belt One Road Initiative is a national strategy initiated by the central government since 2015, which aims at promoting international economic cooperation in the region. Liaoning's strategic role in this initiative is stated in the state circulate *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, "we should give full play to Inner Mongolia's proximity to Mongolia and Russia, improve the railway links connecting Heilongjiang Province with Russia and the regional railway network, strengthen cooperation between China's Heilongjiang, Jilin and Liaoning provinces and Russia's Far East region on sea-land multi-modal transport, and advance the construction of a Eurasian high-speed transport corridor linking Beijing and Moscow with the goal of building key windows opening to the north."

194. There is huge potential for Liaoning to participate in this initiative. Among the 67 countries along the One Belt One Road, 66 are trading with Shenyang, which exports goods to 66 countries and imports goods from 46 countries. Last year, from January to November, Shenyang exported \$1.236 billion to countries along the One Belt One Road, accounting for 31.7% of the city's total exports. Shenyang and the countries along the One Belt One Road have newly signed 22 foreign contracting projects with a total contract amount of \$334 million, accounting for 28.6% of the city's total. Eight projects have been invested in seven countries, including India, Pakistan, and Oman, with a total investment of \$85.7 million, with three projects each over \$10 million.

b) Liaoning's engagement and achievements

195. The government work report adopted at the sixth session of the 15th National People's Congress of Shenyang put forward that Shenyang would implement a more active opening-up strategy, that Shenyang would actively integrate into One Belt One Road, improve the port and streamline the customs procedures, actively create "Shenyang port" and airport economic zone as hubs for opening-up, explore long-term operating mechanism for trains connecting "Shenyang-Manchu-Europe", "Shenyang-Manchu-Russia". Emphasis can be seen on construction of infrastructure, namely ports and transportations, and further trade integration.

196. According to officials in Liaoning government, Liaoning had made huge progress in constructing the three transportation channels which connect "Liaoning-Manzhouli-Europe", "Liaoning-Mongolia-Europe", "Liaoning-Bering Strait-Europe" by improving the infrastructure connection and network. Furthermore, Liaoning has developed numbers of overseas investment projects in countries along One Belt One Road, the investment in and the trade with which account for an important proportion of total overseas investment and total trade of the province.

197. Liaoning Pilot Free Trade Zone (FTZ), officially launched on 1 April 2017, is a provincial project launched by the central government, which forms part of the third batch of government-endorsed pilot FTZs, in a bid to expand opening-up and revitalize the Northeast region. According to the plan, the free trade zone will be built into a trade park with high-end industries, convenient investment and trade facilities, improved finance services, and highly efficient supervision methods within three to five years. Covering an area of 119.89 square kilometers, the free trade zone contains three districts in the cities of Dalian, Shenyang, and Yingkou.

198. According to the *Overall Plan for the China (Liaoning) Pilot FTZ*, as approved by the State Council, Liaoning FTZ should place institutional innovation as the core, draw up replicable and elsewhere-applicable experiences as basic requirements, to accelerate the reform of the market-oriented system and mechanism and actively promote the structural adjustment, to build a new engine for raising the overall competitiveness of the northeast old industrial base and the level of opening up. Main tasks include the transformation of government functions, further reform in investment, transformation and upgrading of trade, innovation and opening up in finance, structural adjustment in the old industrial base, and opening up and regional cooperation in Northeast Asia.

199. Liaoning FTZ has launched several packages of policies, presented in official documents including *Initial List of Policies in Shenyang Area of Liaoning FTZ* and *China (Liaoning) Pilot Free Trade Zone Regulations (draft for comment)*, including Negative List, Single Window, one-stop administrative permission, combining the licenses and other actions to simplify the registration procedure and promote the investment.

200. By the end of 2017, there were 21,641 newly registered enterprises in the Liaoning pilot FTZ, with a registered capital of 313.19 billion RMB. There were 274 foreign enterprises with a registered capital of US\$5.27 billion, 519 enterprises whose registered capital exceeded 100 million RMB. Compared with other new FTZs, by the end of 2017, Liaoning FTZ has the most newly registered enterprises and the most newly registered capital. 99 innovative policies developed in other FTZs have been implemented in Liaoning FTZ and Liaoning has newly developed 29 innovative policies, of which 13 were recognized as the first in the country.

c) *China-Northeast Asia Expo*

201. The China-Northeast Asia Expo (CNEA Expo) is a nation-level exhibition for international cooperation in Northeast Asia approved by China's State Council, hosted by the Ministry of Commerce, the National Development and Reform Commission and the government of Jilin province. It is co-sponsored by several departments in central government as well as the local governments of Liaoning, Heilongjiang, and Inner Mongolia autonomous region. The expo is held annually in early September in Changchun, Jilin province.

202. CNEA Expo focuses on exhibitions, economic and trade cooperation, conferences and forums and cultural exchanges. CNEA Expo has been held 11 times since 2005, and the High-level Forum on Economic and Trade Cooperation in Northeast Asia has been held during 9 of these expos.

203. According to the official press release, at the 11th CNEA Expo which was held in September 2017, over 10,000 exhibitors and visitors coming from 116 countries and regions around the globe attended the expo. The number of high-ranking officials was double that of the previous year. Over 186 senior executives from Chinese branches of Top-500 companies and multinationals, along with 33 senior managers from top Chinese companies and 40 financial institutions and agencies were in attendance this year. The foreign trade volume reached \$ 837 million, an increase of 4.5 percent year-on-year, with export and import orders totaling 689 million and 139 million, respectively. The domestic trade volume amounted to \$374.64 million, up 6.8 percent over the previous year. A total of 235 contracts worth of 224.3 billion yuan (\$34.26 billion) were signed during the expo, ranging from automobile and auto parts industry, the petrochemical industry, the agricultural products processing industry, the equipment manufacturing industry, pharmaceuticals industry, and health and service industry. Since the expo started in 2005, it has generated trade deals valued at more than \$8 billion.

d) *Greater Tumen Initiative*

204. The Greater Tumen Initiative (GTI) (originally known as the Tumen River Area Development Programme) is an intergovernmental cooperation mechanism among four countries in the Greater Tumen Region: China, Mongolia, Republic of Korea and Russia, initiated and supported by the United Nations Development Programme (UNDP) since 1995; DPRK was one of the initial members. GTI focuses on the priority areas of transport, trade and investment, tourism, agriculture, energy, with the environment as a cross-cutting sector.

205. The core decision-making institution of the GTI is the Consultative Commission which is composed of Vice-Ministers from the GTI member governments. The Commission convenes annually to discuss key policy issues and cooperation projects among the GTI members and hosts joint sessions with strategic partners as well as local governments.

206. In addition, GTI works closely with other countries in Northeast Asia to promote further economic cooperation in the region, and hosts both the Northeast Asia EXIM Banks Association as a regional development financing mechanism, and the Local Cooperation Committee in support of cooperation initiatives among local governments in Northeast Asia. The 5th GTI International Trade and Investment EXPO was held on 21-24 September 2017 in Donghae City, Gangwon Province of ROK. The 4th GTI Environmental Board Meeting was held on 16 October 2017 in Beijing. The 10th GTI Tourism Board Meeting, co-organized by GTI Secretariat the Ministry of Culture, Sports and Tourism of ROK

and hosted by Gangwon Province, was held on 31st August 2017 in Pyeongchang Alpensia Resort, ROK.

2. *Inter-provincial Dimension*

a) Four Northeastern Provinces and Region Chief Executive Consultation Mechanism

207. Suggested in Several Opinions of State Council on Further Implementation of Strategy for Revitalizing Northeastern China and Other Old Industrial Bases issued by the State Council in 2009, the Four Northeastern Provinces and Region Chief Executive Consultation Mechanism was officially established in 2010 on the first Joint Cooperation Meeting of Chief Executives of the Four Northeastern Provinces and Region.

208. The Four Northeastern Provinces and Region Chief Executive Consultation Mechanism is composed of the Joint Cooperation Meeting of Chief Executives, the meeting of secretary-general, and the daily work contact office. The Joint Cooperation Meeting had been held four times annually from 2010 to 2013. Several agreements on inter-provincial cooperation in Northeastern China were signed at each meeting.

b) Bohai Economic Rim

209. Bohai Economic Rim (BER) is the economic region surrounding the Bohai Sea, including areas in Liaoning, Hebei, Shandong, Beijing, and Tianjin. This region has undergone major economic and infrastructural changes and is an emerging economic powerhouse of Northern China, rivaling the Pearl River Delta in the south and the Yangtze River Delta in the east as one of the three economic regions in China.

210. Joint Meeting of Mayors for Regional Cooperation Surrounding Bohai, the cooperation mechanism in BER, has been held 15 times from 1986 to 2011; 40 cities in the region have become its member. Agreements have been signed and regional cooperation organizations have been created under this mechanism in many areas, including transportation, ports, energy, technology, industry, etc.

c) Cooperation Between East and Northeast Provinces

211. State Council issued a circular on March 17, 2017, to promote cooperation between east and northeast provinces. Authorities and State-owned enterprises (SOE) in the Northeast region are asked to incorporate Eastern region's experience into their reform to build a business-friendly environment. Leading capital in Eastern China will be encouraged to take part in SOE reform and invest in high-quality projects in northeast provinces through public-private

partnerships (PPP). According to the circular, one-on-one partnerships will be formed between Liaoning and Jiangsu province. Ties of cooperation will also be set up between cities of Shenyang and Beijing, Dalian and Shanghai.

212. Based on the partnership, a symposium was held in Dalian on September 3, 2017, on cooperation between Shanghai and Dalian. On the same day, Shanghai and Dalian also held a signing ceremony for the cooperation and economic and trade talks and cooperation projects. More than 110 companies from Shanghai and Dalian, contracted projects of 57 related to modern agriculture, new energy, biological medicine, wisdom, ports and logistics, finance, urban construction from several aspects, such as cultural tourism investment of more than 170 billion yuan.

3. *Intra-provincial Dimension*

a) Liaoning Coastal City Economic Belt

213. As *Liaoning Coastal City Economic Belt Development Plan* was approved by the State Council in 2009, Liaoning Coastal City Economic Belt has then been recognized as a national strategic program. At the core of the Belt is the Five Spots in a Line, first suggested by Liaoning government in 2005, which consists of five industrial parks on the coast and the Coastal Highway in Liaoning. Liaoning Coastal City Economic Belt was the last coastal region in China that had not been developed as a whole in a planned way at that time.

214. In 2008, seven cities on the coast formed Liaoning Coastal City Economic Union as a regional cooperation organization with governmental administrative functions. Joint Meeting of Mayors in Liaoning Coastal City Economic Union has been held, at which cooperation agreements were signed. For example, Cooperation Agreement on Tourism Integration in Liaoning Coastal City Economic Union was signed at the Meeting in 2011 to promote the integration of tourism industry.

4. *General Conclusions*

215. After reviewing the current initiatives and relevant literature, this section will discuss our general findings regarding the current situation of RCI for Liaoning, including the significance of RCI for Liaoning, opportunities for Liaoning for RCI, and issues of Liaoning's RCI.

a) Significance of RCI for Liaoning

216. From the review of current initiatives and Liaoning's participation and achievements in RCI on every level including international level, inter-provincial

level, and intra-provincial level, it is obvious that Liaoning's active participation in RCI on every level is significant and necessary for Liaoning to get out of the economic stagnancy and achieve further development.

b) Necessity of RCI

217. In the baseline assessment, we have learned the current situation of economic stagnancy of Liaoning and of the whole Northeastern China region. From the experience of the most rapidly developed regions in the country, namely the Yangtze River Delta Region and the Pearl River Delta Region, it is clear that economic development in current days highly depends on RCI on many levels, including interregional, intraregional, and international level.

218. Furthermore, Liaoning is not the only province facing this issue of insufficient RCI. As part of the Northeastern Old Industrial Bases, Liaoning shares similar difficulties and demands with neighboring provinces, Heilongjiang and Jilin. Inter-provincial cooperation in this region is necessary for each of the province and the region as a whole for higher level cooperation.

219. Thirdly, as reviewed above, RCI requires series of fundamental reform and innovation, which is also required for the general development of Liaoning's economy. Thus participation in RCI can be an opportunity for Liaoning to systematically resolve some long-standing and thorny problems in favor of sustainable development of local economy.

c) Liaoning's advantages in RCI

220. Meanwhile, Liaoning has many advantages and huge potential in promoting and participating in RCI on all the levels. First, Liaoning has the geographic advantage. Liaoning is the only province in Northeastern China that both borders other countries and has a coast and is located as a transportation hub in Northeastern Asia, which is a huge advantage for RCI on the international level in Northeastern and Eastern Asia and also on the inter-provincial level in Northeastern China. Regarding the national strategy One Belt One Road, among the 67 countries along the One Belt One Road, 66 are trading with Shenyang, which exports goods to 66 countries and imports goods from 46 countries. As a coastal province, before the Liaoning Coastal City Economic Belt Development Plan was officially established, Liaoning was the last coastal region in China that had not been developed as a whole in a planned way.

221. Second, Liaoning, as one of the old industrial bases, has well-developed infrastructures for transportation on all levels of regional cooperation, including rails, highways, and ports. Furthermore, Liaoning has rich economic and industrial resources, especially in equipment manufacturing industry. Although

reform and transformation of old industrial structure and old way of production are necessary for revitalization and sustainable development, these resources can also be utilized deliberately to constitute Liaoning's comparative advantage compared with other regions in China.

d) *RCI Opportunities for Liaoning*

222. Undoubtedly, governments on every level have noticed the significance of Liaoning's participation in RCI and have initiated abundant policies and strategies to promote RCI on every level. From the review of current initiatives, it is clear that there are enormous opportunities for Liaoning to further participate in RCI.

(1) Favorable national strategy as background

223. As analyzed above, the national strategies of One Belt One Road, Pilot Free Trade Zone, and others, have been playing significant roles in promoting Liaoning's RCI and Liaoning's economic development on all levels as a strong support.

224. One Belt One Road as one of the three main national strategies, along with Yangtze River Economic Belt and Coordinated Development of Beijing, Tianjin, and Hebei Province, involves tremendous resources on both national and international level. Liaoning's advantages, as analyzed above, would allow Liaoning to hugely benefit from this historic opportunity to both promote its participation in RCI and achieve enormous economic development.

225. The other main national strategy, the Coordinated Development of Beijing, Tianjin, and Hebei Province, can also be expected to benefit Liaoning's integration to the inter-provincial regional economy as one of the main economic engines in Bohai Economic Rim.

226. Liaoning Pilot Free Trade Zone as one of the third batch of FTZs and the first FTZ in Northeastern China, has already attracted numerous investment both from domestic enterprises and foreign enterprises in the past 2017, which is among the best in the third batch of FTZs. It has also promoted institutional innovation and reform.

227. Liaoning Coastal City Economic Belt, RCI on the intra-provincial level, which was also upgraded to a national strategy, would further serve as the engine of economic growth in the province.

(2) Abundance of platforms on each level of cooperation

228. In addition to national strategies as background, cooperation platforms and mechanisms have been developed on each level of RCI.

- For international cooperation, there exist the Greater Tumen Initiative and related organizations for governmental cooperation and China-Northeast Asia Expo for economic cooperation.
- For inter-provincial cooperation, there is the Four Northeastern Provinces and Region Chief Executive Consultation Mechanism under which many agreements and organizations on inter-provincial cooperation have been formed.
- For intra-provincial cooperation, Liaoning Coastal City Economic Union was formed to promote cooperation and integration in Liaoning Coastal City Economic Belt.

(3) Challenges to RCI for Liaoning

229. However, our review of current issues and policies suggests that there are significant problems and difficulties undermining opportunities for Liaoning to pursue RCI along all three dimensions. General problems, which are correlated with one another, include:

(4) Local Protectionism and Competition

230. As pointed out in many studies on several initiatives on diverse levels of cooperation, local protectionism prevailing in many local governments on diverse levels is one of the main hindrances to genuine regional cooperation. According to the literature, such local protectionism can be seen in provincial governments in inter-provincial cooperation and municipal governments in intra-provincial cooperation.

231. Local protectionism may stem from an underestimation of the significance of RCI, lack of cooperative mindset, and a deep-rooted sense of competition. Local protectionism leads to ineffective and inefficient cooperation, governments withholding information from each other, and low-end market competition such as providing enterprises with simple benefits to attract investment instead of designing innovative policies. Low-end market competition may also lead to ignorance of sustainability in development, especially in terms of environmental protection.

(5) Lack of Adequate Planning

232. Despite all the coordinating mechanism existing, lack of overall planning is another hindrance pointed out by various literature in the cooperation of Northeastern provinces, cooperation in Bohai Economic Rim, cooperation in Liaoning Coastal City Economic Belt, cooperation within Liaoning Pilot FTZ, etc. Several administrative authorities in the region may separately plan their industrial structure, branding strategy, infrastructure construction, etc.

233. Lack of overall planning in RCI leads to fragmentation and homogenization in the industrial structure which counteracts the benefits of complementary advantages and even encourages unnecessary competition and conflicts, as well as inefficiency in many aspects.

(6) Inadequate Cooperation Mechanisms

234. Many cooperation and coordination mechanisms for RCI remain on a superficial level, which partly led to the lack of overall planning. Although many documents and agreements are signed at the meetings, the implementation and the results are merely recorded, reported, or assessed. Furthermore, meetings which constitute a significant component of some cooperation mechanisms such as Joint Cooperation Meeting of Chief Executives of the Four Northeastern Provinces and Region, Joint Meeting of Mayors for Regional Cooperation Surrounding Bohai, and Joint Meeting of Mayors in Liaoning Coastal City Economic Union, have not been held for several years recently, and their official websites have not been updated soon after the mechanisms were established or the meetings were no longer being held.

(7) Insufficient Institutional Reform

235. Insufficiency of institutional reform, which is recognized to be crucial to Liaoning's economic development in general, remains to be a hindrance to Liaoning's participation in RCI. Especially in Liaoning Pilot FTZ, institutional obstacles, showing up as excessive government intervention in the market, ambiguous or overlapping sphere of administrative authorities, etc., have negative effects on attracting investment and implementing innovative policies. Same in other RCI and in general economic development, more institutional reform should be adopted.

B. Transport infrastructure development and financing

- 236.** According to the ADB (2017) study on Infrastructure Needs, in Asia, 90% of the infrastructure investments come under public funding. In the ADB study SOEs investments come under public funding. On average SOEs account for 25% of total infrastructure investments being far higher in PRC (50%). Private sector is hesitant to invest in infrastructures as these investments are perceived as bringing low returns.
- 237.** Traditionally public infrastructures were provided directly by government or through affiliated agencies with funding coming generally from annual budgets. With increases pressures on budget and mounting public debts, the provision of public infrastructures through the “conventional method of delivery” has become more and more problematic. Alternative ways of financing and delivery are then needed to be put in place through increased participation of the private sector. This is why Public-Private-Partnership (PPP) models were invented and tested in many countries including China. Adaptive PPP models could then convince the private sector to finance more infrastructures.

1. Definition of PPP

- 238.** There is not a universally accepted definition of PPP and many have been proposed. They all imply a contractual arrangement between public entities and private organizations with the ultimate objective being the provision of services to consumers. A rather comprehensive definition is given by the ADB report on PPP operation guidelines⁵: “A PPP refers to a contractual arrangement between public (national, state, provincial, or local) and private entities through which the skills, assets, and/or financial resources of each of the public and private sectors are allocated in a complementary manner, thereby sharing the risks and rewards, to seek to provide optimal service delivery and good value to citizens.” Along the same vein, and widely quoted is the World Bank definition⁶: “PPP refers to a long-term contract between a private party and a government entity for providing a public asset and/or a service in which the private party bears significant risk and management responsibility and remuneration is linked to performance”.
- 239.** There is a vast nomenclature of terms commonly used in any PPP analysis and for sake of clarification they are summarized in the table below.

⁵ “Public–Private Partnership Operational Plan 2012–2020”, ADB 2012;

⁶ WB PPIAF (2017) provides that definition as well as WB (2017) PPP Reference Guide Version 3.

Table 20: Glossary of PPP Terms

PPP Term	Definition
Affermage	An affermage contract is similar to a concession, but with Government responsible for capital expenditures;
Bond Financing	Financing of project through the bond market with Project Sponsor (Investor) issuing bonds;
BOT	Build-Operate-Transfer; many variants: Build-Own-Operate (BOO) or BOOT and DBOT with design included;
Brownfield Project	Refer to project on existing asset;
CA	Concession Agreement
Concession	The term is used for different purposes but basically it means the grant by Government of a right to provide a service or to use an asset;
Conventional Delivery	Refers to traditional provision of infrastructures through public expenditures
CPPPC	China Public Private Partnership Centre
DBOT	Design Build Operate Transfer
Debt Financing	Financing through borrowing from banks in a form of loans;
Divestiture	Transfer or sale to private sector of a public asset;
Equity Financing	Project financing through issuance of shares by Project Sponsor
Fee	Payment by Government to Project Company for services
Financial Closure	Date when project contract is signed and financing is guaranteed
Franchise	Franchise is used to describe an arrangement similar to either a concession or a lease or affermage contract;
GA	Guaranteed Agreement
Government Availability Payment	Government payment for service provided by private sector usually under PBC; equivalent to “fee payment”;
Grantor	Public entity Initiator of the Project, generally Government
Greenfield Project	New Project or New Asset
KPI	Key Performance Indicators
LCY Bond	Local Currency Bond
Lease Contract	Public Entity (or Government) leases asset to private entity to allow provision of services;
Management Contract	Contract between public and private entities to operate the existing asset, usually under PBC;
MDB	Multi National Development Bank
Mezzanine Financing	Hybrid of debt and equity financing
O & M	Operation and Management Contract
PBC	Performance Based Contract
PDF	Project Development Fund (Facility)
PFI	Project Facility Initiative
PPI	Public Private Infrastructure refers to World Bank Data Base
PPP	Public Private Partnership
PPIAF	World Bank Public Private Infrastructure Advisory Facility
PSC	Public Service Comparator

PSO	Public Service Obligation
Project Company	Private sector entity in charge of the project
Project Sponsor	Private sector investor on the project
Risk Allocation	Method of allocation of risks among contractual parties
ROT	Rehabilitation of existing asset/facility (brownfield)-Operate-Transfer
Shadow Banking	Financing operations using non-bank institutions (Insurance, Trusts, Pension Funds...);
SOE	State Own Enterprise
SPV	Special Project Vehicle like the project company
TOD	Transit Oriented Development
Transaction Advisory	Advices provided to single or both parties at the time of contractual negotiations by specialized organization;
User Pay	Payments by customers when using provided infrastructure service
VFM	Value For Money; VFM analysis required before proceeding
Viability Gap Financing (VGF)	Form of subsidy or compensation payment by Government to Project Sponsor when user pay revenues would not cover costs;
WLCC	Whole Life Cycle Costing

2. Types of PPP Schemes

240. Originally PPP schemes were implemented because governments under severe budget constraints were incapable of coping with increasing demands in infrastructures. But the idea of partnership in the provision of infrastructure services goes beyond the simple question of financing. It does introduce new methods of risk sharing between public and private entities. It does also introduce new mechanisms for the delivery of services bringing efficiency gains and in general greater economic benefits to society than delivery under simple private or public responsibility.

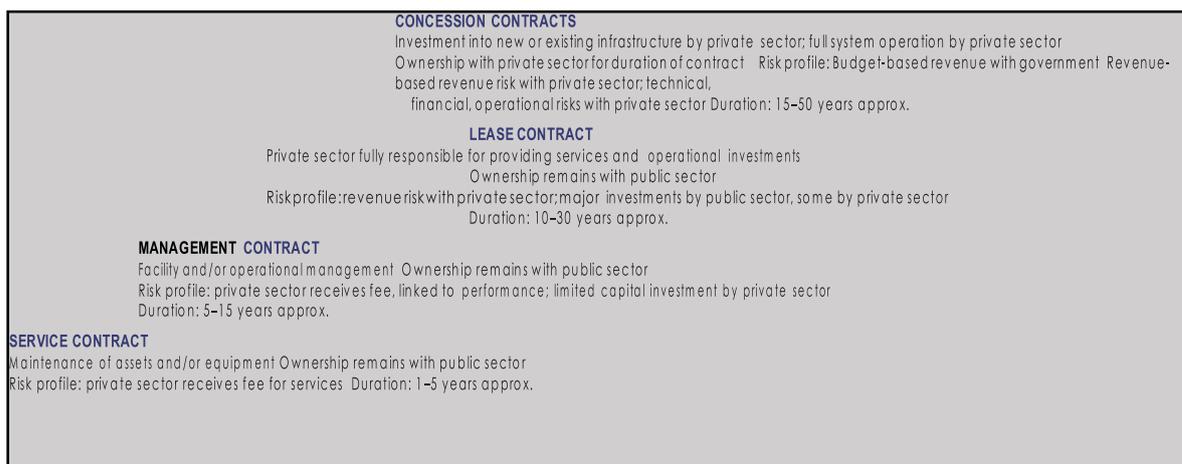
241. There is, in fact, a whole variety of possible PPP schemes but by and large the different schemes differ according to the level of private sector participation and whether the asset is publicly or privately owned. Therefore, contractual arrangements between public entities and private sector organizations belong to the main three classes: a) *Management and service contracts*, b) *Lease contracts or Affermage* and c) *Concession contracts*. Private sector participation increases along the above sequence and asset ownership is gradually transferred (temporally or not) from the public entity to the private sector.

242. In the above, only 3 types of PPP schemes were considered, though they all have variants. The first type "*Management and Service Contract*" refers to the case where a private organization is providing services for a public entity under a

performance based contract using an infrastructure owned by the public entity and built under a separate arrangement. The second type, “*Lease contract*” covers all schemes of “design-build (or not)-operate” where the facility remains in the hands of the public entity but is leased to private operator. The third one under “*Concession*”⁷ name covers all forms of “design-build-operate-transfer” variants where the built facility is temporally owned by the private sector under self-financing or co-financing agreements and is generally transferred back to the public entity at the end of the concession period. The degree of “partnership” and risk sharing varies among and within the three schemes.

243. The different types⁸ of PPPs are presented in the figure below quoted from the ADB PPP Operation Plan 2012-2020. Starting from the lower left of the Figure and going to the upper right shows the PPP types ordered in terms of increased private sector participation in risk allocation and asset ownership and capital investment.

Figure 16: Public Private Partnership Spectrum



244. In the three first types (service, management and lease contracts) private sector risk concerns only the operation aspects of the public service; the public entity finances and builds or refurbishes the asset. In a concession, the private-sector party gets the responsibility and the associated risk for constructing and financing a new asset, or modernizing an existing facility. The concessionaire is given the right to operate the facility for a specified period with the public-sector entity regaining ownership at the end of the concession period. A typical concession is a long-term contract with duration ranging from 25 to 30 years and up over 60 years. Under the “concession” typology they are many options, though they all assume

⁷ The term “concession” is here reserved for all the variants around the BOT concept.

⁸ The figure distinguishes between Service and Management Contract, though they have the same characteristics except that service contracts could be of much shorter duration.

infrastructure construction, financing and temporary asset ownership: Build-operating-Transfer (BOT), Design–Build–Operate-Transfer (DBOT), Build-Own-Operate (BOO).

245. The table below analyzes these key elements for the different broad categories of PPPs highlighting the different responsibilities between the public and private entities.

Table 21:PPP schemes and responsibilities

	Management Contract		Lease Contract		Concession contract	
	Public	Private	Public	Private	Public	Private
Building of new asset	N/A	N/A	Built by public entity under separate contract	Could build asset under separate contract	No implication	Design & build asset as part of concession contract
Provision of service	Principal, regulator and quality controller through KPI	Provision through Performance based contract (PBC)	Principal, regulator and quality controller through annual contract review	Full responsibility for provision of service	Regulator and at intervals auditing of output quality	Full responsibility for provision of service and asset construction
Asset Ownership	Fully under public entity	No ownership	Ownership remains under public entity	Asset leased to contractor who is responsible for maintenance	Asset ownership transferred to public entity at the end of concession period	Temporally owns asset during concession period
Duration	5 to 10 years		10 to 30 years		15 to 50 years	
Financing	If new asset, internally financed	No implication in asset financing	If new asset, internally financed	No implication in original financing; payment of rental fee for asset	Range of options: - No participation; - Participation limited to facilitation; - Co-sharing (equities, grant, guarantees...)	Range of options: - Fully responsible (bank loans, bonds, stock equity issuance...); - Co-sharing
Payment of services	Control payment of services with KPI of PBC	Fees received through Performance Based contract	N/A	Net revenues from user fees after payment of rental fee	N/A	Net revenues from user fees after deduction of asset maintenance costs
Risk sharing	Contractor not performing	Contract fees too low for provision of services	Service inadequate; If leaser losing money, may have to compensate or replace contractor	Collected user fees not covering net costs	Service inadequate; financing risk if co-sharing with private organizations	Collected user fees not covering net costs including provision for return on investment

Source: Consultant

246. PPPs may apply to new infrastructure projects (green field projects) or to existing infrastructure projects (brown field projects) with contracts signed between public and private entities. Public entities would either be: central/national, provincial or local/municipal entities with private entities being usually for-profit organizations with on occasional cases non-profit organizations. Public–private partnerships are generally characterized by six key elements: (i) duration; (ii) asset financing, (iii) life-cycle responsibility and ownership (temporary or permanent); (iii) performance-based returns and user fees; (iv) output and quality of service specification; and (v) risk allocation between public and private sector.

247. PPPs may however not necessarily be suitable for all countries and for all infrastructure investments⁹. The EIU has recently built a PPP readiness Index¹⁰ and results for a few Asian countries are given below.

Table 22: Infrascopes 2014 EIU PPP Index

Country	Index	Regulations	Institutions	Operation	Investment	Finance	Sub-nation
Australia	91.8	100	100	60.2	90.5	94.4	100
Japan	75.8	65.6	66.7	61.4	86.5	88.9	100
India	70.3	65.6	66.7	87.5	60.8	72.2	75
Philippines	64.6	68.8	66.7	44.8	75.3	63.9	50
PRC	55.9	34.4	33.3	75.8	78.3	66.7	75
Indonesia	53.5	46.9	58.3	51.6	59.3	58.3	50
Thailand	50.4	34.4	50	58.1	57.6	61.1	50
Vietnam	33.1	25	25	39.8	55.6	33.3	25
Weight	100%	25%	20%	15%	15%	15%	10%

248. Among the emerging countries, India comes with the highest score in terms of readiness with Philippines coming a good second. For most of them there is room to improve on PPP readiness. Despite good investment climate and official support by authorities, China comes out with only an average scoring. This is due to her low score given to the lack of effective support from the existing regulatory and institutional framework. This assertion is further reviewed below when discussing specific PPP Chinese examples.

⁹ In an ADB Brief on PPP (ADB (2008)), it is mentioned that in UK only 20% of infrastructure investments were through PPP schemes;

¹⁰ *2014 Infrascopes PPP Index, Evaluating the environment for public private partnership in Asia-Pacific*, Economist Intelligence Unit (EIU) 2014. Survey was realized in December 2014 among 80 selected experts. Scoring (maximum 100) is a complex calculation where for all the 6 themes a series of questions were asked. The themes were: 1) *Regulations* or extent of PPP supportive legislations and regulations; 2) *Institutions* and their extent to support PPPs; 3) *Operations* or capacity of public entities to deliver PPPs; 4) *Investment* climate; 5) *Financing* support to PPPs; 6) PPPs penetration at *sub-national* levels.

249. The delivery of public services through PPPs instead of the conventional deliver is expected to bring economic impact benefits and welfare gains if certain conditions are met. A brief list of the conditions to be met is given below:

- Suitable legal and regulatory framework to support PPPs (authorizes the schemes, ensures good governance in the process, and has capacities to resolve contractual conflicts...);
- Knowledgeable public entities capable of managing PPPs;
- Strong financial institutions;
- Government willingness to let private investor in PPP contract have a reasonable return when performance is met;
- Sufficient number of experienced private sector companies with strong financial position.

250. Quite a few documents are available for public entities to check on the justification to go ahead with PPP projects. One of the most often quoted is the “*World Bank Check List for Public Private Partnership Projects*” (World Bank (2014))¹¹. Another one is the “*ADB Public Private Partnership Operation Plan 2012-2020: Realizing the vision for Strategy 2020*” (ADB (2012)).

251. Once it has been agreed to follow a PPP approach, the public entity selects the best option among available PPP schemes. The choice would depend on a series of factors: a) degree of risks that the public entity is prepared to absorb; b) size of the project; c) expected duration of the contract and whether the project is suitable for a “whole life cycle costing” (WLCC); expected profitability of the project; d) sufficient number of companies capable of providing the public service in a satisfactory manner.

3. PPP Projects: Stages and Process

252. PPPs offer many advantages and benefits compared to the conventional way of procuring infrastructures by public entities. The process of delivery of PPPs is however more complex and required more steps. There are many references¹² outlining and discussing the various steps of the process of implementation of

¹¹ The check list looks at 4 major themes: Politics, Law & Institutions, Economics & Finance, and Execution. And from the analysis of 60 cases from IFC projects, a series of questions are drawn to check if a project is a justified PPP candidate.

¹² Interesting other references are; *Conference Paper: “Infrastructure Project Financing, Public Private Partnership –Day 3”*, Price Waterhouse Coopers Advisory Pte (PWC (2017 and the “*Malaysia PPP Guidelines*” (Malaysia (2009.)

PPPs. The most complete reference is the *World Bank PPP Reference Guide – version 3* (World Bank (2017)).

253. Inspired from existing references, details on the PPP implementation process are presented below. The 12 steps are broken down into two parts, the “Pre-PPP Contract Steps” and the “PPP BOT Contractual Arrangements Steps”. For each of the 12 steps activities to be performed by the public entity (grantor), the private sector entity (the sponsor or investor) and the lenders are detailed.

Table 23: Process Steps for PPP Implementation

Pre PPP Contract Steps						
	S-1	S-2	S-3	S-4	S-5	S-6
Activities/Steps	Pipeline of public infrastructure investment projects	Prioritization of public infrastructure investments	Selecting projects as potential candidates for private sector	Qualifying infrastructure investments for PPP	Prequalification of firms on selected PPP project	Bidding Process
Activities of public entity	Compile list of potential projects with estimated costs by sectors	Screening of projects and prioritization according to criteria in conformity with long-term planning objectives	After fiscal situation reviewing and analysis of project types, prepare list of potential candidates to be developed by private sector	First: are conditions for PPPs met? then, carry the Public Service comparator (PSC) and the Value For Money (VFM) test and decide on the optimal scheme	Advertise outline of the PPP project and criteria for prequalification for firms	Establish the short list, issue the bidding document and fix the bidding conditions (varying according to the selected PPP scheme) and the bidding date
Activities of private sector entity	Getting aware of potential projects, estimated costs and firm competition	Follow the prioritization process and ask for transparency in the process	Government may consult private sector on interest to develop some type of projects	With the list of possible PPP projects (and their scheme) firms send EOIs and draw preliminary business models	Prequalification documents include: preliminary FS, business plan; financial plan based on discussions with finance institutions	Bidder's costing is according to WLCC and include expected revenue schedule; bid includes proposed business & financial plan
Activities of Lenders				Lenders aware of PPP projects on the market	Meetings with potential bidders on lending conditions	Conditional financial agreements with bidders
PPP BOT Contractual Arrangements Steps						
	S-7	S-8	S-9	S-10	S-11	S-12
Activities/Steps	Preparation for contract by the presumed bid winner	Confirmation of Financial Plan for presumed winner	Contractual Negotiation and signing of PPP agreement	Procurement (construction or rehabilitation of asset)	Operation	Transfer
Activities of public entity	Select winner based on least cost if conditions are met; contract preparation	Monitor Financial plan and on occasions take equity or cost coverage	Contract includes: cost (WLCC), performance requirements, payment mechanisms, dispute & termination resolution; risk allocation; financial closure	Monitor satisfactory delivery of asset construction through dedicated KPIs	Monitor SPV operation performance & enforce contractual obligations on payment mechanisms	At end of concession of contract duration, <i>Grantor</i> gets back new asset
Activities of private sector entity	Winner set up SPV as <i>project company</i> and prepare agreements with sub-contractors	Confirm details of the plan: commercial loans? Own firm equity, GVt participation, bonds?	Once completing negotiations, SPV signed contract with public entity and with financial institutions & sub-contractors	SPV through sub-contractors realize the agreed asset construction	SPV with sub-contractors provide as agreed O&M and get payments from <i>Grantor</i> & user pay	Transfer of asset to <i>Grantor</i> & close accounting
Activities of Lenders		All details of the Financial plan to be iron out with institutions	Financial institutions signed agreement with SPV	Monitor loan withdrawals and repayments	Monitor loan withdrawals and repayments	Financial institutions involved in final accounts closure

254. For the public entity, the most complex steps are S-4, S-6 and S-9. Firstly, in S-4, assuming infrastructure projects submitted are all goods and economically justifiable, government has to decide if it constitutes a valid PPP projects. There are tools available to help the decision like the Public Service Comparator (PSC) and the Value for Money (VFM) calculation. They consist in comparing the cost of construction of the asset and the delivery of services under conventional delivery and under PPP. Of course, calculations are based on broad estimates since contractual arrangements with a future investor are still unknown. When it comes to the bidding process (S-6) government or the public entity have to be able to specify the payment mechanism to the private sector investor and the length of the concession offered. The payment mechanisms are of three types: a government availability payment, a user pay scheme (tolls/fares) or a mixed solution referred as a viability gap financing where government compensates the investor for shortcomings in the user pay scheme. After completing the negotiations, the public entity would sign the concession or BOT agreement with the *project company (SPV)* which has been specially established by the investor/sponsor. Besides the condition mentioned above, the contract would contain the KPIs used by the public entity to monitor the progress and the performance of the project company and the sub-contractors in the construction and operation phases.

A PPP approach is also a transfer or a reallocation of the *risks* from the public to the private sector entity. Throughout all the steps (from S-5 to S-12) the investor/sponsor, while preparing for the delivery of the infrastructure and accompanying services, would take all the measures to mitigate the risks now allocated to him. The measures would be: hiring reliable sub-contractors, monitoring closely any cost escalation in construction and O&M, negotiate with public entity contract conditions protecting against major negative changes in demand, negotiate reasonable financing conditions, getting clear understanding on conditions and schedule of payment from public entity. Later in the report when analyzing the lessons learnt from PPP case studies and experience, the focus would be again on the key issues which were briefly reviewed here: *Justifying PPP approach, Risk Allocation, Financing Options and Mechanisms of payment*. The above text has presented an elaboration of how PPP are expected to work ideally. It is believed that such description of the best international practice of PPP would help Liaoning Province in developing more effective schemes.

4. PPP Projects: Growth and Trends

255. With sustained growth in infrastructure demands and worldwide common government budget constraints, countries turned to PPPs throughout most of the 1990s. During that time there were massive commitments to the approach. In 1990, the World Bank established the on line “Public Private Infrastructure” (PPI) data base¹³ to monitor levels of activity in PPP projects. PPPs grew steadily from \$7 billion in 1991 to \$68 billion in 1997. As a consequence of the Asian financial crisis (1997- 1998), there was a period of contraction with PPP investments reaching a bottom of \$18¹⁴ billion in 2002. Sustained growth in the global economy in the mid-2000s brought a renewed growth in PPP investments culminating in 2012 to \$154 billion. Interesting enough, the 2008-2009 global financial crisis had no negative impacts as governments invested massively in public infrastructures to soften the impact of the financial crisis. Since 2012, the volume of PPP investment has been on a slow decline reaching \$ 70 billion in 2016. However, cumulative PPP investments reached \$ 1,432 billion in 2016 for a total of 5,847 projects. Some aggregate numbers from the data base are given below

Table 24: PPP Investments by sector

Sector	2016 (\$ Billion)		(\$ Billion)	
	\$ Billion	%	\$ Billion	%
Energy*	770,282	53.8%	40,332	58.9%
Airports	100,441	7.0%		
Ports	76,595	5.3%		
Roads	272,699	19.0%		
Railways	100,092	7.0%		
Transport	549,827	38.4%	25,250	36.9%
ICT	35,860	2.5%	864	1.3%
Water sanitation	76,601	5.3%	1,988	2.9%
Total	1,432,570		68,434	
Note: * in energy electricity accounts for 90%				
Source: PPI World Bank data base				

256. The energy sector and in particular the electricity has traditionally been the dominant sector in PPP with the transport sector being a strong number two. In the transport sector, PPPs in roads get the larger share. And this distribution seems to

¹³ The database records contractual arrangements for public infrastructure projects in low- and middle-income countries (as classified by the World Bank) that have reached financial closure, in which private parties assume operating risks (<https://ppi.worldbank.org/>). The period covered is 1991-2016. Data are provided by government organizations from 139 countries. The sectors covered are: transport (airports, railways, roads and ports), energy (electricity), ICT and water and sewage. The data base is interactive on line and allows multiple combinations.

¹⁴ In the PPI data base, not all projects are PPP. The figures here refer to PPP projects exclusively.

have been quite stable over the years, since similar results can be found in 2016 when compared with the cumulative figures of 1993-2016.

257. Cumulative investments can be displayed by country (see table below). Not surprising, China and India come on the top of the list. However, in India, PPP projects were on average on larger scale than in China (\$ 380 million compared to \$ 113 million). The large economies of Southeast Asia are well represented, though they have more cancelation than China and India (23% for Malaysia). In the past China's involvement in PPP projects was limited and not commensurate to the size of its economy. Things are however changing rapidly with China showing a far higher degree of PPP projects in the last years (2015-2016) with 70 new projects for a total investment of \$ 11.8 billion.

258. Also, very noticeable, in 2015 Indonesia and the Philippines continue to display strong PPP involvement scoring on the top of the list. As of 2015, Myanmar is slowly getting more involved with PPP projects. Of course, the nature of PPP large projects is such that you should not expect regularity in the yearly sequencing.

Table 25: PPI Investments by country (1993-2016) and for 2015

Country	1993-2016			2015*	
	Number of projects	Investments in \$ million	investments cancelled %	Number of projects	Investments in \$ million
India	905	343,638	5	60	7,135
China	1373	154,972	3	70	11,834
Indonesia	117	76,182	11	9	8,716
Philippines	145	74,232	9	19	11,596
Malaysia	107	65,499	23	1	2,675
Thailand	157	53,932	1	16	2,114
Vietnam	87	13,683	7	5	2,083
Kazakhstan	36	12,018	8	0	0
Lao PDR	20	10,890	0	2	2,022
Uzbekistan	9	3,985	35	0	0
Cambodia	41	3,969	5	0	0
Myanmar	9	3,195	0	3	1,700
Total	3006	816195	107	185	49875
Source: World Bank PPI Data Base					

259. From the above table, PPP and private sector investments seem to be a sizable number but, in reality they are small numbers compared to public investments. According to a recent ADB publication (*“Meeting Asia’s Infrastructure Needs”, ADB 2017*), the public sector provides over 90% of the Asian developing countries overall infrastructure investments. This amounts to 5.1% of GDP, far above the 0.4% of GDP coming from the private sector. Public infrastructure investment rates

vary across sub regions and economies (see table below). For instance, in East Asia, public investments in infrastructure account for 6.3% of GDP with private sector investments remaining low at 0.1% of GDP. On the other hand, public sector infrastructure investment is less dominant in South Asia, with the private sector accounting for a significant higher share of investments (2.1% of GDP). In Southeast Asia, the Pacific, and Central Asia, public sector shares in infrastructure investment are definitely smaller than in East Asia.

Table 26: Public & Private Infrastructure Investments (2010-2014)

Region	% of GDP		
	Public	Private	Total
Southeast Asia	2	0.7	2.7
Pacific	2.5	0.3	2.8
Central Asia	2.6	0.3	2.9
South Asia	3	1.8	4.8
East Asia	6.2	0.1	6.3
Indonesia	2.4	0.3	2.7
India	3.3	2.1	5.4
PRC	6.2	0.1	6.3

Source: Meeting Asia's Infrastructure Needs", ADB 2017

260. Except for PRC and to a lesser degree India, total infrastructure investments (public and private) remain a small share of GDP. There are large gaps between the investments needed to sustain the projected economic growth and the observed current levels.

261. The World Bank's Private Participation in Infrastructure Database (PPI) provides a historical perspective of PPP projects for the period 1990 to 2016. It is however important to remember that the World Bank data base only includes only "signed" infrastructure projects exclusively from the private sector excluding PPP projects implicating SOEs. Therefore, it is not surprising that the total volume of PPP activities in China is grossly underestimated. Of courses many of the PPPs recorded in the 1990-2016 period would either be completed by now or cancelled. Comparisons with the CPPPC data bank, given below, are however severely limited.

262. Cumulative figures for China using PPPI data bank is given below. From 1990 and up to now, close to 1,400 projects were recorded for a total investment of \$ 155 billion. Of these numbers 623 projects were in energy (electricity and natural gas) accounting for 37% of the total investment. There were 259 transport projects (airports, ports, roads and railways) accounting for 46% of total PPP investments. During the 1990 to 2016 period, the growth of PPP projects has never been a smooth trend with a continuous series of peaks and drops.

Table 27: PPPs in China by major sectors (World Bank)

Sector	Number of projects	Investment \$ million	Percentage of total
Electricity	423	52,470	33.9%
ICT	4	14,518	9.4%
Natural Gas	200	4,579	3.0%
Airport	20	2,827	1.8%
Port	75	14,702	9.5%
Road	146	30,698	19.8%
Railway	18	22,882	14.8%
Water & Sewage	487	12,295	7.9%
Total	1373	154,971	100.0%
Source: World Bank PPPI Data Bank			

5. PPP Projects in China (CPPPC)

263. As noted, Public-private partnerships (PPPs) have been developing in China since the very late 1980s and the early 1990s, but the first true BOT project was the Laibin-B Power Plant in 1997 (see below). But, Thierot&Dominguez (2015) argues that it was only in 2014 that a landmark in the development of PPP was achieved. In November 2013 the Third Plenum of the 18th Communist Party of China emphasized the decisive role that market forces should play in the Chinese economy and this was confirmed by the Party’s actions in 2014 through a series of circulars, regulations, declarations and debates. And, in 2014, as an outcome of the 21st APEC Finance Ministry, the China Public Private Partnership Center (CPPPC) was established within the Ministry of Finance. CPPPC plays an important role in China in terms of research, consultancy, monitoring and advisory services to local governments.

264. One of the major achievements of CPPPC has been the establishment of a comprehensive data bank on PPP projects continuously updated and with reports every quarter. There was (March 2017) 12,300 PPP projects in the data banks for a cumulative value of RMB 14.6 trillion; and projects have been increasing rapidly reaching 14,220 for RMB 17.8 trillion in September 2017. Of the September number 6,778 were recorded in the management database implying that they have met the VFM criteria and among that number 2,388 were “commercially closed”. The table below gives data for the end of December 2016 and end of September 2017.

Table 28: PPP projects in China (CPPPC)

	December 2016		September 2017	
	Number of Projects	Investment RMB billion	Number of Projects	Investment RMB billion
Total PPP PRC	11,260	13,500	14,220	17,800
Total PPP PRC Implemented	1,351	2,200	2,388	4,100
Total Transport PPP	1,375	4,000	931	3,030
Total Transport PPP implemented	186	743	320	1,160
Total Pilot Projects	743	1,860	697	1,800
Total Pilot Project implemented	363	938	572	1,500
Total Liaoning	487	562	117*	218*
Total Liaoning implemented	36	250	47	N/A
Liaoning Transport PPP	N/A	N/A	39	N/A
Liaoning Pilot Projects	15	N/A	20	N/A
Liaoning Pilot Project Implemented	6	N/A	19	N/A

Note: N/A: not available on the website; * projects under implementation
Source: CPPPC "quarterly reports" <http://www.cpppc.org/en/Quarterly/4778.jhtml>

265. The number of PPP projects in the data base has increased rapidly¹⁵. There were 6,997 projects with planned investments of RMB 8.1 trillion in December 2015; but, the numbers were respectively 11,260 and RMB 13.5 trillion in December 2016 before reaching 12,300 and RMB 14.6 trillion in March 2017 and 14,220 with RMB 17.8 trillion in September 2017. Now, of course there is a big difference between projects listed in the data bank and projects implemented (signed and being implemented). Many of the listed projects never get implemented. For instance, in December 2016, there were 1,375 transport projects and these projects were at the following stages of implementation: 779 at the identification stage, 270 at the preparation stage, 140 at the procurement stage and 186 at the signing stage ready for construction.

266. The CPPPC monitors closely a series of PPP pilot projects serving as demonstration projects for provincial projects. In December 2016, there were 743 pilot projects of which 363 have been signed for a value of RMB 938 billion. In September 2017, 572 projects were implemented for RMB 1.5 trillion. It is not clear how projects are selected to become pilot projects, but their chance of becoming a “commercially close” and constructed project is definitely far higher. PPPs are now proposed from a large variety of sectors but the dominance are in “municipal engineering” and “transport” (accounting for close to 60%). A few provinces in China seem to attract most of the volume of the PPPs (whether they are demonstration projects or not) with the ones toying up the list being Guizhou, Shandong, Xinjiang and Inner Mongolia.

¹⁵ The CPPPC data bank includes all sectors. Sectors like Education and Health are represented.

- 267.** An important question when studying PPPs in China is to assess the degree of private sector participation as opposed to SOEs. According to Kim & Hong (2017), SOEs accounted for 74% of PPPs in 2016 but this is disputed by Bloomberg (February 2017), quoting a report from Fitch, stating that 55% of the PPP pilot projects were SOEs. CPPC displays that type of information only for demonstration projects. Of the total of projects, 55% were from SOEs while 37% were from the local private sector. However, when it comes to implemented projects, the situation is slightly different with 46% of the projects being from the private sector. The usual perception is that revenues to finance the investment should be generated from “user pay” schemes. In reality this accounts in September 2017 for 20% of the projects and 33% of the investments. The other revenue schemes are either direct government payments (40% of projects and 35% of total investments) or a mixed solution of user pay and subsidy (40% of the projects and 32% of the investments).
- 268.** Of particular importance in the table above are the statistics for Liaoning Province. With 117 PPP projects under implementation, Liaoning accounts for only 4% of the PPPs whether in number or in value. But the representation of the province among demonstration projects is even lower being 3% of the total. And only 8% of the Liaoning projects get implemented compared to an average of 14%. It is in reality the whole Northeast Region of China which is grossly underrepresented. There are 39 transport projects in Liaoning and this includes projects in Dalian.
- 269.** The table below provides details on the 39 PPP transport projects listed in the CPPPC data base. Projects have been sorted out according to their degree of implementation. Potential investments are large reaching RMB 85 billion though many may not be implemented. Of the 39 projects, 25 were still at the identification stage (RMB 44.3 billion); 6 were at the preparation stage (RMB 35.1 billion); 2 were at the procurement stage (RMB 2.5 billion) and 6 had reached implementation stage (RMB 3.0 billion). Close to 60% of the projects are roads (urban roads, arterial roads and expressways). There are only 5 rail projects (urban and provincial rail lines) but they account for 40% of the total registered investments. All major cities in Liaoning have transport PPP projects with greater frequencies for Benxi, Shenyang, Liaoyang and Panjin.

Table 29: Liaoning Transport PPPs from CPPPC

Name	Location	Investment (Million RMB)	Degree of Processing	Release Date	Operation Mode	Term of Contract (Yr)
Fourth Ring Expressway in Shenyang (Qipanshan Section)	Shenyang	170.66	Identification	5/4/2015	N/A	N/A
Supporting Facilities and Buildings on Two Sides of Faku - Tongliao Railway	Shenyang	10000.00	Identification	7/6/2015	BOO	20
Shenbei New Area - Faku - Kangping (45km) & Diaobingshan - Faku - Zhangwu (39km) Arterial Road	Shenyang	1500.00	Identification	7/6/2015	BOT	15
Anshan City Ring Railway Reconstruction Project (35km)	Anshan	1600.00	Identification	3/3/2015	N/A	N/A
New Terminal, Supporting Facilities and Airport Road for Anshan Airport	Anshan	300.00	Identification	3/3/2015	N/A	N/A
No. 202 Arterial Road Reconstruction Project	Fushun	500.00	Identification	6/1/2015	N/A	N/A
Xiaoqiao Line Lianzhouling Section Tertiary Road (13km)	Benxi	50.00	Identification	12/1/2015	N/A	N/A
Benhuan Line Sanjialing Tunnel and Approach Road Reconstruction Project	Benxi	80.00	Identification	12/1/2015	N/A	N/A
Shenhuan Line Wolong - Chengjia Section Reconstruction Project (Arterial Road)	Benxi	220.00	Identification	12/1/2015	N/A	N/A
Benkuan Line Beidaling Tunnel and Approach Road Construction Project	Benxi	205.00	Identification	12/1/2015	N/A	N/A
Shenben Line Xiangzishan - Binhe Extension Project Phase I	Benxi	747.00	Identification	7/7/2015	N/A	N/A
Xiangyangshan Overpass and Gushan Bridge Project	Benxi	150.00	Identification	12/1/2015	N/A	N/A
Xiaobao Overpass Reconstruction Project	Benxi	80.00	Identification	12/1/2015	N/A	N/A
Danhua Line (Qianjin - Nanfen Section) Road Reconstruction and Extension	Benxi	280.00	Identification	12/1/2015	N/A	N/A
Benxi Traffic and Logistics Center	Benxi	60.00	Identification	12/1/2015	N/A	N/A
Pedestrian Overpass	Benxi	2.10	Identification	12/1/2015	N/A	N/A
Shenhuan Line Sanjiazi - Wolong Section Reconstruction Project (Arterial Road)	Benxi	210.00	Identification	12/1/2015	N/A	N/A
Yingkou Economic and Technological Development Zone Traffic Center (Gas Station, Oil Station, Parking Lot, Logistics Center, etc)	Yingkou	600.00	Identification	11/2/2015	N/A	N/A
Fuxin Shitong Logistics Center	Fuxin	467.00	Identification	7/14/2015	N/A	N/A
Panying Line Extension Project (43.89km)	Panjin	1200.00	Identification	5/26/2015	TOT	10
Panjin Urban Rail Transit System Project (61.1km)	Panjin	11000.00	Identification	7/3/2015	TOT	10
Panying Railway Project (89.5km)	Panjin	12600.00	Identification	7/14/2015	TOT	10
Kaiyuan Binshui New City Daqing River Bridge Construction Project (Length: 640m, Width: 52m)	Tieling	300.00	Identification	8/28/2013	N/A	N/A
Huludao Port Railway Project (16.5km)	Huludao	1400.00	Identification	1/1/2016	N/A	N/A
Huludao Sixth Line Inncity Reconstruction Project (Secondary Road, 4.305km)	Huludao	75.00	Identification	1/1/2016	N/A	N/A
Haihang Road (Express Way) Construction Project	Huludao	484.00	Identification	1/1/2016	N/A	N/A
Sub Total		44280.76				
Modern Tramcar Project in Hunnan New Area (Shenyang South Railway Station Extension Section)	Shenyang	191.00	Implementation	3/1/2015	BOT	10
Shenben Line Xiangzishan - Binhe Extension Project Phase II (Arterial Road, 17.7km)	Benxi	688.53	Implementation	12/1/2015	BOT	12
Jiben Line, Xiaoqiao Line and Benkuan Line Construction and Extension Project	Benxi	319.15	Implementation	1/1/2016	BOT	12
Shenyang Line Dongjingling - Jingertun Section Project (City Ring Road North Section, Arterial Road, 5.367km)	Liaoyang	538.04	Implementation	12/1/2015	BOT	12
Liaoyang Public Transit Hub (North side of train station)	Liaoyang	959.11	Implementation	5/31/2015	BOT	15
Diaobingshan Highway Connection Project (Secondary Road, 11.2km)	Diaobingsha	256.63	Implementation	3/27/2015	BOT	12
Sub Total		2952.46				
Ecological Corridor Construction Project in Faku County	Shenyang	689.69	Preparation	1/1/2016	BOT	10
Shenyang Line Qingyangdaokou - Guyushu Section Project (City Ring Road East Section, Arterial Road, 7.4km)	Liaoyang	361.93	Preparation	1/4/2016	BOT	12
Shenyang Line Beiwangjia - Guyushu Section Project (City Ring Road South Section, Arterial Road, 14.6km)	Liaoyang	2416.00	Preparation	1/4/2016	BOT	12
Improvement and Integration of Public Transit System	Panjin	430.00	Preparation	5/13/2015	Others	26
Zhonghua Road	Panjin	1505.18	Preparation	5/28/2015	TOT	10
Dalian Bay Sea Crossing Express Way (Bridge + Artificial Island + Tunnel, 25.05km)	Dalian	29669.31	Preparation	6/29/2016	BOT	30
Sub Total		35072.11				
Shenbei New Area General Airport	Shenyang	230.00	Procurement	3/2/2015	BOT	10
Road Network at West of City (Ring Road West Section and Other Roads)	Liaoyang	2244.90	Procurement	1/4/2016	Others	12
Sub Total		2474.90				
Grand Total		79377.43				

270. The table below gives further information on the 6 PPP transport projects in Liaoning Province which are under implementation. A total of 4 out of 6 of the projects consist in constructing and maintaining for a relatively short duration (10-12 years) arterial roads. In each case the local government (grantor) signed a BOT agreement with a project company where the majority shareholder is a highway construction SOE. In four of the BOT cases, a city government transport operation is a shareholder of the Project Company and therefore share with the SOE the construction and operating risk. The roads BOTs do not get user payments and instead they receive annual payments from the local governments. The payments would have been negotiated at the time of the contract agreement but no details are available. Their values are of course key elements in terms of understanding the risk allocation between the parties.

271. The two other BOTs are quite different, being a tramway project in Shenyang and a transit hub in Liaoyang. In both cases they would get payments from user charges. But this type of payment would not be sufficient and local governments would add subsidies to the user charge revenues. Like above it is a typical debt transfer with the amount of subsidy being the key element in the risk allocation.

Table 30: Details on Transport Demonstration Projects-Liaoning

Name	Cost RMB Mill.	Composition of <i>Project Company</i> (RMB Social Capital)	Loan RMB Mill.	Mode	Payment Mechanism
Modern Tramcar Project in Hunnan New Area (Shenyang)	190	Shenyang Hunnan Modern* Transportation Co Ltd (15 Mil.) North Car Construction and Engineering Co Ltd: SOE (60 Mil)	114 i: 5.6%	BOT 10 yrs	Tram fares, other revenue Subsidy: 40.5/yr FIRR: 2.8%
Shenben Xiangzishan - Binhe Extension (17 km Rd in Benxi)	688.5	Liaoning Wuzhou Highway Engineering Co Ltd: SOE (150 Mil)	538.5 i: 5.5%	BOT 12 yrs	Benxi Gvt pays 105 Mil/yr Profit: 7.8%
Jiben, Xiaoqiao and Benkuan Extension (17.7km Benxi)	319.1	Liaoning Wuzhou Highway Engineering Co Ltd: SOE (70 Mil)	249.1 i: 5.5%	BOT 12 yrs	Benxi Gvt pays 48.7 Mil/yr Profit: 7.7%
Shenyang Dongjingling Jingertun Ring Road (5.367km Liaoyang)	538	Bureau of Transportation of Liaoyang* (32.3 Mil) Liaoning Wuzhou Highway Engineering Co Ltd: SOE (75.3 Mil)	430.4 i: 7%	BOT 12 yrs	Liaoyang Gvt make yearly payments (no details)
Liaoyang Public Transit Hub (North side of train station)	959.1	Liaoyang City Bus Co Ltd*(100 Mil) China Third Metallurgical Group & Zhongye Jianxin investment & fund management (Beijing) (187.7 Mil)	671.4 i: 7%	BOT 15 yrs	User charges, Subsidy; non-profit, low revenue
Diaobingshan Highway Connection road (11.2km)	256.6	Shenyang Hunnan Modern Transportation Co Ltd* (30 Mil) Diaobingshan Jiixin Road Construction and Management Co Ltd: SOE (36 Mil)	190.6	BOT 10 yrs	Transport Bur. of Diaobingshan Pay 301.5 Mil 10 yrs operation FIRR: 8%

Note: * government corporation or bureau

In summary, it should be noted that there has been a dramatic increase of PPP projects in China as illustrated by the World Bank and the CPPPC databases. The CPPC, as a monitoring body of the Ministry of Finance, was established in 2014 and the number of projects has accelerated even more since, showing exponential growth in the last years (200% increase from 2016-9 to 2017-9). Despite this growth, PPP investments constitute a small proportion of the total fixed investments (4 to 5%) and there are large provincial disparities with a few provinces taking the “lion share” and others like from the Northeast China lagging behind. There is private sector participation in projects but, government has a dominant presence. The majority of the projects benefit in different ways from government payments and financing with user pay projects accounting for only 30%. SOEs and State holdings account for 60% of the projects. Transport projects account for approximately 15% with 30% of the total investments. All transport projects in Liaoning (mostly BOT roads) imply a transfer of a public debt (government) to public enterprises (SOEs) with often government payments or subsidies. Incurred debt was substantial as loans represent between 75 to 80% of the total investment cost with no attractive interest charges. The contract duration of 10 to 15 years seems to be on the low side for that type of operation.

C. Industrial development for manufacturing exports

272. The favorable factors for "going global" of Liaoning's equipment manufacturing industry, including the implementation of "the Belt and Road Initiative", accelerating international expansion, building Northeast China into an important window for China's opening to the north and a hub for cooperation in Northeast Asia, and promoting the construction of free trade area between China and South Korea, are analyzed as follows.

1. International expansion has become an inevitable choice

273. In the trend of economic globalization and regional economic integration, countries and enterprises consider international development as an important economic development strategy. At present, the international development is in full swing. On the one hand, the infrastructure of the developed countries in Europe and North America has entered an upgraded stage; on the other hand, in the process of industrialization, the construction of infrastructure in developing countries has also formed a huge demand. Therefore, in the world market, there is a huge demand for equipment manufacturing products, elements and industry. At the same time, Liaoning's equipment manufacturing products, factors and industry have an obvious advantage in supply. Through international expansion, it can not only provide high quality equipment manufacturing

products, factors and industry to developing countries, but also combine its comparative advantage in the manufacturing industry with the high-end technology of developed countries, actively participate in the global market competition and value chain reconstruction, and promote industrial transformation and upgrading. International expansion, as an international, inclusive and new cooperation model, will provide Liaoning's equipment manufacturing industry with an excellent opportunity in meeting the needs of the international market, building a global production and operation system, and deeply integrating into the global industrial chain, value chain and logistics chain. Of course, international expansion is not simply a shift of excess capacity.

a) "The Belt and Road Initiative" brings opportunities

274. It brings the demand for construction machinery due to infrastructure construction. "The Belt and Road" involves a lot of countries and regions in Asia, Europe and Africa, and the demand for urban infrastructure is very large. According to the statistics of Asian Development Bank, by 2020, the infrastructure investment demand along "the Belt and Road" is up to 730 billion USD a year. Taking highway infrastructure as an example, in the past two years, nearly 50 excavators have been used in highway construction in Kyrgyzstan, the construction has gradually expanded from Central Asia and Eastern Europe to Southeast Asia, West Asia and North Africa, and there will be a growing demand for cranes, hoisting ships and dredging ships. There are a large number of equipment manufacturing enterprises related to this. For example, Sanyo Heavy Industry Group, Northern Heavy Industries Group, Dalian Shipbuilding Industry Corporation, CRRC Dalian Company and other leading equipment manufacturing enterprises can take this opportunity to be further involved in the international market and achieve their own upgrading and development by using the vast market space.

275. It provides an effective way to dissolve excess capacity. In December 2014, the meeting summary signed by and between China and Kazakhstan identified approximately 63 projects involving electricity, energy, iron and steel, road transportation and other fields. 52 capacity cooperation projects have been concluded so far, totaling more than 24 billion USD. Such a strategic cooperation has accelerated the pace of China's excess capacity "going global", and will also effectively promote the internationalization process of regional equipment manufacturing industry. Although the economic aggregate of equipment manufacturing industry in Liaoning has continued to grow in recent years, the industrial type is mainly labor intensive and resource intensive, the development of technology-intensive industry is lagging behind and added value of products is low, causing overcapacity. However, in those countries along the Belt and Road whose industries are underdeveloped, the infrastructure lags behind and

the economic development is limited. If equipment manufacturing enterprises in Liaoning can cooperate with them, it will be a timely assistance and help to dissolve excess capacity.

276. It has created a new space for the growth of high-end equipment manufacturing. With the intensification of international competition and deepening of transnational cooperation, enterprises having the mature technology, high-quality products and strong management ability will become "strategic dividend" attracting much attention along the Belt and Road. The high-end equipment manufacturing industry is the key engine for equipment manufacturing industry "from big to strong". The quality, technology, service and reputation behind the high-end products, representing the image of a country or region, is the key to industrial transformation and upgrading as well as building the brand of "made in China". In recent years, Liaoning has started the implementation of more than 10 major projects of high-end equipment manufacturing. The *Outline of Liaoning's Action Plan for Made in China 2025* also puts forward to focus on the development of 15 key areas including high-end CNC machine tools, robots and intelligent manufacturing equipment, aerospace equipment, marine engineering equipment, advanced rail transportation equipment and so on. The research breakthroughs in key technologies and the application of major achievements will give the equipment manufacturing industry in Liaoning immeasurable growth space in the international market.

2. National policies have provided strong support

277. As the economy enters a "new normal", "the Belt and Road", "the Internet + manufacturing", the "13th Five-Year plan" and the "Technology Roadmap for Key Areas of Made in China 2025" have brought important opportunities for the development of China's equipment manufacturing industry. Firstly, at the government work conference in 2015, Premier Li Keqiang described the opportunities and challenges for the equipment manufacturing industry brought by "the Belt and Road", and hoped that the equipment manufacturing industry can take the opportunity to go abroad to make full use of the resources in the countries along "the Belt and Road", play their own advantages, integrate into the international market and become new highlights of economic growth. Secondly, China will vigorously develop "the Internet + equipment manufacturing industry". With the Internet platform, intelligent equipment will become the priority direction of equipment manufacturing enterprises. Thirdly, the "13th Five-Year plan" clearly puts forward that the strategic emerging industries including high-end equipment manufacturing will be the key direction of development. In the "13th Five-Year" period, the strategic emerging industries

will focus on cultivating high-end equipment and materials. In the process of the development of high-end equipment manufacturing industry, the key strategic material industrialization and application is critical to its development; according to the latest plan, by 2020, China will vigorously develop key strategic materials to support the development of the high-end equipment manufacturing industry.

a) Unfavorable Environment for International expansion of Equipment Manufacturing Industry in Liaoning Province

278. At present, the new round revolution of science and technology and the rise of industrial transformation are reshaping the world economic structure. The widespread penetration of new-generation information technology has led to continuous breakthroughs, continuous convergence and accelerated the application of technology in key areas and is triggering significant changes in development concepts, technology systems, manufacturing models and value chains of the manufacturing industry. Developed countries and regions have implemented the strategy of "re-industrialization" and "manufacturing return", trying to seize the high-end equipment manufacturing market and continue to expand competitive advantages; meanwhile, emerging economies are developing manufacturing industry by relying on their resources, labor and other comparative advantages; China's equipment manufacturing industry is facing new challenges of "backflow of high-end industries" from developed countries and "diversion of low and middle-end industries" from developing countries.

b) The demand of the international market and the increasing pressure of competition in the international market

279. At present, although the world economy continues to recover, the world economic recovery presents instability and uncertainty because of the uncertainty of the macroeconomic policies in major developed economies, the uncertainty of the European debt crisis, the growth uncertainty of emerging market economies and the regional structural instability uncertainty. As a result, the consumption demand in the international market is depressed and the investment demand is sluggish. At the same time, the implementation of "re-industrialization" development strategy of developed countries and the rapid development of equipment manufacturing industry in developing countries will bring more intense external competition pressure to the internationalization of Liaoning's equipment manufacturing industry.

c) The continuous accelerating of transnational operation and improvement in competitive power of other provinces

280. In recent years, with the continuous improvement of China's open economic development, the transnational operation in the provinces has been developing

rapidly. Compared with some provinces, there are still some gaps in the transnational operation of Liaoning's enterprises. Taking the non-financial outward FDI in 2010-2014 as an example, it can be seen from Table 31 that the outward FDI (flow) in Liaoning ranks the top 10 at the end of 2010-2014, but the ranking has not changed, the scale of outward foreign investment is small, and the proportion is small. At the end of 2010-2014, the proportion of outward foreign direct investment (flow) in Liaoning ranking the top 10 is about 5%-7%, while that of Guangdong is 24.8%, 28.1%, 27.2%, 27.8% and 27% respectively, and that of Shandong accounted is 10.6%, 13.5%, 12.9%, 13% and 10.8% respectively. It can be seen from Tab. 6 that the outward foreign direct investment (flow) in Liaoning ranks the top 10 in 2010-2014, but the rankings are moving backward. The scale of overseas investment is small. The proportion shows a large fluctuation and a downward trend- it is only 3.4% in 2014. However, the proportion ranking the top 10 in Guangdong is 11.5%, 20.8%, 20.8%, 22.1% and 25.2% respectively, and that in Shandong is 13.6%, 14.2%, 13.6%, 15.9% and 9.1% respectively.

281. Therefore, Liaoning has certain advantages in outward foreign direct investment, but there are obvious gaps in both the scale and proportion compared with some coastal provinces and the provinces with late-mover advantages, and it is facing the pressures and challenges of competition.

Table 31: Outward foreign direct investment of Liaoning in 2010-2014

Year	Stocks by year-end			Annual flows		
	Ranking	Scale (hundred million dollars)	The proportion of the top 10 (%)	Ranking	Scale (hundred million dollars)	The proportion of the top 10 (%)
2010	7	27.16	7.3	2	19.36	14
2011	7	32.96	6.8	9	11.44	6.6
2012	7	41.33	7.5	5	27.63	10.9
2013	7	45.47	6.3	7	12.95	4.8
2014	7	92.3	5.1	8	14.79	3.4

Source: China Foreign Direct Investment Statistics Bulletin

d) The bottleneck of internationalization of Liaoning's equipment manufacturing industry becomes more apparent

282. In the development of Liaoning's equipment manufacturing industry, the bottleneck becomes more apparent. Taking 2015 for example, the major economic indicators of Liaoning's equipment manufacturing industry including prime operating revenue, profit, prime operating revenue profit margin, profits and taxes and value-added tax are lower than the national average. The

bottleneck of the development of Liaoning's equipment manufacturing industry together with the downturn of world economy makes the situation of "going global" more severe. Taking Ansteel Group Corporation for example, it can be seen from Table 32 that at the end of 2008-2014, its overseas investment shows a downward trend in the aspects of stock ranking, asset ranking and sales income rankings.

Table 32: Basic indicators of Ansteel Group Corporation's overseas investment at the end of 2008-2014

Year	Inventory Rankings	Total Assets Rankings	Sales Revenue Rankings
2008	38	-	36
2009	33	-	39
2010	36	-	41
2011	37	57	39
2012	44	74	51
2013	47	62	43
2014	88	97	49

Source: China Foreign Direct Investment Statistics Bulletin

D. Sea-Rail Multimodal Transportation

1. National Initiatives and Policies

a) OBOR

283. Embracing the trends toward a multipolar world, economic globalization, cultural diversity and greater IT application, the OBOR initiative is designed to uphold the global free trade regime and an opening world economy in regional cooperation. The construction of interconnected infrastructure is prioritized in the initiative. The participating countries should increase the integration of their infrastructure construction plans and technical standard systems, and jointly push forward the construction of international backbone corridors to gradually form an infrastructure network connecting all sub-regions in Asia and between Asia, Europe, and Africa. The development of regional multimodal transport shall focus on the key passageways, junctions and projects, and give priority to linking up unconnected road sections, removing transport bottlenecks, advancing road safety facilities and traffic management facilities and equipment, and improving road network connectivity. In addition, it's important to include below measures when promoting multi-modal transport, ranging from promoting a unified coordination mechanism for all legs of transportation to increase smooth operations from customs clearance, reloading and multimodal transport between countries; gradually formulating compatible and standard transport rules to facilitate international transport; pushing forward port infrastructure construction; building smooth land-water transportation channels to advance port cooperation; increase sea routes and the number of voyages; enhancing information technology cooperation in maritime logistics; expanding and build platforms and mechanisms for comprehensive civil aviation cooperation; and speeding up the development of aviation infrastructure.

284. The strategic initiative to build the New Silk Road Economic Belt and the 21st Century Maritime Silk Road reflects the common needs of the countries along OBOR and provides a new platform for international cooperation. Located in the heart of Northeast Asia and as the only coastal province along the border in northeast China, Liaoning province is an important gateway to the sea connecting Asia and Europe and plays an important role in the implementation of the OBOR initiative. Supported by the coastal ports and sea-rail multimodal transport, the Russia-Mongolia-China economic corridor provides an important platform for Liaoning province to participate in the OBOR initiative.

285. The guiding documents formulated by Liaoning Provincial Party Committee and people's government regarding the plan to implement the OBOR initiative (in the area of transport) mainly include the following two: *Implementation Plan for*

Liaoning Province's Participation in the "One Belt, One Road" Initiative and The 13th Five-Year Plan for the "One Belt, One Road" Initiative in Liaoning Province. These two documents lay out the overall plan for Liaoning to fully participate in the OBOR initiative. Relying on the Russia-Mongolia-China economic corridor, Liaoning province should accelerate the construction of the "Three Main Passages" in carrying out the OBOR initiative. First, speed up the development of Dalian Northeast Asia International Shipping Center to develop the important sea passage "Liaoning-Bering Strait-Europe" (Liao-Hai-Ou) from the Dalian port, bypassing South China Sea to Indonesia and the South Pacific regions, and finally reach Northeast Passage in the Arctic Ocean through Bering Strait. Second, develop Liaoning-Manzhouli-Europe (Liao-Man-Ou) logistics passage with the Port of Dalian and the Port of Yingkou as the starting point, and Liaoning-Shandong Land-Sea Drop and Pull Transport Channel as the trunk line to integrate the function of the two ports. Third, build Liaoning-Mongolia-Europe railway passage that runs from Jinzhou port and Dandong port to Choibalsan in Mongolia and further goes to Europe. The purpose to build the "Three Main Passages" is to promote trade and investment with cross-border logistics transport.

b) *Northeast China Revitalization Plan*

286. In October 2003, The Opinions of the Central Committee of CPC and the State Council on the Implementation of Revitalization Strategy of the Traditional Industrial Bases in Northeast China clearly put forward the strategic plan of "Making full use of existing port conditions and advantages to build Dalian into an important international shipping center in Northeast Asia". Based on this national strategic plan, the national, provincial, and municipal governments have issued a number of documents over the past decade in succession to support the development of Dalian Northeast Asia International Shipping Center.

287. In August 2004, to speed up the building of Dalian Northeast Asia International Shipping Center, Liaoning provincial government and Dalian municipal government separately issued opinions on the detailed implementation, which include five basic backbone documents, namely *The Decision of Liaoning Provincial Party Committee and Provincial Government on Speeding up the Building of Dalian Northeast Asia International Shipping Center*, *The Opinions of Liaoning Provincial People's Government on Accelerating the Development of Coastal Ports*, *The Development Plan of Dalian Northeast Asia International Shipping Center*, *The Opinions of Dalian Municipal People's Government on Accelerating the Building of Dalian Northeast Asia International Shipping Center*, and *The Opinions of Dalian Municipal People's Government on Implementing the Development Plan of Dalian Northeast Asia International Shipping Center*. These five backbone documents involve 16 areas, including port planning, integration of

port resources, port infrastructure construction, policies on land and sea, investment and financing system, government fiscal and tax support, construction of distribution channels, concession of freight rates, construction of dry ports, development of shipping service industry, supporting services, expanding modern logistics, improving port environment, building free trade port area, development of information resources, and leadership support. The documents state that “special importance should be given to the participation of enterprises and capital in northeast China in the building of Dalian Northeast Asia International Shipping Center and special attention should be given to the economic and trade exchanges and cooperation with Northeast China to provide services and guarantee for the smooth flow of resources and production factors in northeast China.” According to the documents, it is necessary to improve the construction of hardware facilities and transport channels of sea-rail multimodal transport in accelerating the modernization of the transport system to vigorously develop Eurasian Land Bridge, start by upgrading the software and hardware facilities and creating sound customs clearance environment to build Dalian port into an international shipping center that meets the needs of an international shipping center in Northeast Asia, which will be a huge impetus to the economic development of Northeast China. In order to become an international shipping center in Northeast Asia, Dalian port must rely on the economic development of the hinterland, increase its development of the hinterland market in northeast China, improve its logistics service, and change the mindset to provide a convenient and efficient logistics platform according to customers’ needs. The decision to build Dalian Northeast Asia International Shipping Center has played a positive role in promoting the development of sea-rail multimodal transport of Dalian port. In addition, agencies such as the National Development and Reform Commission of the People’s Republic of China, General Administration of Customs, Ministry of Finance, Ministry of Transport, Ministry of Commerce, State Administration of Taxation, Civil Aviation Administration of China, and former Ministry of Railways have all issued specific policies to support the construction of the international shipping center in Dalian. Dalian Dayaowan Bonded Port Area was established with the approval of the State Council. The *Dalian Northeast Asia International Shipping Center Development Plan* was the first international shipping center plan approved by the state. *The Master Plan of Dalian port* was approved by the state for implementation. Dalian municipal government has successively put forward over 20 laws and regulations such as the *Plan of the Shoreline of Dalian Port*, and the *Development Plan of Shipping Industry in Dalian*, which have formed the new port synergetic development pattern “Three Cores with Two Wings” with the harbor areas of Dayaowan, Changxing Island, and Taipingwan as the cores and the Yellow Sea and Bohai Sea as the wings.

288. In August 2014, the State Council issued *The Opinions of the State Council on Major Policy Measures for Supporting the Revival of Northeast China in the Near Future* and stressed: “to speed up the building of an international shipping center for Northeast Asia in Dalian “. During his visit to Dalian, Mr. Xi Jinping, the General Secretary of CPC emphasized that Dalian should be built to “a pilot zone for optimized industrial structure and a forerunner of economic and social development. “ Mr. Li, Xi, governor of Liaoning province, also pointed out that: “we will take the lead in building an international shipping center for Northeast Asia” . The ardent care and high expectation of the CPC and the government have made the goal and task of building an international shipping center for Northeast Asia in Dalian clearer. With the guidance of the grand blueprint, a new round of the development of international shipping and logistics centers has come at an accelerating pace.

c) Liaoning’s FTZ Planning

289. Established at the beginning of 2017, Liaoning Pilot FTZ will improve the overall competitiveness of and further open up the old industrial bases in northeast China. The goal of this FTZ is to nurture a cluster of high-end industries with investment and trade facilitation, robust financial services, and effective and sustainable oversight in a legally compliant environment. It consists of three sub-zones: Shenyang area, Dalian area, and Yingkou area. According to the function planning, Yingkou area is positioned to develop into a hub for international sea-rail multimodal transport channel.

290. The State Council’s policy on Liaoning Pilot FTZ: the *Overall Plan for the China (Liaoning) Pilot Free Trade Zone* issued by the State Council proposes to build a sea-land-air route connecting Asia and Europe. Relying on the FTZ, Liaoning should accelerate the construction of Dalian Northeast Asia International Shipping Center and push forward the construction progress of sea-rail multimodal transport in Yingkou port and the cross-border railway in Shenyang. In addition, efforts should be made to speed up the development of inland port in Shenyang, support the establishment of a customs supervisory center for multimodal transport, and build Shenyang-Yingkou land-sea multimodal transport system. Liaoning should support the FTZ to carry out cooperation and exchanges on customs, inspection and quarantine, certification and accreditation, and standard measurement with participating countries of “One Belt, One Road” and to explore cooperation with these countries on the safety and facilitation of trade supply chain.

291. Liaoning provincial government expressed that the launch of Liaoning Pilot Free Trade Zone will further expand international cooperation in Northeast Asia, and promote the construction of Dalian Northeast Asia International Shipping Center, the sea-rail multimodal transport in Yingkou port, the cross-border railway in

Shenyang and Shenyang-Yingkou land-sea multimodal transport system. In addition, the FTZ will also help build multi-port joint development system and an aviation logistics hub to achieve the joint development of sea, land and air transport. Liaoning Provincial Development and Reform Commission stated that it would advance the building of “Liaoning-Manzhouli-Europe” , “Liaoning-Mongolia-Europe” , and “Liaoning-Bering Strait-Europe” channels, coordinate in pushing forward the construction progress of different railway sections of “Liaoning-Mongolia-Europe” railway inside China, support the shift of Yingkou port from a port of destination to a transit port, support the addition of new container trains between China and Europe, and plan to add international routes for relevant ports and daily domestic routes for major domestic ports. Liaoning Provincial Department of Commerce stated that it will speed up the construction of multimodal customs supervisory center and support Dalian and Yingkou to develop land-rail and sea-rail multimodal transport between Asia and Europe to increase the international competitiveness of logistics enterprises.

2. Internet Plus and Technological Development

292. The study team analyzed the influence of Internet Plus and technological development on traditional logistics, supply chain, marketing and private enterprises.

a) Influence on traditional logistics

293. First, optimize the construction of logistics infrastructure and save cost. Through Internet Plus, timely logistics information can be accessed to help understand and predict the changes in logistics supply and demand in various areas. Internet Plus can also help make reasonable choices about the locations of logistics center, distribution center, and logistics park to give full play to logistics infrastructure and reduce operational difficulties and resource waster caused by unreasonable location choices. The Internet allows for timely knowledge of supply and demand. Besides reasonable location choice, this also means that the model of the combination of central warehouse and local warehouses can be canceled and only the central warehouse needs to be established. The information about the local demand for goods can be sent to the central warehouse and the central warehouse can arrange for direct delivery to the local store, which can achieve effective separation of goods flow and logistics, reduce warehousing and management cost, and help the transformation of inexperienced and blind traditional logistics development to systematic and planned development.

294. Second, integrate resources and effectively promote in-depth collaboration of logistics with other industries. Logistics is the bottleneck that restricts the

development of e-commerce. Through Internet Plus, logistic information of supply and demand is shared on Internet platforms to make asymmetric social information symmetric, effectively solve the problems of too many or insufficient vehicles for available goods, integrate resources, enhance the cooperation of logistics enterprises in different regions to achieve connectivity, mutual benefits, and win-win results of different logistics sites. In this way, resource allocation can be optimized and some problems can be relieved such as low coverage of the sites of some logistics enterprises. Internet Plus can enable the integration of logistics with other industries to promote their in-depth collaboration. Through information technology and the Internet thinking, effectively integrate logistics and data processing between logistics industry and financial service industry, IT service industry, manufacturing industry, and merchandising enterprises. With capital as the link among different industries, expand the market and the scope of business, extend the scope of the logistics business, and promote the transformation of the traditional closed logistics industry towards the direction of openness.

295. Third, promote the elements of logistics functions to become intelligent and information-based. The information application and intelligent level of the traditional logistics industry is low, which has restricted the overall operational efficiency of the logistics industry. The Internet Plus logistics can increase the information application and intelligent level of logistics functions, semi-automate or even fully automate the sorting process, realize the informatization of goods warehousing, storage, and retrieval management, and simplify complicated data. Real-time GPS tracking can effectively allocate vehicles, optimize vehicle loading and distribution route, and enable distribution with drone in the distribution process. Internet Plus makes the information flow faster and smoother in the whole logistics process, improves the operational capacity of logistics, and promotes the transformation of traditional logistics to modern logistics so that the logistics industry in China can compete internationally.

296. Fourth, improve logistics service quality. Due to the limitation of information technology, it is difficult for traditional logistics industry to systematically and effectively provide logistics services to customers. With Internet Plus, logistics enterprises can access the data about customers in a relatively short period of time, including the address, consumption habit, preference, affordability and so on. Logistics companies can also analyze the data through Internet platforms to know the logistics needs of a customer, predict and respond to the needs in a timely manner, and meet the needs in the shortest possible time. At the same time, logistics companies can provide logistics extended services to the customers such as logistics finance, logistics integration, and supply chain integration to improve the logistics service quality and promote the transformation of logistics service from being reactive to proactive to customer requirements.

b) *Influence on supply chain*

- 297.** The traditional supply chain is a value chain transmission process from the resource acquisition by a company to the conversion of the resource with the goal to provide the resource that meets the customer's needs. Supply chain generally includes four processes: material flow, commercial circulation, information flow, and capital flow. The four processes have their own different functions and flow directions. The Internet is one of the most popular communication platforms today. Its introduction has greatly facilitated the supply chain management. On one hand, the implementations of various mechanisms rely greatly on Internet resources; on the other hand, they in return serve as a foundation to integrate Internet resources.
- 298.** First, the Internet promotes the realization of information sharing mechanism. For example, for the current supplier-centered supply chain, manufacturers adopt ERP system to build a highly effective intranet to achieve information sharing within the company. Then they establish cross-organizational extranet with other suppliers, distributors, and consumers to achieve external information sharing. For external information sharing, all company members need to set up permission to ensure business security. This not only allows the allied enterprises to exchange and communicate information at a relatively low price, but also helps these enterprises understand customers' purchasing behaviors and respond customers' needs in a timely manner. Based on the above-mentioned analysis, it is very obvious that the Internet has facilitated the realization of the information sharing system in supply chain.
- 299.** Second, the Internet is conducive to the integration of enterprise cultures and the establishment of cooperation mechanism. In traditional business interaction, enterprise representatives mostly look at things from their own perspectives and cannot really understand other enterprises' cultural values, which, to some extent, has brought some barrier for the communication among enterprises. After the Internet has become popular, the culture and strategy of an enterprise are no longer mysterious. Through the Internet, an enterprise member can quickly understand the cultural value of other enterprises and can get other information about them. This brings great convenience in their communication.
- 300.** Third, the Internet strives for symmetrical information to facilitate smooth and stable supply chain management. With an Internet platform, there is great room for development no matter for the cooperation mechanism, decision-making mechanism, or the incentive mechanism. For the cooperation mechanism, as an old saying goes "if you know the enemy and know yourself, you need not fear the result of a hundred battles". All cooperation between enterprises is based on some common goals. In the past, information was inaccessible. There were not many ways to get information about a company besides beating around the bush about

the company's reputation and development. There could be very high ethics risks. With the influence from the Internet, although ethics risk cannot be completely eliminated, indirect communication between enterprises is enhanced to a great extent and credibility is also greatly increased. Through the Internet, enterprises can know about the development status and customer needs of their peers or other enterprises without even stepping out of their offices. On one hand, this has greatly enhanced the cooperation between enterprises; on the other hand, it has helped enterprises make scientific and reasonable decisions. It is with scientific and reasonable decisions that comes the stable and smooth operation of the supply. Through the Internet, enterprises can get in-depth understanding of the needs of customers and agents, so that they can provide some incentives. When their own needs are satisfied, agents will be more motivated to achieve the goal for their clients to achieve win-win result.

301. In short, Internet Plus has a great impact on traditional enterprises. The traditional industrial philosophy is to conduct mass production, pursue low-cost operation, and then influence end consumers from different channels. The Internet technologies force enterprises to switch from B2B to customized C2B. The supply chain gradually extends the concept of being need-driven to how to interact with customers to deeply understand and serve them. For example, Huaqinwang, the first professional poultry meat wholesale platform in China, relies on Chinese poultry giant Henan Huaying Agricultural Development Co. Ltd., combines offline opportunities with the Internet. As a time-honored traditional enterprise in the poultry industry, Huaying has been producing meat products for many years and has accumulated a wealth of resources in distributors, logistics and so on. Its online subsidiary Huaqinwang, has integrated Huaying's second-level and third-level distributors to transform traditional distributors to service providers of Huaqinwang and has formed a new type of e-commerce distribution chain with the integration of "contract farming - online trading platform - connective purchasing distributors - logistics and distribution - buyer". This pattern integrates resources of various parties, effectively solves the problem of information asymmetry in supply chain, reduces the circulation processes of agricultural products, effectively increases the speed of internal supply chain, smoothly completes the series of processes from product warehousing, getting on shelf, order placing, retrieval from the warehouse, distribution, receipt, and customer service, and guarantees the closed-loop operation of the website to have seized the market opportunity.

c) Influence on marketing

302. The marketing model with Internet Plus is that based on the Internet platform, customers provide their demand information through placing orders. After the enterprise receives the order information, it arranges production or services according to the order, and then delivers the product to the customer through

logistics and distribution. With Internet Plus, the market research and strategy under the traditional marketing model are squeezed and replaced by the big data marketing and order, and the sales channels in traditional marketing are omitted. Under the traditional marketing activities, enterprises are in a dominant position. With Internet Plus, customers gradually take the initiative. They provide their demand information on their own and enterprises accept the order and arrange production accordingly. Internet Plus has brought great impact and influence to the traditional marketing and produced profound changes in marketing.

303. The introduction of Internet Plus into marketing has greatly compressed and simplified the traditional marketing process, effectively decreased the marketing cost, sped up the marketing process, increased marketing precision, and enormously improved marketing efficiency, which are changes brought by Internet Plus to the traditional marketing. At the same time, the real-time nature of Internet Plus enables interactive communication of marketing to become a reality and customers become the leader in marketing. They actively participate in enterprises' processes of marketing research, product production, and end service. Customers gradually become the research and strategy implementer to realize zero-distance contact among enterprises' production activities, market needs, and marketing. In short, the main influences of Internet Plus on marketing are the switch to the dominant position of customers and the qualitative changes of the function of marketing.

304. With the application of Internet Plus in the field of marketing, many enterprises one after another starts an innovative marketing model by applying Internet Plus technologies to do data mining, accurately analyze customers' data, and extend and innovate marketing models. First, precise marketing model. Currently, precise marketing is a relatively widely used model in Internet Plus marketing activities. Internet Plus provides rich information that reflects market prediction in a timely manner, uses Internet Plus big data technologies to extract and analyze data about customers, pinpoint profit sources in marketing. Enterprises can also combine dynamic information in the market to adjust their marketing model to meet the actual needs of customers. Second, stimulation marketing. Stimulation marketing analyzes the customers of a business, and on this basis recommends other business to the customer, recommends the consumption information of the company's related business to the customer to accurately increase the consumption possibility of a specific customer. Specifically, stimulation marketing includes cross selling and upselling. Cross selling means when a customer is already consuming a product, the company can switch between its different products to increase the customer's experience of the company's products; upselling is the practice of encouraging customers to purchase a comparable higher-end product than the one in question. Third, enhancement marketing model.

On the basis of customer experience, this model enhances the customer's habit of consuming and using a specific service or product of the company and turns the customer into a long-term or loyal customer. This requires the company to combine the product and Internet Plus technologies to build the model on the basis of precision marketing, continuously update, upgrade, and expand the company's business or products on the basis of the existing ones, continuously increase customers' enthusiasm in consuming the service or product, and stimulate their long-term consumption.

3. Policy context

- 305.** Internet Plus refers to the process of diffusion, application, and integration of the new generation of Internet-based information technologies (including mobile Internet, cloud computing, big data, IOT, etc.) in various areas of economy and society. It represents a new form of economy that gives full play to the role of the Internet in optimizing and integrating the distribution of factors of production. It blurs and crosses all the traditional boundaries that impede the development of advanced productive forces and creates new industrial chain, supply chains, and value chains through reform, restructuring, and redefinition. Transport industry is one of the industries with early, deep, and wide influence from mobile Internet. Internet Plus transport services are based on the Internet, especially mobile Internet technologies. Led by smart transport and logistics, it restructures the industrial chain and recreates the eco-system to form a brand-new value chain featuring "active identification of customer needs to provide customized services" and corresponding transport service organizational and management system through continuous innovation and reform.
- 306.** In 2013, the Ministry of Transport of the People's Republic of China issued the *Guiding Opinions on Promoting the Development of Information-Based and Intelligent Transport*. In order to achieve standardized and orderly transport development, the Ministry of Transport formulated and published the *Form of Transport Informatization Standard System* and the first lists of transport informatization standards to be strictly followed and formulated and revised a series of industry-based standards such as *Basic Data Element of Transportation Information*. In 2015, the State Council issued the *Guiding Opinions on Actions Actively Promoting Internet Plus*, which puts forward 11 specific operational tasks including building efficient Internet Plus logistics and convenient Internet Plus transport. The *Opinions* states: "it is imperative to accelerate the construction of cross-industrial and cross-regional logistics information service platform, improve logistics supply-demand information connectivity and the use efficiency of this information, encourage the application of big data and cloud computing in logistics,

build intelligent warehousing system, optimize logistics operation process, improve automation, intelligent level and operation efficiency of logistics warehousing, and reduce the cost of logistics.” “ Initiatives should be taken to use technologies such as the Internet of things and mobile Internet to further collect information on the operating conditions and traffic of key facilities in the transport network of highways, railways, civil aviation, and ports, support cross-regional information connectivity of different types of transport, promote the application of intelligent technologies such as the Internet of vessels and the Internet of vehicles, form a more complete transport sensing system, improve the Internet connectivity of factor resources such as infrastructure, transport tools, and operation information to provide full support for failure warning, operation and maintenance, and intelligent scheduling.” The Ministry of Transport responded promptly to the tasks laid out by the State Council with the issuance of the *Guiding Opinions on Taking the Lead of Economic and Social Development under the “Four-Pronged Comprehensive Strategy”*. In this document, the Ministry of Transport clearly states to promote the innovation of new Internet Plus transport forms and modes. In 2016, the Ministry of Transport successively issued the *Implementation Opinions on Promoting the Openness and Sharing of Data Resources in the Transport Industry*, the *Guiding Opinions on Promoting the Network Security in the Transport Industry*, and the *13th Five-Year Plan for Transport Informatization*.

4. Case studies of the integration of Internet Plus and technological development

307. The study team selected the following six ports in China to analyze the influence of Internet Plus and technological development on sea-rail multimodal transport.

a) Case 1: Qingdao port – transformation and upgrading with Internet Plus

308. The development model of Qingdao port is characterized by the construction of modern logistics eco-system for e-commerce to enhance the service capabilities of logistics information. It relies on port logistics chain to build a public information platform of regional logistics. Information is shared with many relevant parties such as the customs, General Administration of Quality Supervision, Inspection and Quarantine, shipping companies, and freight forwarders through the establishment of new Internet-based models such as seaway network, customer service centers, and cross-border e-commerce platforms, which has made the development model of Qingdao port a national demonstration project for the application of the Internet of things in container sea-rail multimodal transport. The port has established and improved the market and the system of customer network management and service to gather the latest information on cargo.

309. At the same time, customer service center has been established to interact with customers on dry bulk cargo and gather the latest information of the cargo. A service system has been set up for the following four categories of cargo: dry bulk cargo, general cargo, oil products, and container goods. Internet technologies and Internet thinking have been applied in the services of land port to achieve “direct and seamless information connection” with Xinjiang International Land Port. A new model of port charges settlement for export container has been developed to guide customers to form the habit to pay online and gather crucial information.

b) Case 2: Humen port

310. By joining hands with Monda Group to create the first port O2O cross-border e-commerce platform in China, Humen port has used the new generation of information technology to achieve the comprehensive upgrading of port O2O cross-border e-commerce. Information industry and modern logistics industry are closely integrated to achieve port modernization with automation, information, Internet, and intelligent technologies. An electronic data exchange and sharing platform has been established among relevant parties including government agencies, inspection agencies, shipping companies, customs clearance, and enterprises. At the same time, logistics, capital flow, and information flow are integrated to help businesses reduce the cost of logistics and to improve information utilization level of the whole port area.

c) Case study 3: Shanghai port

311. Leveraging a similar partnership with Gillion New Software Co., Ltd. to build O2O logistics management platform, the port of Shanghai has developed an e-commerce service system, enhancing online service capability, and implement its Yangtze River Strategy, Northeast Asia strategy, and Internationalization Strategy with the O2O management platform.

d) Case study 4: Lianyungang port

312. In a similar “Intelligent” development initiative, with the aid of mobile Internet, Lianyungang port uses smart phones and various types of industrial mobile terminals to serve production and operation of the port. In terms of terminal production, its self-developed business management information system for large-sized general cargo terminals has further expanded and greatly improved the efficiency of general cargo terminal production scheduling. In terms of communication, two pieces of software, business microblog platform “Yunzhijia” and real-time enterprise communication software “RTX” have been developed, applied, and become important tools for the employees of Lianyungang Port Group Co., Ltd. to conduct daily communication and coordinate work. For customer

services, the “one-stop” service platform has been operating steadily for many years, improving the business efficiency of port customers and reducing their cost.

e) Case 5: Ningbo port

313. Ningbo port has been accelerating sea-rail multimodal transport into the era of Internet Plus by integrat five sub-systems to share data, including the original freight waybill system, loading and unloading system, and wireless transmission system of train marshalling, which has achieved information-based and connectivity-based business operation and on-site control in sea-rail multimodal transport and data sharing with the national railway system, shipping companies, and related entities.

314. At the same time, concepts such as the Internet of things and bid data have also been used to give play to the port’s function of connectivity. The railway production system has greatly speeded up the pace of sea-rail transport into the age of Internet Plus featuring the Internet of things and big data, which will effectively bring into play the pivotal role of port railway in connecting countries along “One Belt, One Road” and in distribution. In the future, just by one click, business specialists can precisely track the sea-rail multimodal transport containers in transit.

f) Case 6: Rizhao port

315. In another case, an intelligent port with the ability to “think”, Rizhao port has independently developed a set of management systems with the integration of information technologies such as GPS positioning, wireless communication, logistics network, and mobile Internet. Its public WeChat platform supports real-time inquiry about the waiting time of vehicles and the intelligent system has brought process reengineering. In addition, the system supports online appointment for goods pickup and online printing of the bill of lading, and provides accurate information. Through the system, big data is shared, the service chain is extended, and information exchange platform is built to achieve two-way information communication. The use of “logistics documents” under e-commerce is being promoted for cargo information inquiry and tracking to build an “Alibaba of port”. Information technologies such as the Internet of things and mobile Internet will be made full use of to help decision makers and the management to do strategic analysis and strength and weakness analysis.

5. Influence of Internet Plus and technological development

316. Internet Plus and technological development has advanced the development of policies and regulations for the integration of the Internet with transport and logistics in Liaoning province. In December 2015, Liaoning provincial people's government issued the *Action Plan to Actively Promote Internet Plus in Liaoning Province*. Article (VII) puts forward opinions on how to implement highly efficient Internet Plus logistics as follows: "(1) Build the system of provincial logistics public information platform. Preference should be given to a logistics information platform of a certain scale to improve its functions and role to provide logistics public information services to the whole province so that it can share information and connect with the information systems of administrative departments of various industries, public information of inter-city logistics, and the information system of logistic enterprises. Logistics public information systems at the city level should be constructed scientifically to improve the system of provincial logistics information platforms. (2) Improve the system of logistics and distribution services. The service procedure of express delivery businesses should be regulated to improve express delivery speed and service quality. An urban express delivery network should be built to be able to cover the whole province, reach the whole country and gradually expand to county-level cities and major towns to build the management and service system of logistics express delivery adaptive to the e-commerce development of the province. Third-party logistics should be developed vigorously, and the fourth-party logistics should be promoted to develop external, organized, and information-based logistics and distribution. The business model of e-commerce logistics and distribution should be innovated to coordinate development of e-commerce and logistics express delivery. Support should be provided to e-commerce enterprises and merchandising businesses to jointly build logistics facilities for warehousing and distribution for highly efficient and smooth e-commerce distribution network. Support should also be given to city communities to set up online shopping express delivery sites. (3) Speed up the construction of Liaoning regional exchange node for national transport and logistics platform (Liaoning provincial transport and logistics public information service platform). All kinds of information resources should be aggregated to increase connectivity between the provincial platform with freight hub stations, port terminals, and logistics parks. Key logistics enterprises are encouraged to set up society-oriented interconnectivity application system or platform with third-party agencies to integrate information about warehousing, transport, and distribution. Efforts should be made to promote the building of passenger transport vehicles system and small package express delivery system. Liaoning's function as a regional exchange node should be utilized as a platform to support data exchange and settlement. Efforts should also be made to promote the construction of multimodal transport system, connect logistics information chain, and enhance the interconnectivity application of multimodal transport. (4) Give play to the leading role of leading Internet enterprises in innovation. Efforts will be given to promote the popularization and application of technologies such as

mobile Internet, satellite positioning and navigation system, RFID, and IC card electronic license, encourage the development of freight APPs and the innovation of operation and service modes such as freight loading, tracking and traceability, and cultivate some third-party leading logistics enterprises with mobile Internet technology as their core competitiveness.”

317. In 2016, in order to thoroughly implement the *Opinions of the General Office of the State Council on In-depth Implementation of the ‘Internet Plus Circulation’ Action Plan* (No.24〔2016〕 of the General Office of the State Council), Liaoning province issued the *Action Plan to Implement Internet Plus*, which puts forward the need to: strengthen the infrastructure construction of intelligent circulation. It is imperative to increase the policy support to the construction of logistics bases and cold-chain system, etc., make scientific planning and layout arrangement of logistics bases, distribution centers, public delivery centers, and terminal delivery networks in the province, increase the input in circulation infrastructures, support the construction of cold chain system for the whole circulation of agricultural products, and focus on the refrigerator construction in major national agricultural production areas. It is necessary to increase the input in the broadband construction in rural areas, extend fiber broadband and mobile network to every village, accelerate the process of speed increase and fee reduction, and eliminate the “digital gap” between urban and rural areas. Further efforts shall be made to make information-based transformation of circulation infrastructures and make full use of the Internet of things and other new technologies to push forward the construction of intelligent logistics and distribution system, and improve the utilization of cold-chain facilities in the whole province. It is necessary to build demonstration logistics system to develop the logistics professional and public information service platform of Liaoning province, promote advanced delivery model, integrate various types of logistics resources, and encourage the innovation of logistics technology, management, form, and services to improve logistics efficiency and lower logistics cost. It is imperative to promote the coordinated development of e-commerce and logistics express delivery in Dalian province as a pilot city, make timely summary of the pilot results of the coordinated development, form the system, practices and experiences that can be replicated and popularized. It is imperative to explore to build the logistics express delivery management and service system adaptive to the rapid development of e-commerce, make efforts to solve the difficult problems such as standardized traffic of express delivery vehicles, terminal delivery, and the training of e-commerce express delivery professionals in basic skills, and shore up weak links in the development of e-commerce logistics.

318. In practice, there has already been construction and application of Internet Plus logistics. The use of Internet of things is to connect things through the Internet.

Sea-rail multimodal transport is not just about information sharing and work coordination between the port and railway; it also involves many other parties such as shipping enterprises, cargo owners, and regulatory agencies. In 2011, Dalian along with the other 5 cities, Lianyungang, Qingdao, Tianjin, Shenzhen and Ningbo have co-applied for a pilot program of national internet of things for sea-rail multi-modal transport. Both NDRC and MOF have approved the program to develop internet of things on demonstrative transport routes like Lianyungang-Alashan, Dalian-Harbin, Qingdao-Zhengzhou, Tianjin- Hohhot, Shenzhen-Chengdu, Ningbo-Wuhan etc. As one of the earliest port to develop sea-rail multimodal transport in China, Dalian port is identified as one of the 6 national demonstrative ports by Ministry of Transport and China Railway. As a result, the TEU transport capacity by sea-rail multi-modal transport have been increasing and taking a leading position nationwide.

319. The IoT program started construction in July, 2014 in Dalian and went on trial operation in May, 2016, and then was approved and completed inspections by experts from Ministry of Transport in April, 2017. It built up an intelligent IoT platform by integrating smart technologies such as satellite positioning, one-stop services for custom declaration, coordination with checking stations and multimodal transport and the inclusion of a “big data storage house” that collects all information of shipping bills, cargos, dock operations, railway companies, inland depots, train operators, supervision authorities. The application of the intelligent IoT platform plays an important role in the following aspects: first, greatly improve the efficiency and quality of sea-rail transport. Second, reduce enterprises’ logistics costs. Third, enhance customer service experience. In addition, thanks to Internet connectivity and monitoring during the whole course of the transportation, the IoT platform can analyze the types of goods, cargo flow, and the efficiency of the distribution so that the port can adjust its goods supply market, operation procedure, and hinterland planning accordingly. The program does not only provide a demonstration example for the application of IoT in sea-rail container multimodal transport, but also will boost the building of the OBOR international logistics channel of Dalian port.

6. The Role of Private Capital

320. In recent years, private capital has become an important force in promoting the development of the national economy, an important pillar of national tax revenues, and a major channel for job creation. According to the *Several Opinions of the State Council on Encouraging and Guiding the Healthy Development of Private Investment*, by giving private capital more freedom and bigger development room, the economy will develop faster and more vigorously.

321. Currently, great efforts have been made to vigorously introduce private capital in three major areas, namely transport infrastructure, transport services, and emerging transport industries.

a) *Transport infrastructure*

322. Transport infrastructure includes roads, waterways (locks), ports, hubs (stations), railways, and civil aviation airports. According to the theory of public goods, most transport infrastructure is public goods or quasi-public goods. At the same time, based on whether the investment project has a fee charging mechanism and whether there is any revenue under the charging mechanism, transport infrastructure can be divided into three categories: non-profitable projects, quasi-profitable projects, and profitable projects.

323. For infrastructure of public goods such as ordinary roads and inland waterways, its nature as public goods determines that the dominance of government investment will not change and it is rather difficult for private investors to invest extensively. Quasi-public goods such as highways and toll roads have more private investors. Railways, especially inter-city railways, have been the key areas where the government advocates the entry of private capital in recent years. Projects of comprehensive transport hubs, passenger and cargo stations, and civil airport will be the key areas to attract private capital in the next phase of transport infrastructure development. Currently almost the construction of all ports is invested by businesses, therefore, it has a relatively high level of commercialization and private investors are more interested in this area.

7. *Transport service industry*

324. Transport services include road transport, water transport, railway transport, air transport, urban passenger transport and so on. Generally speaking, transport service projects are ordinary competitive projects. As road and water passenger and freight transport has already enjoyed relatively high level of market-based operation and better rules and regulations, it has already been fully opened to private capital in road and water passenger and freight transport, urban passenger transport, and auxiliary transport industries such as driving training, vehicle maintenance, shipping agency, ship inspection, ship leasing and so on.

325. Due to the special nature of air transport and out of the consideration of safety, most private businesses hold a wait-and-see attitude when it comes to investment in this area. The construction of feeder airports require less investment and the construction period is short. It requires about RMB 300 million to build a feeder airport. By investing in feeder airports, private investors can get a relatively large amount of shares even controlling stake with a relatively small investment. Because of incomplete reform of investment and financing system and the special

requirement in operation and management in rail transport, there still will be some difficulties for full access of private investment within a certain period of time in the future.

8. *Emerging transport industry*

- 326.** Emerging transport industry includes intelligent transport, modern logistics, traffic information services, energy conservation and emission reduction in transport, etc. Similar to high-tech industries, emerging transport industries are ordinary competitive industries. Under the government support to develop high-tech and emerging industries, if transport industry wants to change its development mode and achieve transformation, it is necessary to vigorously promote the development of transport information service and intelligent transport technologies. Logistics information service platform, the development of new energy vehicles and vessels, and intelligent technologies such as Internet of things are the future development directions of transport. As the development of high-tech industry is market-oriented, private capital has become the main investment in this field. The emerging transport industry has huge development and investment potential. Therefore, it is a key transport area to introduce private capital.
- 327.** Based on the above analysis of the characteristics of the three major transport areas and key investment projects, a comparison of possible entry approaches of private capital and the willingness of investors to enter is shown in Table 9.

Table 33: Three Transport Sectors to Attract Private Capitals

Transport area	Investment project	Entry form	Willingness of investor
infrastructure	Highway, railway	Issuance of financial tools such as bonds and trust funds	With low returns, it is unlikely to attract private investor to enter as the main investor
	Trunk highway, rural road, airport	Various investment compensation measures	Investment compensation can attract some investors, but their willingness is low
Transport service	Highway and waterway transport	Eliminate local entry barriers and improve the tendering system to regulate the behavior of the bid solicitor	Investors have strong willingness to enter
Emerging industry	Intelligent transport, modern logistics, information service, energy conservation and emission reduction	Encourage and guide the entry through preferential policies on tax and interest rate	

328. Private capital can enter the transport industry in many different forms. However, due to the different attributes and characteristics of the projects in various areas, variance exists in its entry space and mode, and the role it plays. Table 10 is a summary of the ways in which private capital can be introduced in the three major transport areas.

Table 34: Ways to Attract Private Capitals into Transport Sector

Transport area	Operation nature	Project	Measure to attract private capital
Transport infrastructure	Profitable, quasi-profitable	Highway, bridge, and port	1. Traditional ways such as BOT, transfer of the operation right and the right of toll collection, issuance of business bonds, and company listing; 2. Setting up transport industry fund; 3. Securitization of highway assets; 4. Entrusted loan.
	Quasi-profitable	Airport, ship lock, railway, hub station	1. Setting up transport industry fund; 2. Entrusted loan; 3. Establishing transport hub complex.
	Non-profitable	Free trunk road, rural road, waterway channel	1. Establishing charity foundation; 2. Issuance of local bonds; 3. Entrusted loan.
Transport service		Road, water transport and auxiliary industry	1. Direct investment; 2. Establishing logistics industry park; 3. Bond issuance; 4. Company listing.
	For-profit, monopoly	Railway transport	Difficult to attract private capital under the current system.
	For-profit	Air transport	The market is relatively open, but state-owned enterprises still play a dominating role and it is difficult to for private air transport enterprises to develop.
Emerging transport industry	For-profit	Intelligent transport, modern logistics, information service, energy conservation and emission reduction	1. Transport industry investment fund; 2. Direct investment; 3. Establishing transport industry park; 4. Issuance of business bonds; 5. Company listing

9. Case studies of private investment in transportation

a) Case I. Beijing Subway Line 4

- 329.** Beijing Subway Line 4 is a major rail transit line in Beijing's mass transit network. The 28.2 km-long subway line, with a total investment of 15.3 billion yuan, runs from north to south of the city. The whole project was divided into two parts, namely Part A and Part B. Part A mainly covers civil engineering with an investment of around 10.7 billion yuan, accounting for 70% of the total investment. The established company, Beijing Metro Line 4 Co. (a wholly-owned subsidiary of the Beijing Infrastructure Investment Co., BIIC) is responsible for Part A's investment and construction. Part B mainly covers metro vehicles, signal, vending system and other mechanical and electrical equipment. Part B's investment capital reached about 4.6 billion yuan, accounting for 30% of the total, and was financed and built by the Beijing MTR Corporation, or BJMTR (a three-way Joint Venture among the Hong Kong MTR Corporation, the Beijing Capital Group (BCG), and the BIIC that acts on behalf of the government side).
- 330.** The Beijing municipal government has also awarded the JV a concession to operate and manage Line 4 for 30 years. Expenditures for BJMTR include: the construction of Part B, lease payment of Part A to Beijing Metro Line 4 Co., the maintenance of all facilities (including both Part A and Part B) and the replacement of all assets except for the tunnel. The revenue of BJMTR includes: fares and income generated from other commercial activities within the station.
- 331.** The Beijing municipal government may adjust BJMTR's lease payment of Part A based on the ridership. In case that the passenger flow is lower than expected and fares income decreases, the rent will be lowered to make up the loss of BJMTR; otherwise, the rent will go up to avoid an excess profit scenario. When the 30-year concession period expires, BJMTR will return the facilities of Part A to Beijing Metro Line 4 Co., and transfer the well-preserved facilities of Part B voluntarily to the designated agency of the government.

b) Case II. Fuling-Fengdu Highway in Chongqing

- 332.** Chongqing Fuling-Fengdu Highway, with a total length of 46.5 kilometers, is a major component of Chongqing's highway network. Its total investment was 4.179 billion yuan, and the project won the approval in 2008. The construction was commenced in June 2009 and was open to traffic in 2013. The bidding was launched in April 2008. Road & Bridge International Co., Ltd. won the bidding and was awarded the investor in the mode of "BOT+EPC". As authorized by the Chongqing municipal government, the Chongqing Municipal Commission of Transportation signed an investment agreement with the bid-winner in August 2008. Both sides agreed that the investor shall be responsible for the investment,

construction, operation and management of the project according to the masterplan and government demands. After the signing of the investment agreement, the investor then set up a company in accordance to the clauses as listed in the agreement to fulfill its obligations. With the authorization of the municipal government, the Chongqing Municipal Transportation Committee signed a concession agreement with the company in May 2009, granting the company the right to invest, construct, operate and manage the Fuling-Fengdu Highway. The company is expected to fulfill duties including examination and approval, proactive design, land acquisition and demolition, financing and construction of the project.

c) Case III. Phase II of Shenzhen Metro

333. The construction of the Shenzhen Metro consists of Phase I, II and III. Phase I was fully financed by the government, with 70% of the investment capital coming from the municipal government and the remaining 30% from bank loans. In 2007, the PPP model was first introduced to Phase II subway expansion, making the government and social capital each account for 50% of the total investment. Private enterprises repaid bank loans through the development of superstructure property, such as vehicles. The government contributed to the construction financing through directed use of land premiums. Take the operation model of Qianhai Station as an example. In 2008, three properties of Qianhai Station were open for bidding, auction and listing. The Shenzhen Metro Group (SZMC) won the bid, it then raised 1.74 billion yuan of land premium from the SASAC. The premium was then transferred to the municipality's fiscal department, and then to the SASAC in the same day to enable the SASAC to put the money to the SZMC. The SZMC thereof gained the right to land use for the purpose of attracting market capital for the subway construction.

d) Case IV. Hangzhou-Shaoxing-Taizhou High-speed Railway

334. On December 23, 2016, the Hangzhou-Shaoxing-Taizhou High-speed Railway was formally commenced in Taizhou. The 269-km railway was designed with a speed of 350 km/h, and the total investment is about 44.9 billion yuan. The China Railway Fifth Survey and Design Institute Group Co., Ltd. was responsible for the survey and design of the project, which is among China's first public-private partnership (PPP) funded high-speed railways. According to the PPP financing framework, the project will be co-funded by private capital (accounting for 50% of the total), State-owned China Railway, Zhejiang Communications Investment Group and local government. In September 2016, a PPP cooperation agreement was signed between the Zhejiang Communications Investment Group and three private firms, namely the Fosun Group, the Geely Holdings Group and the Wanfeng Auto Holdings Group. It was agreed that the railway shall be jointly financed and constructed by Zhejiang Communications Investment Group, Taizhou City, Shaoxing City, private capital and China Railway, and shareholdings

by private capital is acceptable. The Fosun Group, which financed the construction of the railway, is a large investment group whose main businesses include investments in health and medicine, real estate, steel, mining, retail, cultural and service industries; the Geely Holdings Group, an auto making and operation company, is a local private enterprise, and became famous after its acquisition of Volvo; the Wanfeng Auto Holdings Group, a local private enterprise in Shaoxing, is mainly active in auto parts industry, machinery and equipment, financial investment, etc.

335. In short, private capital is huge in amount with strong vitality and growth capacity. Its introduction into the sea-rail multimodal transport industry is conducive to expanding funding channels and enhancing sea-rail multimodal transport industry's sustainable development ability. It can accelerate the shift of traditional transport to emerging transport industry to optimize and upgrade the industry. In addition, private capital can also help establish a competitive mechanism to improve the efficiency of transport service. It is beneficial to improve transport service system to promote better and faster development of sea-rail multimodal transport in Liaoning province.

Table 35: Policies Listed in this Section

No.	Name	Release time	Release agency
1	<i>《Implementation Plan for Liaoning Province's Participation in "One Belt, One Road" Initiative</i>	2016	People's Government of Liaoning
2	<i>The 13th Five-Year Plan for the "One Belt, One Road" Initiative in Liaoning Province</i>	2016	People's Government of Liaoning
3	<i>The Opinions of the Central Committee of CPC and the State Council on the Implementation of Revitalization Strategy of the Old Industrial Bases in Northeast China</i>	2003	The State Council
4	<i>The Decision of Liaoning Provincial Party Committee and Provincial Government on Speeding up the Building of Dalian Northeast Asia International Shipping Center</i>	2004	People's Government of Liaoning
5	<i>The Opinions of Liaoning Provincial People's Government on Accelerating the Development of Coastal Ports</i>	2004	People's Government of Liaoning
6	<i>The Development Plan of Dalian Northeast Asia International Shipping Center</i>	2004	People's Government of Liaoning
7	<i>The Opinions of Dalian Municipal People's Government on Accelerating the Building of Dalian Northeast Asia International Shipping Center</i>	2004	People's Government of Dalian
8	<i>The Opinions of Dalian Municipal People's Government on Implementing the Development Plan of Dalian Northeast Asia International Shipping Center</i>	2004	People's Government of Dalian
9	<i>Dalian Northeast Asia International Shipping Center Development Plan</i>	2007	People's Government of Liaoning
10	<i>The Master Plan of Dalian port</i>	2007	People's Government of Liaoning
11	<i>The Opinions of the State Council on Major Policy Measures for Supporting the Revival of Northeast China in the Near Future</i>	2014	The State Council

12	<i>Overall Plan for the China (Liaoning) Pilot Free Trade Zone</i>	2017	The State Council
13	<i>Guiding Opinions on Promoting the Development of Information-Based and Intelligent Transport</i>	2013	The Ministry of Transport
14	<i>Form of Transport Informatization Standard System</i>	2013	The Ministry of Transport
15	<i>Guiding Opinions on Actions Actively Promoting Internet Plus</i>	2015	The State Council
16	<i>Guiding Opinions on Taking the Lead of Economic and Social Development under the “ Four-Pronged Comprehensive Strategy “</i>	2015	The Ministry of Transport
17	<i>Implementation Opinions on Promoting the Openness and Sharing of Data Resources in the Transport Industry</i>	2016	The Ministry of Transport
18	<i>the Guiding Opinions on Promoting the Network Security in the Transport Industry</i>	2016	The Ministry of Transport
19	<i>The 13th Five-Year Plan for Transport Informatization</i>	2016	The Ministry of Transport
20	<i>Action Plan to Actively Promote Internet Plus in Liaoning Province</i>	2015	People’s Government of Liaoning
21	<i>Opinions of the General Office of the State Council on In-depth Implementation of the ‘Internet Plus Circulation’ Action Plan</i>	2016	The State Council
22	<i>Action Plan to Implement Internet Plus</i>	2016	People’s Government of Liaoning
23	<i>Several Opinions of the State Council on Encouraging and Guiding the Healthy Development of Private Investment</i>	2010	The State Council

10. Bottlenecks and Challenges

336. In the *Medium and Long-Term Plan for the Development of the Logistics Industry (2014-2020)* (No. 42 [2014], State Council) issued by the State Council, the first high-priority project to develop is multimodal transport, among which sea-rail transport is the most efficient logistics mode. Compared to highway-water multimodal from the perspective of the cost, normally sea-rail transport can save about 30% of the cost. In the “21st Century Maritime Silk Road” under the national “One Belt, One Road” strategy, export-oriented processing economy is the dominant economy, and it is hoped to enhance trade exchange between China and countries along the Silk Road through maritime transport channels. Therefore, under the Initiative, China is more willing to conduct economic exchange with other countries, which demands more sea transport-based international logistics. Multimodal transport, especially container multimodal transport, has become an advanced, highly efficient, and important transport model thanks to its outstanding advantages in time, cost, and efficiency. Sea-rail multimodal transport is an integral link of multimodal transport. Despite of the advantages of sea-rail multimodal transport, its development in China had lagged behind in the past. Analysis of the study team shows that there are currently many bottlenecks and difficulties in the development of sea-rail multimodal transport in Liaoning province.

a) Insufficient Freight Supply

337. The freight volume of sea-rail multimodal transport port depends on the economic development of the hinterland. In recent years, with the support of various national preferential policies, although the economy in northeast China has been somewhat more developed, it still lags behind other economically developed regions in China due to its long-standing problem in economic structure, the biggest obstacle to the scale of economic development. Compared to domestic ports, the proportion of foreign trade export is very low. Therefore, the low-level economic development of the hinterland has led to insufficient supply of foreign trade goods and low volume of export. There is not sufficient freight for sea-rail multimodal transport in Liaoning province.

338. In recent years, the US financial crisis has impacted the global industry chain. As a result, the overall international economic environment does not look very promising and the foreign trade volume has not seen much increase. From 2014 onwards, the total volume of import and export has been decreasing for two consecutive years. The total volume of import and export in 2016 was USD 86.521 billion, which is not much higher than that in 2010 (see Table 11). Consequently, the growth rate of foreign trade freight has been decreasing.

Table 36: Total Import and Export of Liaoning 2009-2016

Indicator (USD 100 million)	Year							
	2009	2010	2011	2012	2013	2014	2015	2016
Total volume of import and export	629.2	806.7	959.6	1039.9	1142.8	1139.6	960.8	865.21
Total export volume	334.4	431.2	510.4	579.5	645.4	587.6	508.4	430.65
Total import volume	294.8	375.5	449.2	460.4	497.4	552.0	452.4	434.56

339. In addition, China has long coastline in superior geographical locations. The ports are relatively densely distributed, which means that some ports share the same hinterland and they have overlapping hinterland resources. The competition between sea-rail ports is actually the competition for hinterland goods supply. Further economic development will make the competition fiercer. Take the Port of Dalian in Liaoning Province as an example. In the course of developing into an international large port, Dalian Port has been facing with the severe challenges of foreign ports and domestic ports that were squeezing its resources. The challenges posed by foreign ports are mainly as follows: the competition among Northeast Asian ports grew more fiercely than ever before, e.g. the strategic objective of building a “Central Port In the Pacific Rim for the 21st Century” put forward by Busan Port in South Korea, and the slogan of building a “Asian Centenary Home Port” or a “Super-port in Asia” by the Kobe and Tokyo Port respectively in Japan. While domestic competitions mainly came from: first, the competition with Qingdao Port and Tianjin Port, which, together with Dalian Port, are all located in the Bohai Bay and are close to each other in terms of air-line distance. However, in recent years, the port hinterland and economy of Qingdao Port and Tianjin Port are better than the three northeastern provinces, making the two ports’ cargo handling capacities larger than the Dalian Port; second, the challenges posed by Yingkou Port, which has been developing with a strong momentum in recent years. In order to speed its expansion and increase the handling capacity, the port has input great human and material resources into the development of the hinterland’s market. Hence, its competition with Dalian Port grew ever stronger. Despite Dalian Port enjoys obvious advantages in terms of infrastructure and hardware facilities, construction size, supporting hardware and software equipment, etc., Yingkou Port is closer to the economic hinterland compared to Dalian Port. This has resulted in a reduced overall logistics cost for Yingkou Port, making many sources of freight

start to transfer from Dalian Port to Yingkou Port. Over recent years, the cargo handling capacity of Yingkou Port has exceeded Dalian Port. Insufficient goods supply is a factor restricting the development of sea-rail multimodal transport in Liaoning Province.

b) Higher Freight Rate

340. For different cargo owners, their sensitivity to freight rate varies. Generally speaking, high value-added goods can afford higher rate, and low-value added goods are more sensitive to the rate. Bulk freight is more sensitive than container goods. Theoretically, the cost of container transport by train = the cost of container transport by highway × 50%. However, in reality, the freight rate adjustment system for rail transport is not as flexible as highway or water transport; Highway transport mostly involves private and individual vehicles attached to transport companies with flexible prices; the self-employed in highway transport business mostly make verbal negotiations, and the final price is agreed upon by both parties; the rate of empty car move on the way back is relatively low, and consignment on the return trip compensates the costs. Railway carries out uniform tariffs regardless of time and place. However, the competitive environment of the market varies in different regions and at different times. The unified tariffs cannot cater to demands in such a highly competitive market and also prevent railway transport enterprises from true autonomy and independent decision-making. As stipulated in the 2015 *Notice of NDRC on Adjusting the Price of Railway Freight Transport and Further Perfecting the Mechanism of Price Formation*, only railways owned by the China Railway Corporation (CRC) which adopts special tariff and joint railways controlled by CRC are allowed to lift the price ceiling by no more than 10% and keep the same price floor, with the transport tariff promulgated by the state as the benchmark price.

341. At the same time, the empty container rate is high retuning from inland to ports, and the turnaround time is long, which further increases the cost of container shipping. Therefore, sea-rail multimodal transport in Liaoning province lacks the advantage of low cost. For example, the density of container trains traveling from the port to major inland container logistics center is about two shifts per week on average. Generally, it takes three days for containers with scattered and small quantities of cargo to assemble in the port through train transport, and another three days for the return trip, emptying, goods delivery, and return to the port. It takes one day through highway transport to reach the port, saving four to five days in contrast to sea-rail multimodal transport. Therefore, Liaoning sea-rail multimodal transport has no competitive advantage in transport cost.

c) Infrastructure Issues

342. First, port container terminal and the railway facilities do not compatible with each other. Currently, most port railway reaches terminals, but the loading and unloading line is not long enough for whole train operation. Therefore, it is difficult to bring into full play the advantages of train operation. Meanwhile, some ports are not capable of direct sea-rail transfer of containers. Road drayage is required to complete the transfer between the terminal yards and the railway station, thus making direct discharge impossible, which seriously affects the efficiency of sea-rail multimodal transport. In addition, some ports do not have access to railway, which has caused obstacles in connecting the port and the railway and brought additional operating costs.

343. Second, the railway facilities need to be further improved. Port railway refers to the railway run by the port. It is not only an important facility in port production, but also a key link in sea-rail multimodal transport. The railway network in the port area closely affects the production ability of the terminal, whether the terminal's berth function is fully played, and how to improve goods distribution of the port. There are many inland areas without access to railway and the places with access to railway do not necessarily have container business. Therefore, after clients hand over containers to the carrier, the exact time of arrival cannot be promised and the delivery deadline cannot be guaranteed, which makes it impossible for clients to make arrangement of liner connection, production, or consumption. In recent years, with the acceleration of railway construction, the situation in some areas has been improved, but the problem of overall insufficient capacity still exists. Import and export containers that enter and leave a port are subject to the impact of factors such as shipping schedule and container lease period, so most of these containers have requirement for shipping timeliness. Containers for short- and long-distance transport have higher requirements. Constrained by insufficient transport capacity, to some degree, railway cannot fully meet the timeliness requirement. Meanwhile, limited by insufficient container goods supply and insufficient container supply, the operation of container train cannot be completely guaranteed, which results in the transfer of many containers to other transport modes such as highway or water transport after they are discharged from ships.

d) *Institutional Problems: Insufficient Sea-Rail Coordination System*

344. Currently, most of the policies to promote the development of multimodal transport are part of some documents of development opinions and there are not many documents issued directly for multimodal transport. For example, the development of multimodal transport is mentioned in the *Catalogue of Key Industries, Products, and Technologies Currently Vigorously Encouraged by the State for Development* and the *CPC Central Committee's Recommendations for the 12th Five-Year Plan for Economic and Social Development*, but the relevant content is not specific and lack feasibility and operability.

- 345.** In terms of legislation, only a few laws in China such as *Maritime Law* and *Contract Law* provide legal provisions for multimodal transport. These laws only touch on multimodal transport and are not specifically formulated for it, so they cannot regulate the overall development of multimodal transport and are unable to restrict the specific operation procedure. On April 1st, 2017, the *Terminology of Multimodal Transport of Goods* and the *Multimodal Transport Unit Identifier*, two industrial standards promulgated by the Ministry of Transport of the People's Republic of China officially took effect. That was the first time that industrial standards in multimodal transport have been promulgated and the void is filled. The promulgation of these two fundamental standards have laid the foundation for the issuance and revision of subsequent standards, which marks an important step forward in the development of multimodal transport in China.
- 346.** There is lack of a special organization for comprehensive sea-rail multimodal transport organization and administration. The powers and responsibilities of various departments lack coordination. They act in their own way and only fulfill their respective roles and do not coordinate with each other. Although the super-ministry reform in 2018 in China has moved the Ministry of Railways and the Civil Aviation Administration of China under the administration of the Ministry of Transport, there still lacks an agency responsible for unified administration of multimodal transport within the Ministry of Transport. For example, the Transportation Department of Liaoning Provincial has the following responsibilities: promote the construction of an integrated provincial transport system, coordinate the development of highways and waterways and the construction of railways and civil aviation in the province, establish a sound institutional mechanism in compatible with the provincial integrated traffic transport system, modify main transport routes and key hub nodes layout across the province, and facilitate the integration of various means of transport; supervise provincial highway and waterway construction, manage the construction and maintenance of provincial transport infrastructure such as highways and waterways, manage the planning, utilization and supervision of the ports, port-appropriate shorelines, channels and associated auxiliary facilities; manage local railway industries in the province. China Railway Shenyang Group is responsible for railway transport. Its business covers three sub-provincial cities including Shenyang, Dalian and Changchun; Benxi, Anshan, Jilin and Fushun (the fourth "relatively large city" recognized by the State Council); coastal cities including Dalian, Jinzhou, Yingkou, Dandong, Panjin, Huludao and Shanhaiguan District of Qinhuangdao. Shenyang Railway Administration is responsible for supervision and management of railway transport safety, railway engineering quality and safety, and railway administrative law enforcement, etc., and relevant railway supervision and management for China Railway Harbin Group Co., Ltd., and China Railway Shenyang Group Co., Ltd. It is thus clear that it is very difficult to coordinate, as railways, highways, and

waterways in Liaoning are administrated under different administrative agencies which belong to different administrative areas.

347. In addition, the lack of information sharing and coordination between transport agencies has made the procedure of multimodal transport more complicated, which cannot reflect the advantages of multimodal transport in high efficiency and low cost at all. In terms of coordination system, these agencies do not have timely and smooth information communication and lack a regular joint meeting system, which is unfavorable for timely briefings, problem communication, and solution seeking. In terms of institutional mechanisms, the construction of global trade system is yet to be improved and the construction of infrastructure such as container central station, sea-rail multimodal logistics hub ports for bulk cargos is yet to be expanded to give play to the policy advantages of the FTZ.

11. Incomprehensive Network

348. Currently, “going global” has already become a reality instead of just an aspiration for Chinese enterprises. However, the connection between domestic and overseas industrial chain requires a more solid maritime logistics channel. The profit margin that enterprises get from goods production and sales is smaller and smaller, and circulation has become the main source of profit. Multimodal transport, especially container multimodal transport, has become the most advanced, most efficient, most systematic, and most important transport model thanks to its remarkable advantages in time, cost, and efficiency. Sea-rail multimodal transport is a major link in multimodal transport. However, the following several practical issues exist in the actual operation of sea-rail multimodal transport:

a) Lack of systematic facilities design

349. The facilities connecting railways with port terminals lack systematic design. Ports mainly handling railway containers do not have a sufficient distribution system. Therefore, transloading to road transport vehicles is often required, which increases the cost and reduces efficiency. As the infrastructure for sea-rail multimodal transport, the railway transport network in Liaoning province needs improvement and port railways are still not an important part of the whole railway transport network. Sea-rail multimodal transport in Liaoning province lacks a railway container central station close to ports, railway access from the terminals, and the systematic connection between the railway hub station in the city and the railways in port areas and national railway network.

b) Insufficient Information sharing

350. The international logistics information platform based on maritime transport and the railway TMIS information platform have their own working mechanism and lack

information sharing. In addition, the interface connecting these platforms is not standardized, which makes it difficult to achieve the core values of sea-rail multimodal transport such as “one-step declaration, inspection, and clearance.” For example, various departments such as railway, port, multimodal system management units, transit stations, shipping companies, shipping agencies, shippers, and regulators have each established an independent information management, without a unified information exchange platform for the same businesses across the systems. Unshared information makes it impossible to provide container businessmen with one-stop streamlined service (one window, one bill, and full convenience). Besides, since information are not shared among ports and foreign railways, large volumes of data are entered repeatedly by ports and railways, which leads to inefficient information transfer and a poor connectivity between ports and railways. One main focus to develop sea-rail transport is to construct information sharing platform of sea-rail multimodal transport to achieve the exchange and sharing of information about container trains, status prediction and confirmation of railway containers, and container liner schedule. Although the (Dalian port) national demonstration project of the application of the Internet of things in container sea-rail multimodal transport has successfully passed the inspection of the expert group of the Ministry of Transport, various functions of sea-rail multimodal transport in Liaoning province are yet to be strengthened.

12. Resources Shortage in Transit Stations

351. One bottleneck during the development of sea-rail multimodal transport in Liaoning Province is that resources in transit stations are scarce. Take Dalian Port in Liaoning as an example. Currently, cities and regions with inland ports and transit stations in Liaoning are Shenyang, Changchun, Jilin, Mulin, Shuangliao, Kaiyuan, Suihua and Tongliao. The role and main function of these transit stations and inland ports are to provide loading and unloading, warehousing, and door-to-door services. They are engaged in bulk cargo assembly, and containers management, maintenance and cleaning business, with a purpose to extend the port function to inland areas and to provide a more complete service system. However, some serious problems are found in the transit stations. For example, small transit area, old facilities, incompetence and low efficiency. It is not only unlikely to ensure timely loading and unloading, which affects the turnover of containers and the packing and unpacking operation, but also generates high costs. As a result, customers are not motivated to use sea-rail multimodal transport. From the full service flow chart of containers, transfer stations are a significant factor that hinders the development of sea-railway multimodal transport. Moreover, during the construction of international sea-railway multimodal transport, it is found that the assembling and distributing system of Dalian Port based in inland ports and specialized fields in the three provinces in northeast China is incompetent to meet

the transport demand. With the huge market in Japan, South Korea and Russian Far East, Mongolia and Europe, it would be inevitable to have empty containers on the return trip if the Port held on to the existing assembling and distributing system. Due to the knock-on effect, there would be excessively high cost of transport and continuous loss of customers, which is not conducive to the development of Dalian Port.

Table 37: Policies listed in This Sub-section

No.	Name	Release time	Release agency
1	<i>Medium and Long-Term Plan for the Development of the Logistics Industry (2014-2020)</i>	2014	The State Council
2	<i>Notice of the National Development and Reform Commission on Adjusting the Railway Freight Rate and Further Improving the Pricing Mechanism</i>	2015	National Development and Reform Commission
3	<i>Terminology of Multimodal Transport of Goods</i>	2017	The Ministry of Transport
4	<i>Multimodal Transport Unit Identifier</i>	2017	The Ministry of Transport
5	<i>Maritime Law of the People's Republic of China</i>	1992	National People's Congress
6	<i>Contract Law of the People's Republic of China</i>	1999	National People's Congress

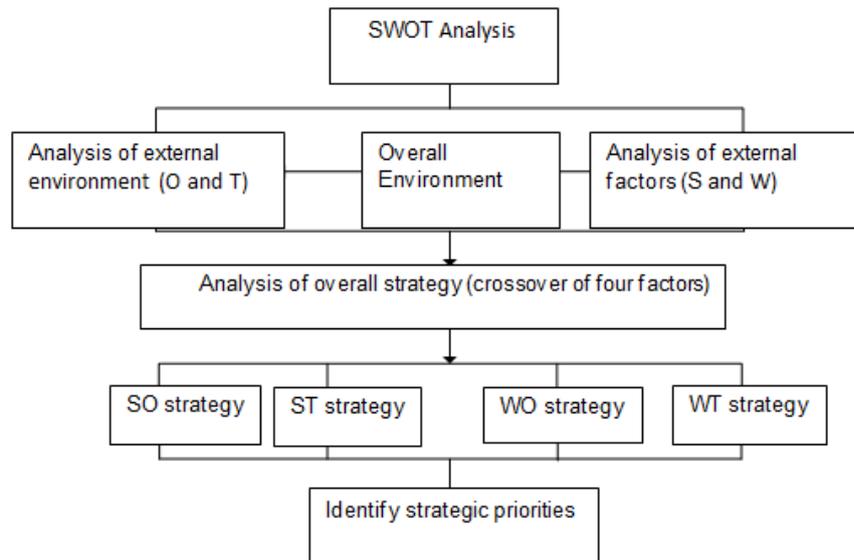
E. Port Management

1. SWOT Analysis

352. SWOT is an analytical method used to determine the competitive strengths and weaknesses of the company and the opportunities and threats faced by the company, so as to integrate the company's strategy with its internal resources and external environment. SWOT represent: internal strength, meaning the aspects with obvious advantages in the competition; internal weakness, meaning the aspects with disadvantages in the competition; external opportunity, meaning opportunities that can be more easily obtained and easily bring benefits compared with competitors; and external threats, meaning unfavorable trends or challenges brought about by the development. This is a set of methods to conduct a comprehensive systematic evaluation with the comprehensive consideration of various factors including internal conditions and external environments, which utilizes the internal strengths, overcome the inherent weaknesses, grasp external opportunities, avoid competitor's threats and develop the analysis and decision-making system in line with the company's future development strategy by adopting the strategy matching method. Based on SWOT analysis, we can get four sets of strategies, namely, SO strategy, WO strategy, TS strategy and WT strategy. SO strategy is to grasp external opportunities and seek rapid development relying on internal strengths; WO strategy is to utilize external opportunities to improve internal weakness and enhance the overall capabilities; TS strategy is to utilize the company's strengths to avoid or reduce the combat from external threats; WT strategy is to avoid or respond to external threats by overcoming internal weaknesses. SWOT analysis system is shown in

353. .

Figure 17: SWOT Analysis Schematic



SWOT analysis steps:

- (1) List the strengths and weaknesses, possible opportunities and threats of the enterprise;
- (2) Combine strengths, weaknesses, opportunities and threats, and form SO, ST, WO and WT strategies;
- (3) Screen and select from SO, ST, WO and WT strategies, and determine the specific strategies that enterprise should adopt.

2. The Operational Efficiency Evaluation of Dalian Port

354. There are China's biggest and the most advanced tens-thousand-ton crude oil quays and tens-thousand-ton ore terminals in Dalian, which is a domestic port with the largest reserve for self-owned storage tanks. Dalian port focuses on the handling, transport and storage of crude oil, refined oil and liquid chemical engineering products, accommodating 300-thousand-ton tankers with loading efficiency up to 12 thousand tons per hour. The capacity of oil tanks in its harbor district is more than 3 million cubic meters and its annual comprehensive throughput is above 56 million tons. Dalian Port is Asia's most advanced transit base of bulk liquid chemical products and also China's largest roll-on-roll-off

transportation port for marine passenger vehicles. There are seven shipping channels in the whole port, with a well-developed transport network. Its existing railway special lines inside harbor are more than 150 kilometers, its warehouse more than 300,000 square meters, its goods yard 1.8 million square meters and all kinds of handling equipment up to over 1000 units. It is now equipped with containers and more than 80 modern professional berths for roll-on and roll-off of customers' goods of crude oil, refined oil, grain, coal, loose-packed ore and chemical products, with more than 40 tens-of-thousand-ton-and-above berths. Its port throughput capacity reaches 240 million tons, and its container throughput capacity nearly 8 million TEUs. In 2015, the total throughput capacity of whole port goods at Dalian Port reached 415 million tons, ranking the eighth in China and eleventh in the world.

a) Strength

- 355.** Dalian is the core area of opening up in Liaoning Province. With superior geographical location, it has vast waters opening to Japan, DPRK and ROK. It is also an important city driving the economic development of surrounding regions. Dalian Port is a vital hub for exchange of resource, capital and experience in the peripheral zones, as well as the channel connecting the North and the South for grain, wood, oil and other raw materials. Dalian Port has now become the largest port in terms of trading volume and share in Liaoning Province.
- 356.** Dalian port has excellent natural conditions with affluent resource along the coastline. With wide area of waters including the free sea area covering 346 square kilometres, domestic tens-of-thousand-ton cargo ships come and go freely in the sea. There is no freezing phenomenon in winter here. Its great geological conditions promote the further expansion of the port, which provides adequate room for its growth.
- 357.** Its transportation routes extend in all directions. Located on the southern tip of Liaodong Peninsula and adjacent to the Yellow Sea and the Bohai Sea, Dalian Port has obvious strengths in modern logistics by sea, land and air.
- 358.** It has high level of information input, modernization and intelligence. Dalian Port is now equipped with the operation mechanism and management system catered for four-generation ports.

b) Weakness

- 359.** The capacity of Dalian Port's basic supporting facilities is not good enough. The maximum depth of water in Dalian Port channel is only -13.5 meters. Without professional berths adapted to international transportation, the channel cannot

meet the needs for large container ships to get under way for all-weather trade activities.

360. In Liaoning region, besides Dalian Port, other ports in Liaoning Province, such as Panjin Port and Yingkou port, inadvertently poses a serious threat against Dalian Port; in particular, the recent rapid growth of annual throughput of Yingkou Port is puts considerable pressures on Dalian Port.

361. Affected by political factors, Dalian Port Group is transformed from a planned state-owned enterprise. The backward management concepts restricted the development of Dalian Port.

362. Modern logistics system has complex process and demands for professional technology. However, Dalian Port lacks compound specialists, especially, logistics professional.

c) Opportunities

363. Global economic integration has led to the development of trade and logistics. After China's access to WTO, affluent resources are brought around the world, which has provided more room for expansion of import and export of harbor.

364. During the implementation of The Belt and Road Initiative, the support of national policies on the development of harbor has provided brand new opportunities for Dalian Port, which is a large port with geographical advantages and ability to promote the economic development of the surrounding area.

365. The development of local industry in Liaoning region has provided great room for growth of import and export goods at Dalian Port, where advanced high-tech industry, agricultural processing industry and modern service industry have improved the market capacity and development space.

d) Threats

366. Ports compete with each other. Located in the southern tip of Liaodong Peninsula, Dalian Port is adjacent to the foreign advanced ports of Japan and ROK, and to the domestic ones such as Yingkou Port, Jinzhou Port and Jingtang Port. In the meantime when Dalian Port goes on a rapid rise, other ports are also looking for opportunities to develop themselves.

367. The impact of economic crisis is also a challenge confronting Dalian Port. The financial crisis will cause instability in financial markets and unstable future prices, and thus affecting the development of Dalian Port in different aspects.

3. Analysis of Pure Technology Efficiency and Scale Efficiency of Dalian Port Operation

368. Based on the selected input and output indicators from 2007 to 2016 (specific data are seen in the attached table), take the data into the model to calculate the comprehensive efficiency value ρ^* and pure technology efficiency value θ^* of Dalian Port from 2007 to 2016 with Deap2.1 software, and calculate the pure scale efficiency with $S^* = \rho^* / \theta^*$. In addition, ports with the need for the financial redundancy adjustment of each year will also be displayed in the results. The specific results are shown in **Error! Reference source not found.**

Table 38: The Optimal Solutions of Model 1 and Model 2: ρ^* , θ^* and S^*

port	Dalian Port		
year	ρ^*	θ^*	S^*
2007	1.000	1.000	1.000
2008	0.872	0.993	0.879
2009	0.839	0.980	0.856
2010	0.837	1.000	0.837
2011	0.790	1.000	0.790
2012	0.759	0.987	0.769
2013	0.832	1.000	0.832
2014	0.947	1.000	0.947
2015	1.000	1.000	1.000
2016	0.974	1.000	0.974
average	0.885	0.996	0.888

Note: ρ^* represents the overall efficiency value, θ^* represents pure technology efficiency value, and S^* represents scale efficiency.

369. From the overall efficiency value in **Error! Reference source not found.**, the overall efficiency value of Dalian Port in recent 10 years shows the trend of declining first and then rising; In 2007 and 2015, the overall efficiency value was 1 and achieved DEA efficiency, indicating that Dalian Port was at the forefront of production and had high operation efficiency in these two years; in 2016, the overall efficiency value was 0.974, which was very close to the efficiency value of 1. This slight decline was due to the change of the company's input and output utilization rate and scale.

370. From the pure technology efficiency in **Error! Reference source not found.**, the pure technology efficiency value of Dalian Port in recent 10 years did not achieve DEA efficiency only in 2008, 2009 and 2012, but the value was very close to the efficiency value of 1 in these three years, and the average value of pure technology efficiency in recent 10 years was also very close to the efficient state. The high technology level benefited from the support of the national policy of “Belt and Road” and the policy of revitalizing Northeast old industrial bases. From this we can see that the low comprehensive efficiency value in Dalian Port is not due to the pure technology efficiency. In order to improve their performance, simply upgrading the technical level may not be able to achieve the desired effect. So the company needs to make adjustment according to its own conditions to greatly enhance the operational performance of Dalian Port.

371. From the pure scale efficiency value in **Error! Reference source not found.**, the average value of scale efficiency in Dalian Port in recent 10 years was 0.888, and the scale efficiency in Dalian Port reached the efficiency value only in 2007 and 2015. For the analysis of the economies of scale, if the scale efficiency value gradually increases, it means that the returns to scale of the port are gradually increasing. In this case, the port can increase the input to obtain the highest profits. If the scale efficiency value gradually decreases, it means that the returns to scale of the port are decreasing. In this case, the port can reduce the input to reduce unnecessary resource waste. If the value remains unchanged, it means that the port achieves scale efficiency. From the table we can see Dalian Port achieved scale efficiency only in two years. In 2016, the returns to scale of Dalian Port increased, so the port can increase the input, gain high profits and achieve scale efficiency. In other years except 2016, the returns to scale of Dalian Port decreased, so the port should reduce the input, reasonably arrange resources and make reasonable adjustment to the scale of the company.

4. The Redundancy Analysis of Dalian Port Operational Efficiency

372. In the past 10 years, the overall efficiency value of Dalian Port Company did not achieve DEA efficiency, reflecting the waste of resource input and rising operation costs. As a result, the output indicator did not reach the expected optimum, and there was redundancy for the input and output. From Table 39, we can see that the input and output of Dalian Port Company in recent 10 years did not reach DEA efficiency in the overall efficiency value, so we should adjust the selected indicators. In the input indicators, the target value of the total assets in 2008 should be 28.80520 billion RMB, so the radial variable of the output should be reduced by 324.67 million RMB to achieve the DEA optimum of the comprehensive efficiency. In the output indicators, the target value of operation income should be 724.8 million RMB, so the radial variable of input should increase

by 65.47 million RMB. The target value of earning per share is 1130 RMB, so the radial variable of input and output should increase by 100 RMB and 200 RMB respectively. The target value of net profit should be 451.79 million RMB, so the radial variable of input and output should increase by 4.19 million and 151.47 million RMB respectively to achieve DEA efficiency.

Table 39: Analysis and Adjustment of the Financial Redundancy of Dalian Port Company (Unit: 10,000 RMB)

	s^-	s^+	p^*	s^-	s^+	p^*	s^-	s^+	p^*
Y_1	6547	0	895164	16029	0	810275	5020	0	400559
Y_2	0.01	0.02	0.113	0.002	0.007	0.13	0.02	0.028	0.180
Y_3	419	15147	72480	1222	12017	73806	961	0	76707
X_1	0	0	743166	0	0	656756	0	0	248775
X_2	0	-32467	2880520	0	0	2784405	0	-193475	2523910

Note: s^- input slack, s^+ output slack, P^* target value.

5. Operational Efficiency Evaluation of Yingkou Port

a) Current status of the geographic environment

373. Yingkou Port sits in Yingkou city in Liaoning Province in Northeast China and lies at the intersection of Northeast Economic Zone and Bohai-Rim Economic Circle. It's the nearest transport port to the economic hinterland of the three north eastern provinces and the hinterland of the four leagues in east Inner Mongolia. Also because of its lower transportation costs compared with other ports in Bohai-Rim Economic Circle, Yingkou Port enjoys an advantageous position in competition and shows an outstanding location advantage.

374. Yingkou Port plays an important role among the 20 major ports in coastal areas of China and is a highly potential one in Bohai area with great convenience for sea-going. It currently covers seven port areas including Yingkou, Bayuquan, Xianrendao, Panjin, Haiyanghong, Suizhong Shihe and Liutiaogou in Huludao. Bayuquan, the core port area, covers a land area of over 20 square kilometres and is equipped with plenty of transport equipment such as containers and rolling trucks.

Goods that are transported mainly include coal, food, ores, large equipment, product oil, liquid chemicals and crude oil. Currently, Yingkou Port has become a new pass connecting China with Eurasian Land Bridge and also an important hub in the east line of the New Silk Road of China.

b) Economic hinterland-based development

375. Development of a port depends on many factors, such as geographic advantage, development status of the economic hinterland and support of national policies. Economic hinterland is critical to an inland like Yingkou Port. The development status of the economic hinterland determines structural changes of the transport environment in the neighbouring cities of the port. Transport advantages help transport goods from inland areas to Yingkou Port rapidly and conveniently, which accelerates goods transportation at the port and boosts market response. Meanwhile, developing economic hinterland of the port can drive its scale upgrading in an industrialized way.

376. Yingkou Port enjoys a major development advantage of hinterland, but the economic development of its hinterland lags far behind coastal areas in the south. Unlike coastal areas, major advantages of Yingkou Port lie in the abundance of crops and mineral resources of the economic hinterland. Therefore, relying on the development of its economic hinterland, Yingkou Port will step up to a higher level.

c) Support of national policies

377. Since 2002, in order to revitalize the Northeast old industrial bases, China proposed to greatly develop the economy in Northeast China. Driven by the initiative, the economy of the region develops dramatically and industrialized enterprises rise rapidly, providing guarantees in transport of goods resources for development of ports, especially Yingkou Port. As the weak international economy gradually betters off, domestic ports generally develop steadily and show a positive momentum. In order to boost industrialization adjustment, enhance the domestic demand and improve the economic development of ports that depend on goods for internal trade, China constantly strengthens goods connection with both inside and outside China, enhances in-depth cooperation, deepens business development and innovatively improves the optimization of industrial chains. It makes efforts to expand market, conduct optimal decision-making management in market and goods resources, streamline production organization and improve operation decision-making. Regarding safety management, great efforts are made to improve safety awareness, boost production efficiency and upgrade services by relying on information-based development of ports. Yingkou Port, located at the intersection of Northeast Economic Zone and Bohai-Rim Economic Circle, shows a strong location advantage thanks to the geographic edge and policy support. It strives to provide customers with quality services in an all-round way. In recent

years, as domestic demand surges, upgrading of the industrial structure drives the development of regional economy in the Yingkou Port area. Also as Bohai-Rim Economic Circle rises to the level of national strategy, Yingkou Port enjoys a promising development prospect in the long run and it will be improved in returns to scale and optimized in the industrialization structure.

6. Analysis of Operational Efficiency of Yingkou Port

a) Port Throughput

378. As a vital factor for evaluation of Yingkou Port's performance, Yingkou port's throughput plays an important role in accelerating its containerization and internationalization. Located in Northeast China, Yingkou Port has an important position among the numerous ports of Liaoning. Under the circumstance of the gradual recovery of economic environment, the logistics industry at Yingkou Port also became vital. The accelerated growth of economic development expedited the domestic and international transportation of goods, which fueled the development of the whole industry chain, created job opportunities, increased per capita income, and thus driving the development of Yingkou city. This paper mainly makes theoretical research on the indicators of cargo throughput, cargo throughput YoY growth, container handling capacity and container handling capacity YoY growth at Yingkou Port. The throughput of Yingkou Port greatly increases with the economic development, which is likely to play a vital role in implementing the strategy of accelerating the economic development.

379. For the purpose of energetic growth, Yingkou Port continuously streamlined its industrial structure and made great efforts to expand its main business. Upon continuous struggling, Yingkou Port successfully made market expansion. The continuous expansion of business brought huge prospect to the development of Yingkou Port, which is specialized in transportation of farm crops, mineral resources, large equipment and oil products. We can adopt the above-mentioned measures to increase the transport volume of Yingkou Port and its business income. In this way, we can rapidly upgrade Yingkou's advantages in transportation, optimize its industrial structure, reduce its transport costs, enhance its transport volume, make decisions on its throughput management, continue its simplified development mode and strive to improve its performance.

b) Human Resources of Yingkou Port

380. To accelerate the talent optimization system is the cornerstone of corporate success. Talents play an increasingly important role in the survival and development of enterprises. Yingkou Port Company Limited is no exception. Talent is the soul of an enterprise and the guarantee for the normal development of a company. However, high-level talents often have strong mobility, and they will

choose positions with personal development potential. If their own advantages are not used reasonably, talents will make a quick decision whether to leave the enterprise or complain to the higher authorities. If the management can reasonably deal with it, they can retain the talents and save the company from economic losses. Due to various reasons of Yingkou Port, the low proportion of high-level talents is rather serious. According to the statistics, the proportion of high-level talents in Yingkou Port Company does not exceed 40%. This shows that Yingkou Port Company Limited needs to attract more high-tech, highly managerial and professional talents from the society, and must deepen the contacts with specialized schools in choosing talents. College students have strong plasticity before entering into the society, so it is easy to cultivate their affinity for the enterprise and a sense of honour. The company should also conduct specialized business operations training for the college students in a timely manner, and tap their own potential to maximize the economic profits for the company. At the same time, however, they should also establish a compensation mechanism to meet their life and cultural and emotional needs.

381. In modern enterprises, talent is competitiveness and the key to gain high efficiency. They know how to use their own advantages to get high remuneration, so these talents have a greater choice and development space. So Yingkou Port should establish a reasonable talent selection mechanism and effective talent management methods. At the same time, the company should establish a reasonable remuneration system according to the performance of employees. In conclusion, Yingkou Port can win more opportunities in the future development only when it vigorously invests more in talent development.

c) Operation Costs of Yingkou Port

382. Due to the rapid development of China's economy, the future development prospect of the port is accelerated as a result of changes in the industrial structure and trade trends. The main business of Yingkou Port is the transportation of crops, mineral resources, oil products and large-scale equipment. It has considerable throughput, and its main business is continuously enriched, which also increased the main operation costs of Yingkou Port. On cost reduction, we can start from the operation costs of Yingkou Port. In order to embrace the future development opportunities, Yingkou Port should constantly optimize its industrial structure, make efforts to strengthen the regional cooperation, establish the market service agencies and reduce unnecessary losses. Therefore, Yingkou Port should continuously expand the scale of business scope, increase the industrial input, and constantly improve the quality of industrial services, so as to meet the customer's demand for timeliness, quality and information accuracy. In order to improve its own business performance, Yingkou Port can improve its overall operation income

and gradually increase the profits only by optimizing the industrial upgrading and reducing its operation costs.

7. Analysis of Efficiency of Yingkou Port

383. Based on the selected input and output indicators from 2007 to 2016 (the specific data are seen in the attached table), take the data into the model to calculate the comprehensive efficiency value ρ^* and pure technology efficiency value θ^* of Yingkou Port from 2007 to 2016 with Deap2.1 software, and calculate the pure scale efficiency with $S^* = \rho^* / \theta^*$. In addition, ports with the need for the financial redundancy adjustment of each year will also be displayed in the results. The specific results are shown in Table 40.

Table 40: Optimal Solutions of Model 1 and Model 2: ρ^* , θ^* , S^*

port	Yingkou Port		
year	ρ^*	θ^*	S^*
2007	0.873	0.974	0.896
2008	0.886	0.987	0.897
2009	0.869	0.981	0.886
2010	0.901	1.000	0.901
2011	0.898	1.000	0.898
2012	0.904	0.999	0.905
2013	0.894	0.973	0.919
2014	0.865	0.937	0.924
2015	0.873	1.000	0.873
2016	1.000	1.000	1.000
Average	0.896	0.985	0.943

value

Note: ρ^* represents the overall efficiency value, θ^* represents pure technology efficiency value, and S^* represents scale efficiency.

384. In Table 40, we can see that the overall efficiency value of Yingkou Port in recent 10 years fluctuated around 0.85, and reach DEA efficiency value of 1 in 2016. Yingkou Port may need to adjust its input structure to increase the overall efficiency value. The pure technology efficiency value of Yingkou Port in 2010, 2011, 2015 and 2016 was 1, which was DEA efficient. There are a total of 14 DEA efficiency values, accounting for 46.7% of all samples. The development level of

Dalian in all aspects is among the best in Liaoning Province, so the average value of pure technology efficiency in Yingkou Port is lower than Dalian, but is very close to the efficiency value. The technical efficiency value of Yingkou Port has small fluctuations. Yingkou Port developed steadily in recent 10 years, and stabilized to the efficiency value in 2015 and 2016, so it needs to make improvement decisions in technology and scale according to its actual conditions, so as to maintain its stable development trend. From the pure scale efficiency value in Table 4.3, the average value of the scale efficiency in recent 10 years in Yingkou Port is 0.943. Yingkou Port reached the scale efficiency value in 2011, 2012, 2015 and 2016, and the returns to scale decreased each year, so it should reduce the input, reasonably arrange resources and make reasonable adjustment for the size of the company.

8. *Analysis of Yingkou Port Operational Efficiency*

385. Redundancy adjustment should be made for the years in which DEA did not reach the efficiency value of 1. The table below shows the financial redundancy adjustment for Yingkou Port.

**Table 41: Financial Redundancy Analysis and Adjustment of Yingkou Port
(Unit: 10,000 RMB)**

Adjustment year		s^-	s^+	p
2007	Y1	9817	0	376376
	Y2	0.02	0.155	0.237
	Y3	1362	2426	54657
	X1	0	0	247162
	X2	0	0	1652761
2008	Y1	4953	0	383729
	Y2	0.001	0.158	0.239
	Y3	686	240	53374
	X1	0	0	256171
	X2	0	0	1632973
2009	Y1	7766	0	398816
	Y2	0.02	0.148	0.230
	Y3	1118	0	57424
	X1	0	0	269305
	X2	0	-193475	1722295
2012	Y1	343	0	291757
	Y2	0	0.160	0.370
	Y3	32	11757	39268
	X1	0	0	201560
	X2	0	0	1133244
2013	Y1	6593	0	240911
	Y2	0.006	0.128	0.333
	Y3	638	13365	1351
	X1	0	0	155417
	X2	0	0	1019950
2014	Y1	12687	0	200269
	Y2	0.012	0.037	0.230
	Y3	10636	0	31961
	X1	0	0	123017
	X2	0	-201381	905612

Note: s^- input slack, s^+ output slack, P^* target value.

386. In the past 10 years, the overall efficiency value of Yingkou Port Company did not reach DEA efficiency, and the output indicators did not reach the expected best conditions. There was redundancy in input and output. From Table 4 we can see adjustment is needed for relevant indicators. In the input indicators, the target value of the total assets in 2009 should be 17.22295 billion RMB, and the radial variable of the output should be reduced by 1.93475 billion RMB to reach the optimal DEA of the comprehensive efficiency. In the output indicators, the target value of operation income was 3.98816 billion RMB, and the input indicator variable should increase by 77.66 million RMB. The target value of earnings per share was 2300 RMB, and the radial variable of input and output should increase by 200 and 1480 RMB respectively. The target value of net profit was 574.24 million RMB, and the input radial variable should increase by 11.18 million RMB to reach DEA efficiency. The target value of the total assets in 2014 was 9.05612 billion RMB, and the output radial variable should reduce by 2.01381 billion RMB to reach the optimal DEA of the comprehensive efficiency. In the output indicators, the target value of the operation income was 2.00269 billion RMB, and the input indicator variable should increase by 126.87 million RMB. The target value of earnings per share is 2300 RMB, and the input and output radial variables should increase by 120 and 370 RMB respectively. The target value of net profit was 319.61 million RMB, and the input radial variable should increase by 106.36 million RMB.

9. Operational Efficiency Evaluation of Jinzhou Port

387. Jinzhou Port started construction in October 1986, was officially opened to navigation in October 1990 and was approved by government as first-class open commercial port in December of the same year. In 1993, it experienced shareholding reform and became China's first port subject to joint-stock operation by government and enterprise separately. In May 1998 and June 1999, Jinzhou Port B stock and A stock were respectively traded at Shanghai Stock Exchange. In December 1998, Jinzhou Port took the lead among its peers to pass the ISO9002 international quality system certification. The port is the most convenient sea gate in the west of Liaoning, the middle and west of Jilin and Heilongjiang, the east of Inner Mongolia, the north of North China and even the Siberia area of Russia. It's a northern regional port prioritized by Liaoning Province for development and a major part in the development strategy for Liaoning Coastal Economic Belt. Jinzhou Port covers a planned land area of 24.3 square kilometres and water area of 32 square kilometres, has a planned coastline of 14,018 meters and plans for 52 berths. So far, it has covered a land area of around 9 square kilometres, has a 4,998 meters of coastline in total and has 20 for-profit berths with a designed annual throughput capacity of 42.95 million tons and 600,000TEU containers. The berths include 250,000t tanker berths and 100,000t bulk & general

cargo berths that can accommodate 150,000t tankers and 100,000t bulk & general cargo carriers and container berths that can accommodate the sixth-generation container vessels with a handling capacity of up to 70 million tons and a container throughput capacity of 700,000TEU. Currently, Jinzhou Port has become available for container transport for internal and foreign trade, handling, warehousing, transport and service for oil products, chemicals, large bulk & general cargo and break bulk cargo and bagging of bulk cargo. It is mainly divided to five function areas including petrochemicals, containers, break bulk & general cargo, ship service and port industry. Ultimately, it will be developed into a modernized international commercial port with diversified service functions integrating large-sized oil chemical port, comprehensive container port and regional bulk & general cargo port. Throughout 2011, Jinzhou Port accumulatively finished up to 75.8212 million tons of goods throughputs, including a coal throughput of 22.9654 million tons and a container throughput of 839,900 TEU.

388. On July 25th, 2017, at the 58th standing committee meeting of Jinzhou municipal government, the Opinions Regarding Support for the Development of Container Logistics Industry at Jinzhou Port (draft) was discussed and passed in principle. On August 16th, No. 82 Document issued by Jinzhou Government (2017) was officially released. The policy will provide container shipping enterprises and logistics fleets with policy subsidies that are unprecedented in effect and coverage.

a) Strength

389. Jinzhou Port is located at the north bank of Bohai Gulf. There are many wholesale markets and refineries with enormous transaction value in the city and the location advantage for Jinzhou to develop logistics is retained. The “Five Points and One Line” policy of Liaoning facilitates Jinzhou to grow bigger and stronger and eventually develop into a major energy port in North China on the basis of current advantages.

390. With the temperate monsoon climate, Jinzhou Port sits at the traffic artery of Liaoxi Corridor. As it is free from attacks of typhoon throughout the year and the sea area is frozen but not closed in winter, it is in effective operation every day. With a competition advantage of broad land area, the Port can accommodate 45 berths.

391. Since China started to implement the plan of revitalizing the old industrial bases in Northeast China, Jinzhou started to carry out the strategy of “Developing the City with Ports”. With proper market positioning and development objectives, Jinzhou Port makes great efforts in market development and strives to extend the industrial chain and expand the operation scope.

b) Weaknesses

392. In the process of developing port logistics, Jinzhou Port encounters the problem of fund shortage in the port construction. Especially in order to introduce advanced port facilities, build large-scale specialized container terminals and enable large ships to enter the waterway, large amount of fund is required to widen and deepen the waterway.

393. Jinzhou Port needs specialized talents in logistics. The majority of employees lack expertise in modern logistics and lag behind in mentality. The management also lacks specialized talents, especially in logistics.

394. Regarding port infrastructure, Jinzhou Port lags behind in the level of modern logistics. The current waterway cannot meet the navigation demand of large berths and large ships, which reduces the trading volume of bulk cargo and oil products and the container throughput to some extent and affects profit making of the Port.

c) Opportunities

395. The development of Jinzhou Port gains great support from government in both policy and fund, which consolidates the foundation of the development.

396. The rapid development of e-commerce in recent years is a tremendous measure for the Port. Online third-party logistics accelerates development of websites and offers port companies sizeable profit.

397. The rapid economic growth provides the growth space for the Port. In recent years, The GDP growth of Jinzhou city speeds up and therefore, stable development of other industries offers stable source of goods for the improvement of Jinzhou Port. Advantageous geographic position makes logistics faster and more convenient.

d) Threats

398. Ports in Bohai Gulf show a disordered trend of development, which severe redundant construction, unclear regional division of labour and positioning and excessive market capacity. Compared with Dalian Port, Jinzhou Port lags further behind and shoulders greater competition pressure.

399. Demand of customers is further individualized, which is a headache for ports. Their need for better services and individualized products should be addressed by Jinzhou Port along its development path.

400. Sea routes of Jinzhou Port are mostly domestic ones with little outward land transportation and its few international routes are just for transfer, not direct navigation to the outside. Consequently, foreign ports exert certain influence on domestic ones.

10. Factors Affecting Port of Jinzhou Efficiency

a) Establishing a Port Logistics System with Clear Division of Labor

401. There are only two ports in the west of Liaoning province: the port of Jinjiang and the port of Huludao. As it is small in scale, the port of Huludao does not pose a threat to the port of Jinjiang. However, some of the goods such as oil and food may be diverted from the port of Jinzhou to the port of Huludao as the latter gradually develops in the future. In order to build a better port cluster in Liaoning and to strengthen and expand the port of Jinjiang, it is necessary to integrate the resources of the two ports so that the two have clear division of labour, remain competitive in different and respective areas and form a port logistics system of a reasonable layout. As for the way of integration, the previous discussions between the two sides have failed due to different local interests. So it would be difficult for the local governments of Jinzhou city and Huludao city to push ahead with the integration of the ports. A more plausible way is to look to the port of Dalian to take the lead, draw on its experience of the integration with the port of Jinzhou and rely on the strength of Dalian port to integrate the port resources of the port of Dalian and the port of Huludao. Such integration will make the port of Jinzhou and the port of Huludao as two feeder ports with equal status in the important layout of Dalian as the North eastern International Shipping Centre. In order to avoid homogeneous competition and make sure that the two ports have their own non-overlapping advantages, the bulk cargoes and containers of domestic trade transferring at Dalian Port will be diverted to both ports. The integration between Jinzhou Port and Huludao Port can not only ease the competitive pressure on Jinzhou Port, but also form a port logistics system with a clear division of labour in the west of Liaoning province, thus accelerating the economic development in the region.

b) Cutting the Logistics Cost of the Port

402. After Japan merged Osaka, Kobe and Amagasaki-Nishiaza-Nishinomiya Ashiya ports into Hanshin Port, ships can enter the three ports with only one approved application. Also, after the merger, for the ships entering the port, the taxes and charges, which are determined based on the weight of the ship, are collected only once, reducing the total cost by 15% and resulting in a substantial increase in the business volume of Hanshin Port. The port of Jinzhou can learn from this experience. As the side wing of the port of Dalian, it should increase its cooperation in port businesses with Dalian port and streamline the entry procedures as soon as possible. After going through the procedure for entry application at Dalian port, ships can enter the two ports so as to reduce time and logistics. In addition, the port of Jinzhou and Dalian can consider jointly collecting the taxes and charges so as to reduce the logistics cost of the shipping companies. Less burden can be attractive to shipping companies, hence more shipping companies and port businesses. In this way, the direct revenue of the two ports

might reduce, however, the facilitated procedure and the cost cut would attract more shipping companies to transit. The increase in the tonnage-based tariff on foreign ships would make up the loss of revenue. Jinzhou port and Dalian port, with their reforms of the application procedure and port charge, can enjoy closer cooperation, more port business and stronger competitiveness as higher efficiency of clearance and lower charge can greatly reduce the logistics cost. In the future, Jinzhou port and Dalian port can even cooperate in regional clearance, under which the enterprises can “file declaration at its registration location and get release at the port”. Enterprises can file the import and export declarations at the registration location and go through the checks at the product entry/exist customs. In this way, the time for customs clearance and the time at the ports have been cut dramatically.

c) Building Logistics Facilities

403. Without the investment in and construction of logistics infrastructure, there is no development of port logistics to speak of. The port of Jinzhou should make the most of its own resources, continue to deepen waterway construction, speed up the deep-water port development, and constantly improve the port's handling capacity with the cargo throughput expected to reach 100 million tons and container throughput 1 million TEU in 2013. Therefore, the port of Jinzhou should increase investment in logistics machinery, logistics system engineering, channel depth and terminal infrastructure, and promote the interconnected development of port, warehousing as well as logistics industries and organizations. The following constructions should be completed as soon as possible: an oil terminal for the 250,000-ton class and four coal terminals for the 50,000-ton-class in the western sea, two coal terminals for the 100,000-ton-class, container terminals and a 600,000-li crude oil storage and transit base. In addition, a land of larger capacity should be used to build the logistics centre. Based on the combination of the development plan of Jinzhou city's modern logistics and the development plan of Liaoning province's coastal ports, logistics service centres dedicated to container, coal, grain and oil should be built step by step. Meanwhile, the port of Jinzhou needs to further improve the collection and distribution network by constructing the railway leading to the port and the road accessing the port so as to improve the scale and service efficiency of the integrated logistics service.

d) Establishing the Logistics Chain for the Main Cargoes

404. The port of Jinzhou mainly handles crude oil, grain, ore and coal. By way of investment promotion, policy support, joint venture and cooperation, enterprises producing or processing these goods can be attracted to the vicinity of the port to provide logistics storage and processing services. In this way, the logistics services occurring in the upstream and downstream transportation, processing and distribution are transferred to the port area and the establishment of such a supply

chain system will improve the logistics services of the port area. At present, PetroChina has started the construction of a crude oil storage facility. The port of Jinzhou can take this opportunity to further work with petrochemical enterprises to consider the feasible plans of oil refining and processing projects in the port area so as to establish a logistics chain of oil products. In addition to the establishment of upstream and downstream supply chain for oil products and grain, the establishment of similar supply chains for other imported and exported bulk cargoes such as the copper and zinc concentrates should also be considered so as to give the Port of Jinzhou a unique advantage in logistics service and sharpen the competitive edge of the port.

e) *Building an Information Network for the Port Logistics*

405. IT application is the necessary condition to realize efficient logistics service. The port of Jinzhou should strengthen the application of information technology and establish an information platform that can be operated by logistics enterprises and be connected with networks of shipping, economy and trade as well as port information. This information platform should be made up of three parts: the public information of the port, logistics information and the information of logistics enterprises. For the establishment of the port information platform, we can draw lessons from the mode and experience of Dalian Port Logistics Network and adopt the mode of "government coordination and business operation" to build the port electronic network system. The logistics enterprise information platform is an operating platform which can be used to search for information about the terminal, airport, shipping company, freight forwarding, fleet, warehouse and train, and it also offers the entrusted trading platform.

f) *Improving the Quality of Logistics Service*

406. The port of Jinzhou Port should strengthen its close cooperation with shipping enterprises, railway enterprises and highway enterprises to integrate their respective advantageous resources and provide integrated logistics services so as to jointly form a fast and convenient logistics chain system. At present, the port of Jinzhou has realized the direct access of the national railway locomotives. It should build on this and make good use of the wide network coverage of the railway system. It should continue to strengthen cooperation with the railway companies to jointly discuss about feasible strategies to expand the logistics service scope and manage the overall logistics process.

g) *Establishing the Port-vicinity Industrial Cluster*

407. The establishment of the port-vicinity industrial cluster not only helps to stabilize the supply of the port's freight, but also helps to provide a complete package of services through a more integrated product supply chain, hence a better service of

the port. Therefore, the port of Jinzhou should pursue the development of port logistics as a priority of the port-vicinity industry, speed up the establishment of the west sea industrial zone and take proactive measures to attract large enterprises to settle in the port through investment attraction and preferential policies. According to the rationale behind the industrial cluster, the key is to attract and develop refineries and chemical industrial enterprises. The port of Jinzhou can also learn from the experience of the coastal industrial cluster of the port of Rotterdam in Europe, which actively attract the food industry such as grain, fruit and vegetable and attracts trading, storage, processing and transportation companies to come to the port area so as to form an industrial chain of food. In addition, port-related companies such as ship building and maintenance, port machinery and equipment manufacturing can also be set up in the port industrial zone to facilitate the development of the export and processing of the warehouse logistics. As for the construction of the west sea industrial zone, the port of Jinzhou should attach importance to nurturing industry focus and develop the port industry with the port's main business at its core to build an industrial logistics chain so that the port industry can facilitate the port logistics. As for how to attract enterprises to settle in the port, the landlord port model can be adopted. Under this model which is characterized by a large amount of land, the port of Jinzhou can attract strong logistics enterprises with cheap lease and a concession of large land. Preferential policies can be extended to the internationally renowned logistics enterprises and leading enterprises in the field so that they can drive the economic development of the port and improve the port's logistics service and competitiveness.

11. Technical and Scale Efficiency of the Port of Jinzhou

408. Data of the target output and input from 2007 and 2016 are imported into the model (see the attached table for details) and the port's overall efficiency and pure technical efficiency of those years are calculated with the software Deap2.1. The ration of overall efficiency to pure technical efficiency provides scale efficiency, as indicated in $S^* = \rho^* / \theta^*$. In addition, the results also reveal the years of financial slack and the port needs adjustments. Refer to

409. Table 41 and

410. Table 42 for detailed information.

Table 42: Optimal Efficiency Solutions

Port	Port of Jinzhou		
Year	ρ^*	θ^*	S^*
2007	0.713	0.794	0.898
2008	0.697	0.783	0.891
2009	0.748	0.830	0.901
2010	0.742	0.817	0.908
2011	0.697	0.792	0.880
2012	0.856	0.948	0.903
2013	0.956	0.978	0.978
2014	1.000	1.000	1.000
2015	1.000	1.000	1.000
2016	1.000	1.000	0.931
Average	0.834	0.969	0.929

Note: ρ^* =the overall efficiency, θ^* =pure technological efficiency, S^* =scale efficiency.

411. From the pure technical efficiency in

412. Table 42 we can see that in 2014, 2015 and 2016, the port of Jinzhou has been viewed as efficient according to DEA. Compared with the ports of Dalian and Yingkou, the average pure technical efficiency of Jinzhou Port is relatively low, but it is very close to being efficient, indicating a high level of technology. According to DEA, Jinzhou port has not been considered as effective in many years, with a relatively low technical efficiency from 2007 to 2012, which indicates a relatively low level of technology. To enhance the competitiveness, the first and foremost is to upgrade the technology and then, adjustment to the scale is needed. From the pure scale efficiency in Table 4 and 5 we can see that in the past decade the port's average scale efficiency is 0.929 and the port is viewed by the model as scale effective in 2014 and 2015. In the case of Dalian and Yingkou, they have two years of being scale effective. In the case the port of Jinzhou, it has a decreasing returns-to-scale each year, so the port should reduce input and rationally arrange the resources and make reasonable adjustments to its size.

**Table 43: Analysis and Adjustment of the Port's Financial Slack
(Unit: 10,000 RMB)**

Year		s^-	s^+	p
2007	Y1	66399	0	321666
	Y2	0.008	0.313	0.351
	Y3	1303	34731	41045
	X1	0	0	226974
	X2	0	0	1223845
2008	Y1	50162	0	230717
	Y2	0.017	0.128	0.205
	Y3	3597	29557	46100
	X1	0	0	136744
	X2	0	0	1200416
2009	Y1	47582	0	260280
	Y2	0.025	0.074	0.208
	Y3	5188	12385	40766
	X1	0	0	160815
	X2	0	0	1219501
2010	Y1	37835	0	222338
	Y2	0.021	0.080	0.201
	Y3	3471	20614	40990
	X1	0	0	132341
	X2	0	0	1119838
2011	Y1	30777	0	147646
	Y2	0.021	0.079	0.180
	Y3	3662	31292	48860
	X1	0	0	75400
	X2	0	-17915	1007406
2012	Y1	6499	0	125307
	Y2	0.009	0.011	0.180
	Y3	1390	9871	36664
	X1	0	0	63215
	X2	0	0	784697
2013	Y1	1925	0	88317
	Y2	0.003	0	0.143
	Y3	493	0	22630
	X1	0	0	41199
	X2	0	-93625	565533

Note: s^- =input slack, s^+ =output slack, P^* =target indicator.

12. Factors Affecting the Operation Efficiency of the Port of Jinzhou

413. From

414. Table 43, it can be seen that in the past ten years, the overall efficiency of Jinzhou Port Co.,Ltd. has not reached the optimal score identified by the DEA model, indicating that there is a waste of the input resources. As the output indicators failed to reach the optimal results, there is output redundancy. In terms of the input indicator, the target of total assets in 2011 is 10074.06 million RMB and to reach the optimal overall efficiency identified by DEA, the output radial variables need to be reduced by 179.15 million RMB. In terms of the output indicator, the target of operating revenue is 1476.46 million RMB and the input variable needs to be increased by 307.77 million RMB. To reach the target earning per share of 1800 RMB, the input and output radial variables need to be increased by 210 RMB and 790 RMB. The target net profit is 488.86 million RMB and the input and output radial variables need to be increased by 312.92 million RMB to reach the optimal results in DEA. The target total asset of 2013 is 5655.33 million RMB and the output radial variables need to be reduced by 936.25 million RMB to realize the optimal overall efficiency in DEA. In terms of the output indicator, the target operating revenue is 883.17 million RMB and the input indicator variable needs to be increased by 19.25 million RMB. To reach the target earning per share of 1430 RMB, the input radial variables need to be increased by 30 RMB.

13. SWOT Analysis of the Port of Dandong

a) Strengths

415. Firstly, the port of Dandong is located in the north-eastern point of Liaodong Peninsula. To its east, Yalu River empties into the sea. It borders Dalian and has Yellow sea on its south. Facing Korean Peninsula on its right, it is 119 nautical miles away from the port of Nampho, North Korea, 232 nautical miles away from the port of Incheon, South Korea and 844 nautical miles away from the port of Kobe, Japan. It directly serves the economic hinterlands of Dandong city and Benxi city and its radiation range covers the relatively well-developed three-dimensional transportation network of the four provinces including Liaoning, Jilin, Heilongjiang and Inner Mongolia.

416. Secondly, the railway of the port area is connected with the main lines such as the eastern part of the Northeast China railway, Shenyang-Dandong railway, Beijing-Haerbin railway, Changchun-Dalian railway and linked with Korean Peninsula via the Yalu bridge, and is able to carry out international intermodal transport. Highways lead to Northeast China and Inner Mongolia through the main lines such as Shenyang-Dandong highway, Hegang-Dalian highway, Dandong-Xilinhaote highway, Dandong-Tonghua highway and Dandong-Helinhe highway.

b) Weaknesses

417. Of the three major ports in Liaoning Province, the port of Dalian has a diversified development mode. The port of Yingkou mainly handles the export of food from the Northeast China. The port of Jinzhou mainly handles the export of minerals and energy. The three ports act as three pillars in the region.

418. Infrastructure. The ports in Liaoning province face fierce competition in terms of the construction of land ports along the routes, the upgrading of infrastructure and equipment, the optimization of the design and construction of the inland railway and road routes as well as the carrying capacity and service life of the highways, therefore, the development is affected.

c) Opportunities

419. In the Plan for the Development of Logistics in Northeast China (Plan) issued by NDRC, the Port of Dandong was included in the layout of major logistics corridors in Northeast China and Dandong was also included in the second-tier logistics node cities in Northeast China. The "Plan" emphatically points out that according to 12th Five-Year Plan, the eastern part of Northeast China will enjoy clear and smooth logistics corridors, railways of improved capacity and accessibility, upgraded highways and the accelerated expansion of Dandong port which is the sea port on the east corridor. There will be strengthened planning and construction of the west corridor linking the east of Inner Mongolia, Mongolia, and the three provinces of Liaoning, Jilin and Heilongjiang and enhanced transport capacity of the Huoliuguole-Tongliao-Shenyang-Dandong Channel. The port of Dandong, with food and steel as its focuses, should join "North grain South shipped" port logistics system, build new ore terminal and take part in the establishment of the supply logistics system of iron ore.

420. We will capitalize on the coastal advantages and bonded logistics policies of northeast China to speed up the construction of infrastructure at the border ports such as the Yalu River Highway Bridge, enhance the capacity to handle border crossings and apply ICT to work. We will develop the border logistics between China and DPR Korea by relying on such ports as Dandong and Huichun.

d) Threats

421. Firstly, the ports of Dalian, Yingkou and Jinzhou in the province have similar operations and businesses with the port of Dandong. To rise above in the competition, it will have to offer differentiated and distinctive business and services. As the mode is already set, major reforms are bound to meet some obstacles.

422. Secondly, in 2015, there are many key construction projects at Dandong port including bulk cargo berths, container berths, waterways for 10,000-ton-class , general berths, yards dedicated to enterprises, berths for roll-on/roll-off vehicles,

berths for roll-on/roll-off passengers, roads, yards, power supply, water supply and firefighting. Better infrastructures and facilities will gradually raise the port of Dandong to a higher platform. If it wants to go farther and farther, its facilities and equipment need to meet many more challenges.

14. SWOT Analysis of the Port of Huludao

423. The port of Huludao is located in Bohai Liaodong Bay, which is in the southwest of Huludao, and is in the district of Longgang. During Ming dynasty, it is called “hulutao” (meaning the cover of a calabash) as the shape of the place is like a calabash. The port features a wide bay and deep water. In summer, the wind and wave are not strong and in winter, it only freezes a little and is almost ice-free. The annual throughput exceeds 30 million tons. The Liutiaogou and Suizhong port areas under construction are expected to handle 300 million tons in the long-term, becoming another major energy port in Bohai. With Shen Shan Railway and the branch line of Huludao on its back, the port of Huludao is connected with Jinhu Road and Shenshan Road. The convenient traffic makes it the marine node of Northeast and North China. The port of Huludao was originally for commercial use and then transformed to a military port after the founding of the People's Republic of China. In 1984, the port was transformed to one jointly used and developed by the military and civilian. Domestic trade and transportation were carried out at the port. After nearly a hundred years of continuous construction and maintenance, the port of Huludao has a production and operation capacity of a considerable scale. It now has four berths for production use, with two for 10,000-ton-class and two for 5000-ton-class. Its annual overall handling capacity totalled more than 1 million tons. It is a port for general cargoes with petrochemical products, food and building materials as its main business. Its cargo businesses extend to major domestic ports in Shanghai, Guangdong, Fujian and other places. In terms of the first phase of the port's expansion project, the terminal for 10,000-ton-class and the access road leading to the port have been completed and the terminal for 20,000-ton-class and the terminal for 35,000-ton-class are under construction. During the second phase, six berths are for the 10,000-ton-class and the total investment of the project reaches 100 million RMB.

a) Strengths

424. Firstly, Huludao city enjoys favourable geographical condition. It is located in the southwest of Liaoning Province. It has Jinzhou on its east, Shanhaiguan on its west and Liaodong Bay of Bohai Sea on its south. Together with Dalian, Yingkou, Qinhuangdao, Qingdao and other cities, Huludao city is a part of the Bohai Economic Circle. It is rich in natural resources, with a variety of mineral resources. The city enjoys rapid economic development and well-developed agriculture. The city formed a wide-ranging industrial system of both light and heavy industry, with

the petrochemical industry as the main body, and metallurgy, building materials, machinery, shipbuilding and power generation as the key focus. The city's traffic extends in all directions and the city enjoys an integrated transport layout of a set of railways, roads, highways and pipelines. Huludao city has a coastline of 261 km, offering a wealth of resources along the shoreline.

425. Secondly, the city enjoys the support of policy. It is one of the strategic focuses of Liaoning Province's "five points, one line" development strategy and is also a key development zone in the coastal economic belt. In its overall planning of the ports in Liaoning province, the Liaoning provincial government has determined the nature of the port of Huludao (It is an important part of the ports of Liaoning province and of the coastal ports in the west of Liaoning province; it offers strong support for Huludao city's layout of port-vicinity industry and its further opening up; it serves as the basic resources to safeguard the coordinated and sustainable development of the coastal ports and coastal economic zones in Liaoning province, and provides a convenient outlet for the transport of materials from the east of Inner Mongolia. In the short term, the port is mainly involved in serving the economic development and industrial layout of Huludao city and acts as the downstream port of Mengdong Coal. In the long-term, the port will gradually develop to be a modern and comprehensive port area of a relatively large scale, distinctive specialization and strong comprehensive service.) Now the port has a clear direction of development. At the same time, Huludao city, with the economic situation of the city in mind, has formulated a "three points, one line" development strategy to develop the port economy and the port-vicinity economy, create a coastal economic belt of fast growth, and further straighten out the development pattern. At its northern end, it has actively developed the north port industrial zone in the Jinzhou Bay area. At its southern end, it has developed forward-looking plans to build Suizhong coastal economic zone.

b) Opportunities

426. There has been a gradual increase of the throughput of Huludao port. Especially since the 21st century, the annual growth rate has been relatively high. However, due to its small size, its contribution to the marine industry of the city still remains small. In 2001, the city's GDP totalled 18.4 billion RMB and the total output value of the marine industry reached 7.085 billion RMB, of which 1.315 billion RMB was from the port and ship building industry, accounting for 18.56% of the total output value of the marine industry and 7.15% of the city's GDP. From 1989 to 2001, the throughput of the port increased rapidly, registering a growth rate of 8.09%. However, due to its small base, its contribution to the city's marine industry remains small. At the same time, due to the small size and low level of modernization, the port of Huludao is not in a good position to compete and its development is limited. At the end of 1999, the port's terminal for 10,000-ton-class

was officially put into operation. Now, the port has two berths for 10,000-ton-class and two berths for 5,000-ton-class, with its throughput totalling 5.008 million tons. Its direct economic hinterlands include Huludao city, Fuxin city, Chaoyang city and Chifeng city and its indirect economic hinterlands are Inner Mongolia, Jilin province and the west of Heilongjiang province. The major cargoes include petroleum, chemical products, grain, fertilizer, cement, steel, ore and building materials, with corn accounting for 55%, oil for 27-28%, and the rest being zinc ingots, chemical products, salt and groceries. The port mainly serves large and medium-sized enterprises and the agricultural enterprises in Huludao city.

c) Weaknesses

427. The port of Huludao is adjacent to Jinzhou and Qinhuangdao ports, and has a comprehensive hinterland. In comparison with other ports, Huludao port is less competitive. The port is both for commercial and military use, so its openness is greatly limited, handling basically zero foreign trade cargo. Of the 258 kilometres of coastline of Huludao city, 6 are suitable for port construction. At present, only one port is built, namely, the port of Huludao (the port of Suizhong is a supporting facility for power plants). The port has a small handling capacity, a far cry from the port of Qinhuangdao, the port of Dalian and the port of Bayutu, the first two of which handle more than one hundred million tons of throughput and the last of which more than 30 million tons of throughput. This situation fails to match the actual needs of socio-economic development in the region. At present, the annual import and export volume of Huludao city alone reaches 3 million tons. As for the hinterlands including the east of Inner Mongolia Autonomous Region and the west of the provinces of Liaoning, Jilin and Heilongjiang, the annual import and export volume totals 30 million tons. So it is urgent to expand and improve the existing ports and build new ports. Meanwhile, the major function of the port of Huludao now is concerned with transportation. With this single function, the port's role in industry and trade has not been brought into full play. The vast majority of goods handled by the port are transit flows, which are rarely stored and processed. Experience of port economic development shows that storage and processing are important links for the port to boost regional economy. In addition, the port's equipment is aging and its infrastructure is yet to be improved, so it is urgent to realize the modernization and informatization of port facilities.

15. SWOT Analysis of the Port of Panjin

428. Located in the centre of the Liaohe River Delta, Panjin city enjoys a favourable geographical location. It is one of the nearest estuaries for the Panjin city and the urban clusters of the middle of Liaoning province. It enjoys access to its vast economic hinterlands through convenient land transportation such as highways,

national highways and railways. However, now the port of Panjin is only involved in the import and export of some domestic and foreign trade of Panjin city, and its potential is not fully tapped. At present, the four berths at the inland river port are for below-3,000-ton-class, with the designed annual capacity standing at 700,000 tons. Over the years, the goods handled by the port of Panjin are oil, which accounts for more than 80% of the total throughput. This indicates that the port handles a single type of cargo. Panjin is an important petrochemical base of Liaoning province with heavy traffic of cargoes. The economic development of Panjin mainly relies on crude oil resources, but the port offers no obvious impetus to urban development. The coastal industry has just started and there is an urgent need for the support of the deep-water port.

a) Strengths

429. Firstly, the port of Panjin enjoys favourable geographical condition. Located in the Liaodong Bay New Area of Panjin, it is situated in the southwest of Liaoning province. It is in the centre of urban clusters of the middle of Shenyang, the economic circle of western Liaoning and the coastal economic belt of Liaoning. As an important node of regional economic development, it is found at the junction of Shenyang Economic Zone and Beijing-Tianjin-Tangshan urban clusters and at the intersection of the economic circle of Northeast Asia and the Bohai Economic Rim. It enjoys convenient transportation. On its west, it is 65 nautical miles away from the port of Jinzhou and on its south, it is 37 nautical miles away from the port of Youyuquan. In terms of the land distribution, the port distribution road behind the port of Panjin is connected with Panying road, which is connected with State Road 305. In addition, the port distribution road is directly linked with Binhai Avenue, which is a key road of the province and leads to major coastal cities of Liaoning province. The port distribution railway leads from Bohai Station on the Haicheng-Gou Bangzi route. Starting in 2009, the project was complete and open to traffic in May 2012.

430. Secondly, in recent years, the port of Panjin has been committed to upgrading its hardware and software facilities. Its hardware facilities have begun to take shape. As the berths under construction are put into operation, the port can handle the 100,000-ton bulk cargo ships and the 300,000-ton crude oil vessels. In terms of soft environment, the promotion of the port was approved in 2016; companies dedicated to port trade and port logistics have been established. Meanwhile, the approved 50,000-square-meter bonded warehouse and export supervision warehouse were put into use and the construction of a 500,000-square-meter bonded logistics center is being accelerated. An electronic trading platform of commodity is established to provide the information of the commodity market and transactions. The port has worked with a number of banks to provide the clients with logistics financial services such as pledge by warehouse receipts so as to help

the clients with capital shortage. Inland ports have been built to cooperate in the port operation and to expand the business in the hinterlands. As the hardware and software facilities continue to improve, the service sector is taking off and in a stage of rapid development.

431. Thirdly, Panjin city enjoys a coastline of rich resources, vast beaches, flat terrain, and its potential is yet untapped. The port of Panjin has a land area of 30 square kilometres. Abundant land resources not only greatly reduce the cost of land development in the coastal areas, but also provide sufficient space for the development of the port and the gathering of related industries. The depth of water near the port of Panjin is ideal and the coastline is rich in resources. According to the Master Plan of the Port of Panjin (Revised), during the planning period, the port area of Rongxing will construct 65 berths for production use with a total quay length of 39.0 km, a planned land area of 44.7 km² and an expected throughput capacity of 300 million tons in the long-term. The port of Panjin is located in Liaodong Bay New Area, with a planned area of 400 square kilometres and rich resources in water and electricity, capable of meeting the needs of the future development of the port of Panjin.

b) Weaknesses

432. Firstly, a vague understanding of the port leads to its weak functionality. The port of Panjin is not just a port or a logistics centre. It is a hub for water and land transportation and involves a series of industries. It should be seen as the centre of finance, information, economy and trade, which offers logistics services, information services, business and financial services and industrial functions. However, at present, the port is only utilized in the field of logistics. The vague position of the port results in a lack of functions in Panjin City.

433. Secondly, the port does not serve the economy of hinterland very well and its overall competitiveness is weak. The port of Panjin is not recently constructed and is located at the northernmost part of Liaodong Bay, so the water area on the south side of the port is very narrow, which has restricted the port development. Due to this limit, the port's demands for development cannot be met and the port's role in boosting the regional economy is not obvious. At present, due to the influence of the distribution system, fee collection, the set freight route and the structure of goods, the port only has limited carrying capacity for enterprises in the hinterland limited. So the enterprises have to resort to farther neighbouring port of Yingkou and Jinzhou. Market mechanism has not been given full play to guide the pricing of the port. Due to market rules, this has resulted in a lack of overall competitiveness.

434. Thirdly, there's a mismatch between the ports and the waterway facilities. Since the "12th Five-Year Plan" period, the port of Panjin has a waterway for 50,000-ton-class, while the waterways for 100,000-ton-class and 250,000-ton-class have been constructed as planned. However, the designed scale of some terminals reached 70,000 tons, 100,000 tons and 300,000 tons. The construction of waterway severely lags behind. There's been a mismatch and discordance between the waterway and berth.

435. Fourthly, railway distribution channel is yet to be further extended. Since the "12th Five-Year Plan" period, the port of Panjin has successively built railways into the port and dedicated port distribution railways through which the port plans to further connect to Shenpan railway and Fu-Pan Railway so as to expand the hinterland. However, due to various reasons, the construction of these external corridors of the railways lag behind and the expansion of port into its hinterland is limited.

436. Fifthly, port logistics and IT application are yet to be improved. As the port speeds up the construction of hardware facilities such as terminal, its soft environment is still weak. The IT application needs to be expanded and the port needs to be further modernized. In terms of services, the port's main port business needs to be strengthened and its logistics expanded. The port's business system is relatively simple and the port service facilities still need to be improved.

c) Opportunities

437. Firstly, the support of national development strategy and good policy guidance. Against the backdrop of strong policy support to revitalize NEA, the "Belt and Road" initiative, the strategic platform for the coordinated development of Beijing, Tianjin and Hebei, the China-Mongolia- Russia Economic Corridor and the establishment of a China-Korea FTA, Liaoning province has built an important corridor connecting Asia and Europe. In order to be further integrated into the opening-up landscape of the province and the country province with a broader scope, wider range and deeper level, the port of Panjin, located in Liaodong Bay, should actively follow the national strategy and build itself to be an important node of the shipping system in Northeast Asia.

438. Secondly, the economic, social and industrial Development in Northeast China is promising. There is an increase of the international cooperation in Northeast Asia, which adds new impetus to the overall revitalization of the region. Adhering to the principle of orderly, optimal, coordinated and green development, the coastal ports maintained a healthy and sustainable development, with enhanced ability to support the transport of key goods and better service. Progress has been made in green development. The ports played a bigger role in supporting the development

of the regional economy and industrial agglomeration and can better meet the needs of economic and social development.

- 439.** Thirdly, the development of coastal economic belt drives the industrial development of the port. As Liaoning's coastal economic belt was elevated to be a part of national strategy, Shenyang economic zone was also designated as a pilot area of comprehensive reform. Liaoning has put forward the development pattern of "twin engines linked by one axis ", with the Shenyang economic zone being the link, the coastal area and the hinterland as the two engines. This planning promotes the development of the province. In addition, the development of the coastal economic belt has led the development of many industries in which the province enjoy advantages such as petrochemical, building materials, automobiles, steel and power.
- 440.** Fourthly, the development of the port-vicinity industry in Panjin Liaodong Bay New Area accelerated. Panjin city will continue to make all efforts to develop Liaodong Bay New District. To show the government's close attention to the port, it has declared that during the "13th Five-Year" period, it will continue to speed up the construction of port facilities, improve the collection and distribution system and perform well in the work related to port's upgrading to the first class. It will also comprehensively improve the port's capability and level and make major efforts to open up new routes and inland dry ports. It will insist on the combination of responsibilities, rights and interests, implement target management and facilitate the port to truly act as an important node of Northeast Asia shipping system.
- 441.** Fifthly, the function adjustment of the port of Yingkou Port has resulted in the transfer of freights. On January 26, 2007, the port of Yingkou and the port of Panjin have signed a joint venture contract for coordinated development. From the perspective of the port of Panjin itself, the purpose is to make full use of the resource advantages of the port of Yingkou such as the freight, deep-water channel, tugboat and barges, increase the throughput of Panjin Port and speed up the construction of the port so that the two ports can enjoy their complementary advantages.

d) Threats

- 442.** Firstly, there is fierce competition from the surrounding ports. While serving the local economy, the port of Panjin is capable of serving a broader hinterland. As the constructions of terminal facilities and the external collection and distribution channels speed up, the port of Panjin will enjoy a higher standing in the coastal ports of the province. It will not only become a pillar for the leading industries in the Panjin area, but also become an important part of the regional port cluster. With a higher status and a broader service range, the port of Panjin is bound to encounter

some overlapping with other ports. It is certain that it will face some competition from certain ports including Dalian, Yingkou, Jinzhou, Dandong and Huludao ports.

- 443.** Secondly, the development of the industry is facing challenges. As the construction of hardware facilities such as terminal continues to accelerate, the development of soft environment lags behind. The IT application in the port business needs to be advanced and the port needs to be further modernized. In terms of the service, the port needs to strengthen its main business and expand its logistics function. Port business system is yet to be diversified and port service facilities need to be improved. The high port charges may result in a loss of freights.
- 444.** Thirdly, the port has a great responsibility to protect the ecosystem. The port construction occupies a large number of beaches. The large-scale reclamation damages the environment of coastal wetland, resulting in lower carrying capacity of the environmental. There is increasingly sharper contradiction between the port construction and marine ecological protection. There are prominent environmental problems such as oil and gas pollution and dust pollution. The environment of the port needs to be further improved.

16. SWOT Analysis of the Port of Suizhong

- 445.** On the morning of September 29, 2014, the "Anping 5" vessel, a 50,000-ton bulk cargo ship, was steadily anchored at the general terminal of the port of Suizhong, marking the official opening of the port. The opening ceremony was presided over by Cao Yingfeng, general manager of Suizhong Port Group. Liu Huanxin, director of Department of Transportation of Liaoning Province, Gao Baoyu, chairman of Yingkou Port Group and Suizhong Port Group, Yang Cuijie, deputy mayor of Huludao government and Guo Lun, secretary of Suizhong County Committee, attended the ceremony and delivered speeches.
- 446.** The construction of Suizhong Port, whose prospective design is undertaken by CCCC First Harboar Consultants Co Ltd, started in September 2012. The initial construction projects include three general berths for 50,000-ton-class, with a quay length of 800 m and a land area of 2.4 km². The designed annual throughput is 4.3 million. Hydraulic structure takes the form of gravity caisson wharf. The official operation of Suizhong port will further promote the rapid development of port- vicinity industry in Huludao and comprehensively enhance the strategic position of Huludao in the Liaoning coastal economic zone and even in the Bohai Economic Circle. Meanwhile, strategic layout of port development in Liaoning province is further optimized, the port collection and distribution system in western Liaoning province is improved, the overall service of Liaoning port cluster is enhanced, and the development and opening up of Liaoning coastal economic belt can be better bolstered and guaranteed.

a) Strengths

447. The port of Suizhong is located in Liaoxi Corridor, adjacent to northwest China, north China and eastern Inner Mongolia. Geographically, it is well-positioned and enjoys good natural conditions. It is planned to build 59 large-scale deep-water berths, with the throughput exceeding 100 million tons. The planned land area stands at 25 square kilometres. Suizhong and eastern Beidaihe new area look to the port to realize the dream of “boosting the industry and the region with port”. Since September 22, 2012 when the construction of the port officially started, three projects of terminal for 50,000-ton-class have been going well; an investment of 1.5 billion RMB has been put into place; port dredging and channel dredging have been basically completed; 350 meters of terminal shoreline surfaced and the supporting facilities and constructions are under way including backfilling of the site, port yard, road and auxiliary production area. The establishment of a 10-square-kilometer port-vicinity industry zone at the back of the port area, port distribution railway and port distribution highway are all in the early stage.

b) Weaknesses

448. Firstly, the berth structure of our province is not suitable for international shipping. China is an importer of crude oil. Liaoning's crude oil processing capacity ranks first in the country. The imported oil comes from the Middle East, mainly transported by the 250,000-300,000-ton-oil tanker. The largest oil terminal in our province is the Tieyuwan oil terminal of the port of Dalian Port, which can only accommodate 150,000-ton oil tanker. As for the port of Suizhong Port, it even only has berth for the 80,000-ton cruise ship.

449. Secondly, the IT application in the port lags behind. The upgrading of the transportation system to the integrated logistics management should be synchronized with the IT application. Port business involves shipping companies, port stations, freight forwarding, shipping agencies, roads, railways, transportation, enterprises, banks, insurance, taxation, supervision, multinational corporations and other relevant departments of logistics. A large number of information and documents would be produced during the intricate operation revolving around the goods including acceptance check, discharge, storage, three inspections during customs clearance, packaging, processing, distribution and sales. To realize the above-mentioned information, we should process the documents electronically and the "paperless trade" will soon become a passport to enter the international trade and transportation system and an important symbol of high efficiency, management level and modernization. To realize the electronic processing of port information and documents as well as the “paperless trade”, Liaoning still has a long way to go.

c) Opportunities

450. At the same time, in order to further speed up the port development and give full play to the leading role of Suizhong Port in the economic and social development of the county, Dongdaihe New Area and Suizhong Port Group have been closely working with each other since the beginning of the year so as to speed up the construction of the logistics park in front of the port. At present, the constructions of six general-purpose warehouses have been completed with a total area of about 60,000 square meters. The general-purpose warehouses No. 1, 2 and 3 have been put into use and the general-purpose warehouses No. 4, 5 and 6 are expected to be handed over in June of next year. The supporting mobile warehouse for machinery, the warehouse for tools and attachments and the maintenance warehouse have been constructed. The 4,000-meter main road has been built and is open to traffic. A cargo yard of about 230,000 square meters has been established. The reclamation of a 450,000-square-meter-land has been completed and the land has gone through the basic treatment. In 2016, the total investment in the logistics park in front of the port amounted to approximately 630 million RMB and the park covers an area of approximately 437,000 square meters. The project started in 2014 and is expected to be completed in full. By then, it will become a modern port logistics park with complete functions, advanced facilities and first-notch service, adding momentum to the realization of “the interconnected development of the port” and boosting the rapid development of port-vicinity economy.

451. To sum up, the development of coastal economic belt of Liaoning province has both advantages and disadvantages. It not only faces opportunities but also challenges. The strengths go hand in hand with weaknesses and the opportunities coexist with and challenges. But on the whole, the advantages are more obvious and the opportunities outweigh the challenges. After the implementation of “Revitalization of NEA”, the northeast economic area is blessed with rare opportunities for development and the coastal economic belt of Liaoning province plays an increasingly important role in this region as it is Northeast China’s forefront of opening up to the outside world and international industrial transfer. It is also the international shipping center in Northeast China and the engine of the revitalization of the northeast old industrial base. As a leader in the economic growth and industrial development and a linkage of the region, the coastal economic belt plays an important role in the “Revitalization of NEA”. All ports should fully capitalize on the existing advantages and make up for their deficiencies. They should seize the rare opportunities and embrace the challenges. By implementing the strategies of industrial cluster, internationalization, coordinated and interactive development as well as indigenous innovation, all ports should work hard to forge ahead in a firm way and build on the momentum so as to form a landscape where the ports enjoy benign and interactive development, which will in turn promote the common

development and common prosperity of the northeast economic zone and promote the revitalization of the northeast old industrial base.

17. Comparison of Bohai Bay, the Yangtze Delta and Pan-Pearl Delta

- 452.** The logistics industry covers transportation, storage, freight forwarding and information sector and is regarded as one of the National Emerging Industries. In 2015, China introduced a number of policies on the logistics industry. For example, the National Development and Reform Commission issued *the Notice on Accelerating Implementation of Major Projects Related to Modern Logistics*; the Standardization Administration of China jointly published the *Medium- and Long-term Development Plan for Logistics Standardization (2015-2020)* with multiple departments; and the Ministry of Commerce issued *the Implementation Opinions on Constructing Intelligent Logistics Distribution System*, etc. China's logistics industry should grasp the opportunities brought by the "One Belt One Road" (OBOR) initiative to vigorously develop modern logistics. It should also adapt to the requirements by OBOR initiative, increase its competitiveness and rapidly integrate itself into international logistics, so as to compete internationally, to provide good full logistics services for Chinese and foreign companies, and to earn market share.
- 453.** As for regional development, the logistics industry is relatively mature in the Pan-Pearl River Delta region. For example, in 2014, Shenzhen issued *Measures on Promoting E-Commerce and Logistics Industry in Shenzhen*, which mainly includes facilitating innovation and integrated development, improving infrastructure construction, promoting industry regulation and administration, building friendly environment for development, and strengthening institutional protection for development. In 2003, Xiamen announced the *Opinions on Accelerating the Development of Modern Logistics Industry in Xiamen*, which is a key policy for logistics industry development. In 2010, the Xiamen Municipal Government issued *Opinions on Supporting the Development of Modern Logistics Industry*, which strengthened land use guarantee, as well as fiscal and taxation support for the industry. It also provided stronger support for economic and social development in Xiamen, and for the transformation and upgrading in the consumer industry. In 2015, Sichuan built "safety belt" for 6800 kilometers of road, and Chongqing introduced *Three-Year Action Plan for Promoting Modern Logistics Development*. Various measures to encourage modern logistics industry development have also been taken in the Yangtze River Delta region. For instance, Jiangsu province published *the Opinions on Modern Logistics Industry Development Policies*, and specified the transformation and upgrading target of Suzhou port from 2015 to 2017. Shanghai implemented *Temporary Administrative Measures for Customs Bonded Logistics Center*, which specified 20 measures for maritime transport development and 10 principles for optimizing logistics operation. In the Bohai Bay economic rim region, various rules and regulations are also introduced one after another to vitalize the logistics industry. In particular, policies to support the joint-development of the manufacturing and logistics industries are

introduced. In 2015, the State Council approved the *Outline of Cooperation and Development in the Bohai Bay Economic Rim Region*, which promoted OBOR and coordinated development of Beijing–Tianjin–Hebei (BTH) region. In the same year, Tianjin announced *Opinions on Promoting Logistics Industry Development*, which gave strong support for logistics companies to realize industrial consolidation, upgrading and restructuring through mergers and acquisitions. Liaoning province also published *Opinions on Accelerating the Development of the Service Industry and the Four-Year Action Plan for Promoting Transportation and Logistics Development*. Jilin province issued *Development Plan for Logistics Parks* to regulate logistics parks and accelerate the construction of Faw Volkswagen automobile logistics park and North Asia agricultural products logistics park. Heilongjiang province introduced the “Internet + circulation” plan.

a) *The indicator system and data source*

454. Based on the BCC model in the Data Envelopment Analysis (BCC-DEA), and from the perspective of the financial efficiency of listed state-owned ports companies, the input indicators are generally indicators of costs such as asset size index and operating costs. And the output indicators focus on profitability and solvency index, such as operating income, net profits and earnings per share (EPS). Based on the requirements on input-output index in the variable return to scale model, the principle of input index is the smaller the better, and output index is the larger the better. This report chooses two input indicators—total assets and operating costs, both of which reflect business investment of logistics companies. Operating costs refer to all costs resulting from selling goods or services. As for output indicators, we choose three indicators—operating income, net profits and EPS, all of which indicate profitability of those state-owned logistics companies. Operating income refers to the total inflow of economic benefits from daily operation of the business such as selling goods, providing labor services and transferring the right to use assets. These input-output indicators can fundamentally reflect the basic input-output performance of port enterprises.

455. Table 44 shows the indicators and abbreviations.

Table 44: Input-Output Efficiency Indicators for Port Enterprises

Input Index		Output Index		
Total Assets (in ten thousands)	Operating Costs (in ten thousands)	Operating Income (in ten thousands)	Net Profits (in ten thousands)	EPS
X_1	X_2	Y_1	Y_2	Y_3

456. In this report, a total of 18 port logistics enterprises listed in 2006-2015 are selected as the decision-making units. All input-output indicators are from the 2015 financial highlights, income statements and balance sheets of those listed logistics enterprises. The method requires that all input and output data are positive numbers. However, the output data of some port logistics enterprises are negative, which cannot meet the requirements of data envelopment method. In this report, the linear transformation invariance of data envelopment method is used to process the negative values. Research findings by Ali and Seiford (1990) prove that the data envelopment method does not change the efficient frontier when there is linear invariance^[15]. Pastor (1996) also argues that data envelop method with variable output-scale returns can transform its output data without affecting the effective value^[16]. The average original data of the sample port enterprises in 2006-2015 selected in this paper are shown in

457. Table 45.

Table 45: Average Original Indicators Data for 18 Port Logistics Enterprises by Region from 2006 to 2015

Region	Sample Enterprise	Input Index		Output Index		
		X_1	X_2	Y_1	Y_2	Y_3
Bohai Rim	Jinzhou Port	862648	72404	114885	16444	0.1
	Dalian Port	2233316	281874	397056	66578	0.2
	Yingkou Port	1114830	164710	248793	34401	0.64
	Tielong Logistics	427047	239496	298462	35464	0.3
	Rizhao Port	1069588	225322	311463	47361	0.4
	Tianjin Port	2275617	936085	118574 1	116836	0.36
Yangtze River Delta	Shanghai Int'l Port Group (SIPG)	7457931	1261501	212332 7	575425	0.14
	Shanghai Lingang	140942	78180	98433	1191	0.03
	Lianyungang	395017	86433	119692	10631	0.27
	China Shipping Develop Co.	4456693	572208	729622	99960	0.27
	Nanjing Port	87111	8522	14983	2299	0.13
	Wanjiang Logistics	958779	735277	771145	-5688	0.04
Pan-pearl River Delta	Yantian Port	533876	17489	41417	54005	0.57
	Guangshen Railway	3010460	953266	123401 3	122260	0.17
	Beibu Gulf Port	353705	109107	145138	16714	-0.39
	Chongqing Port	438748	77741	105066	7831	0.15
	Xiamen Port	357664	286467	318685	20425	0.32
	Xiamen Int'l Airport	357664	41350	88202	31331	0.42

b) Relative Efficiency of Bohai Rim, Yangtze Delta and Pan-Pearl Delta

458. Based on the variable returns to scale model (1.1) and data calculation results by DEA software, the author concludes the comparison of the overall efficiency, technical efficiency and scale efficiency of port logistics enterprises in different regions from 2006 to 2015, which also reflects the differences in the competitiveness of enterprises from the efficiency point of view (see Table 9). Here, the overall efficiency value C_r^* , technical efficiency value T_r^* , and the scale efficiency are calculated according to the formula of $E_r^* = C_r^* / T_r^*$. The trend of changing overall efficiency, technical efficiency and scale efficiency of port logistics enterprises in different regions from 2006 to 2015 are shown in Figure 3.

Table 46: Average Efficiency for Port Logistics Enterprises, 2006-2015

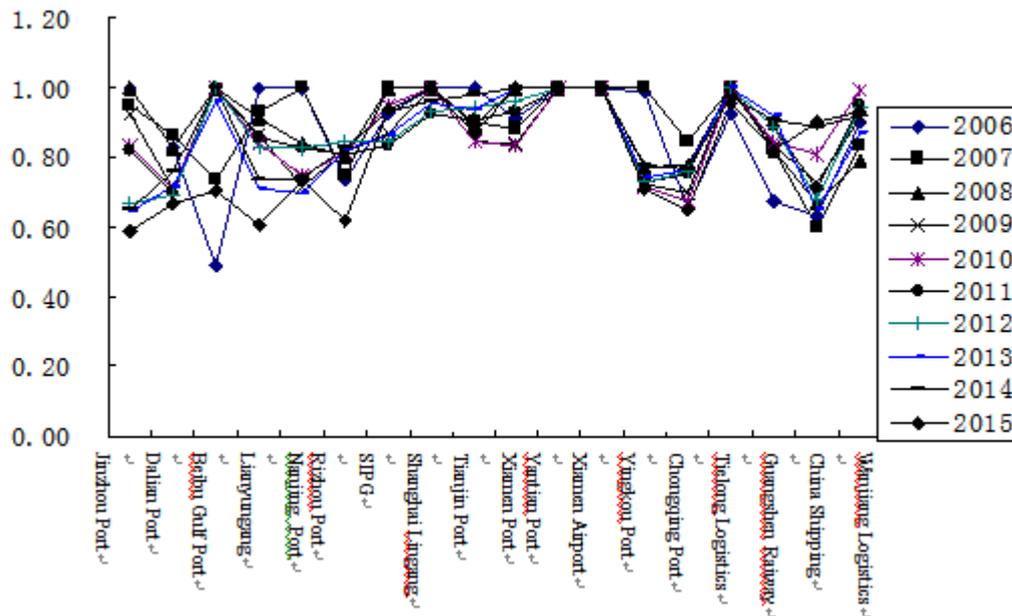
	Sample Enterprise	Overall Efficiency (C_r^*)	Technical Efficiency (T_r^*)	Scale Efficiency (E_r^*)	Decreasing Return to Scale
Bohai Rim	Jinzhou Port	0.732	0.821	0.892	drs
	Dalian Port	0.690	0.811	0.851	drs
	Yingkou Port	0.798	1.000	0.798	drs
	Tielong Logistics	0.91	1.000	0.91	-
	Rizhao Port	0.846	0.909	0.930	drs
	Tianjin Port	0.948	1.000	0.948	drs
Yangtze River Delta	Shanghai Int'l Port Group (SIPG)	0.945	1.000	0.945	drs
	Shanghai Lingang	1.000	1.000	1.000	-
	Lianyungang	0.859	0.865	0.993	drs
	China Shipping Develop Co.	0.630	0.752	0.838	drs
	Nanjing Port	1.000	1.000	1.000	-
	Wanjiang Logistics	0.930	1.000	0.930	drs
Pan-pearl River Delta	Yantian Port	1.000	1.000	1.000	-
	Guangshen Railway	0.904	0.956	0.946	drs
	Beibu Gulf Port	0.922	0.927	0.995	drs
	Chongqing Port	0.773	0.782	0.988	drs
	Xiamen Port	1.000	1.000	1.000	-
	Xiamen Int'l Airport	1.000	1.000	1.000	-

Note: DRS: decreasing returns to scale, IRS: Increasing returns to scale

459. For the Bohai Rim region, Tianjin Port exhibits the highest overall, technical and scale efficiency among those port logistics enterprises, followed by Tielong Logistics, Rizhao Port, Yingkou Port, Jinzhou Port and Dalian Port. The line chart of the 10-year average overall, technical and scale efficiency of the selected enterprises from 2006 to 2015 shows that (see Figure 18) the differences in the three efficiency indicators of the six port enterprises are not obvious and have an upward trend. All overall efficiency values failed to reach the optimal level due to scale efficiency. The technical efficiency values of Tianjin Port, Tielong Logistics and Yingkou Port all reached 1. The scale efficiency values of port logistics

enterprises failed to reach the optimal level, and were in the stage of decreasing returns to scale. It shows that these enterprises cannot effectively coordinate all lines of production due to excessive production scale, which reduces production efficiency.

Figure 18: Efficiency Differences of State-owned Logistics Companies by Region from 2006 to 2015



460. For the Yangtze River Delta region, the overall efficiency, technical efficiency and scale efficiency of Shanghai Lingang and Nanjing Ports reached the optimum by DEA. The technical efficiency of Shanghai International Port Group and Wanjiang Logistics also reached the optimum by DEA, while the overall efficiency of Lianyungang and China Shipping were relatively low. The reason why the overall efficiency of Shanghai Port, Wanjiang Logistics, Lianyungang and China Shipping did not reach the DEA optimum is mainly the inefficiency of scale. Besides, the four state-owned companies were all at a stage of decreasing returns to scale. It indicates such problems as excessive production scale and unreasonable division of labor within those companies. From Figure 18, we can see that average overall, technical and scale efficiency of China Shipping in the past 10 years were at a relatively low level, while the efficiency index of other state-owned logistics enterprises was relatively stable.

461. For the Pan-Pearl River Delta region, the overall, technical and scale efficiency of Yantian Port, Xiamen Port and Xiamen International Airport reached the DEA optimum. The overall efficiency of Guangshen Railway and Beibu Gulf Port indicated weak DEA efficiency. Both the overall and technical efficiency of Chongqing Port were relatively low. The overall efficiency of Guangshen Railway,

Beibu Gulf Port and Chongqing Port did not reach DEA optimum mainly because of technical and scale inefficiency. All three companies were at the stage of decreasing returns to scale, indicating that imbalances in input-output still existed in these companies due to excessive production scale.

c) *Redundancy Analysis for Port Logistics Enterprises*

- 462.** In addition to analyzing the efficiency of each evaluation unit, the DEA method is more important in that it can identify the improvement direction of invalid units in DEA, and then provide the adjustment values of each invalid evaluation unit so as to achieve the best efficiency portfolio. This requires projection analysis of invalid DEA units.
- 463.** Through the projection analysis of redundant inputs and insufficient outputs of the evaluation units, the absolute value of redundant inputs and insufficient outputs of each unit is obtained, which can be used to determine the effective adjustment direction and adjustment value of each unit. Furthermore, the input redundancy and output insufficiency ratio of each evaluation unit are analyzed, and the analysis results are compared with the remaining units in the evaluation system in the same period to find the main cause of inefficiency and to remedy flaws in the investment decision-making process. It also enables each evaluation unit to tap into their own advantages, make reasonable use of the existing input resources, and try to get the maximum output with limited input resources. In addition, through the vertical analysis of the input redundancy and output insufficiency ratio changes of the same unit during the evaluation period, it is possible to obtain improvement in input redundancy and output insufficiency, to help port enterprises find out the direction to improve input-output relations, and to provide reference for making rational investment decisions.
- 464.** Firstly, for the Bohai Rim region, Jinzhou Port, Dalian Port and Rizhao Port are three important ports, and they play a significant role as transportation bridges for industrial development and revitalization in the region. The overall efficiency of the three enterprises did not reach DEA optimum in recent years, indicating that the waste of input resources has led to the gradual increase of operating costs. As a result, the output fails to reach the optimal status, and the input-output redundancy exists. The adjustments made through redundancy analysis are shown in Table 47. Judging from the average input-output of Jinzhou Port in the past 10 years in Table 47, for the overall efficiency to reach DEA optimum, both input and output indicators need to be adjusted. On the input side, the target value of total assets should be 5,383,730,000 RMB, and the output radial variable needs to be reduced by 3,242,750,000 RMB in order to achieve the optimal overall efficiency by DEA. On the output side, the target value of operating income should be 1,399,980,000 RMB, and the input radial variable needs to be increased by 251,130,000 RMB.

The target value of net profits should be 451,790,000 RMB and the input and output radial variables needs to be increased by 35,950,000 RMB and 251,400,000 RMB respectively in order to achieve DEA effectiveness. Due to space limitations of this report, Dalian Port and Rizhao Port follow similar analysis.

Table 47: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Bohai Rim Region (RMB10,000)

	Jinzhou Port			Dalian Port			Rizhao Port		
	s^-	s^+	p^*	s^-	s^+	p^*	s^-	s^+	p^*
Y_1	25113	0	139998	397056	92323	0	31256	0	342719
Y_2	3595	25140	45179	66578	15481	56528	4753	16 71 0	68824
Y_3	0	0	0	0	0	0	0	0	0
X_1	0	- 32427 5	538373	223331 6	0	- 476002	0	0	1069588
X_2	0	0	72404	281874	0	0	0	0	225322

Note: s^- input slack, s^+ output slack, p^* target value

465. Secondly, for the Yangtze River Delta region, the overall efficiency of Lianyungang, China Shipping Development and Wanjiang Logistics do not reach the DEA optimum, and input-output redundancy analysis is shown in Table 48. Taking Lianyungang as an example, both the output and input indicators need to be adjusted in order to achieve optimal overall efficiency by DEA. For the input index, the target value of total assets should be 3,697,010,000 RMB, and the input radial variable needs to be decreased by 237,750,000 RMB to achieve optimal overall efficiency by DEA. Similarly, the target value of operating costs should be 233,090,000 RMB, and the input radial variable needs to be reduced by 14,990,000 RMB to achieve optimal overall efficiency by DEA. For the output index, the target value of net profits should be 118,030,000 RMB, and the output radial variable needs to be increased by 54,350,000 RMB. The target value of EPS should be 0.078, and the output radial variable needs to be increased by 0.018. China Shipping Development and Wanjiang logistics follow similar analysis.

Table 48: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Yangtze Delta (RMB10,000)

	Lianyungang			China Shipping Development			Wanjiang Logistics		
	s^-	s^+	p^*	s^-	s^+	p^*	s^-	s^+	p^*
Y_1	25113	0	139998	397056	92323	0	31256	0	342719
Y_2	3595	25140	45179	66578	15481	56528	4753	16 71 0	68824
Y_3	0	0	0	0	0	0	0	0	0
X_1	0	- 32427 5	538373	223331 6	0	- 476002	0	0	1069588
X_2	0	0	72404	281874	0	0	0	0	225322

Note: s^- input slack, s^+ output slack, p^* target value

466. For the Pan-Pearl River Delta region, the overall efficiency of the Guangshen Railway, Beibu Gulf Port and Chongqing Port do not reach DEA optimum. The input-output redundancy analysis is shown in

467. Table 49. Taking Guangshen Railway as an example, to reach DEA optimum, the output indicators need some adjustments. The target value of operating income should be 12,911,070,000 RMB, and the input radial variable has to increase by 570,940,000 RMB. The net profits target should be 1,859,650,000 RMB, and both the input and output radial variables need to be adjusted. The input radial variable should increase by 56,570,000 RMB, and the output radial variable should increase by 580,480,000 RMB. Beibu Gulf Port and Chongqing Port follow similar input-output redundancy analysis with Guangshen Railway.

Table 49: Input-Output Redundancy Analysis for the State-owned Port Logistics Enterprises in the Pan-Pearl Delta Region (RMB10,000)

	Guangshen Railway			Beibu Gulf Port			Chongqing Port		
	s^-	s^+	p^*	s^-	s^+	p^*	s^-	s^+	p^*
Y_1	57094	0	1291107	11485	0	156623	29334	0	134400
Y_2	5657	58048	185965	1323	10981	29018	2186	27384	37402
Y_3	0	0	0	0	0	0	0	0	0
X_1	0	0	3010460	0	0	353705	0	0	438748
X_2	0	0	953266	0	0	109107	0	0	77741

Note: s^- input slack, s^+ output slack, p^* target value

d) Conclusion

468. First of all, the empirical results of the overall, technical and scale efficiency of port enterprises in the Bohai Rim, the Yangtze River Delta and the Pan-Pearl River Delta regions conclude that, most of the port efficiency values do not reach the DEA optimum mainly because of scale inefficiency, which may result from waste of resources input, unreasonable division of labor, and insufficient standardization of logistics infrastructure, leading to poor information acquisition needed for making production decisions in those state-owned logistics companies. These various reasons may lead to high investment in operating costs; hence the output fails to reach the optimal status. Therefore, as the leading players in China's logistics industry, port enterprises must develop modern corporate system, strengthen the construction of modern logistics system, and promote the development of modern logistics industry toward the direction of centralization, scale effect and integration. For example, the Bohai Rim region should focus on port transformation, upgrading and innovation, and on operation efficiency improvement as well as operating costs reduction through strategic integration with large manufacturing companies. In this way, the Bohai Rim region can become a new engine for China's economic growth, transformation and upgrading, and those companies will become demonstration enterprises for regional coordinated development.

469. Second, compared with the overall and scale efficiency, the technical efficiency of state-owned logistics enterprises in the three major regions has more room for improvement. In this era of "Internet +" and integration, science and technology shorten the space and time gap and make communication easier for logistics companies. Although technical inefficiency is not the main reason at the moment for the poor overall performance of state-owned logistics enterprises, it is part of it. Technology should be exploited to establish a smart logistics information service platform featuring interconnection and interworking, an efficient and smart terminal distribution network, and a smart logistics allocation and deployment system, so as to effectively improve information management and technological application capabilities of logistics companies. At the same time, focus should be given to enhance service innovation, to build a tiered team of high-end talents and basic technical personnel, and to create more value for clients.

470. Finally, empirical results indicate that the overall, technical and scale efficiency of Shanghai Lingang and Nanjing Port in the Yangtze River Delta region and of Yantian Port, Xiamen Port and Xiamen International Airport in the Pan-Pearl River Delta region all reach the DEA optimal level. Shanghai Lingang has been constantly improving its service innovation capability against the background of government policy support and rapid regional development. In particular, it has formed unique advantages in providing talent service, comprehensive production and life services, and financial investment services. The Yantian Port, Xiamen Port and Xiamen International Airport in the Pan-Pearl River Delta are large state-owned enterprises. All three ports have strong geographical and technological advantages as well as transportation infrastructure. In recent years, the growth rates of three ports have been steadily rising. This phenomenon demonstrates that the overall efficiency of enterprises is affected both by its own operation status and regional development pace. Therefore, to improve the competitiveness of state-owned logistics enterprises, attention must be given to create favorable macro-environment for modern logistics, and to give full play to the service functions of modern government to improve macro-environment by exploiting the layout strategy of "integrated logistics" and building comprehensive logistics centers and bases, and by consolidating regional resources and developing smart logistics parks with rational layout and high efficiency. For instance, Jinzhou Port, Dalian Port and Rizhao Port take advantage of the geographical advantage of the Bohai Rim region and state preferential policies for modern logistics, to make reasonable development strategies and continuously improve the overall performance and core competitiveness of port enterprises.

IV. Implementation Plan

A. Macroeconomic management and performance

471. The section presents a series of actionable macroeconomic policy recommendations for new RCI initiatives and related commitments that can contribute to revitalizing sustained and inclusive growth for Liaoning Province. Emphasis is on measures that are feasible, incentive-compatible for both public and private sector actors, and harmonious with central government domestic, regional, and global initiatives. Recommendations several categories to promote direct implementation.

1. *Rebalancing economic structure*

472. To better support the industrial subsector of the services sector, Shenyang can emphasize exporting labor-intensive services, which can fall under agriculture, hospitality, or mining. To this end, Shenyang's Hushitai Economic and Technological Development Zone, which focuses on agricultural products processing, can take the lead.

473. Liaoning should direct increased resources towards R&D efforts. Developed nations typically spend 2-3% of their GDP on R&D expenditures; while evidence from Fan and Watanabe (2006) indicated that, during China's peak growth of 9% from 1991 to 2000, R&D expenditures nationwide remained at 1.1% in 2001. The manufacturing sector can develop further via increased R&D into sensors, management systems, and industrial software, all of which are pegged as key technologies to develop under the Made in China 2025 initiative.

474. Northwestern cities, such as Tieling, Chaoyang and Fuxin, can experience increased economic growth via active rural-urban integration with Shenyang and cities along the coastal belt. Coastal cities, such as Dalian, should play to their strengths in tourism, consulting, and information services.

2. *Increasing Foreign Direct Investment into Strategic Sectors*

475. To better attract and/or direct FDI into the strategic sectors, the government can consult the 2013 Catalogue of Advantage Foreign Investment Industries in Central and Western China to find Liaoning's 18 advantage industries.

476. For example, development and production of key parts of medical equipment falls under one of the 18 industries listed. By further attracting FDI into the medical equipment manufacturing industry Liaoning can play to its strengths and boost its involvement and commitment to the Made in China 2025 (MC2025) blueprint, which lists biopharmaceuticals and advanced medical

products as one of ten key industries. FDI into this industry is supported by the central government; the National Development and Reform Commission has already stated its intent to draft policy that will grant foreign investors the same treatment as domestic companies regarding the delivery of MC2025 (see Dai:2015).

- 477.** R&D expenditures as a part of GDP and FDI flows are linked. As shown in four Central and Eastern European nations, an increase of R&D expenditures in GDP results in a substantial increase in FDI. Liaoning's provincial government could draft policy supporting greater R&D expenditures in its 18 advantage industries and Made in China 2025 industries such as medical equipment, power equipment, and automated machine tools.
- 478.** It would do well to strengthen the institutional environment in a manner that draws its level of quality closer to that of the source country's institutions, as this can significantly increase FDI flows (Bellak et al: 2016). The creation of such a business environment dovetails with the following section.

3. Promote open, competitive, and transparent commerce and investment climate

- 479.** Liaoning should use the newly approved Liaoning FTZ to facilitate investment and trade to the maximum extent. This can in five decisive ways.
- Pushing a comprehensive upgrade of sea, land and air transportation
 - As the “negative list” shortens, lift restrictions on investment in high-end manufacturing to allow further opening up
 - Form a comprehensive, streamlined and efficient management system for the administrative committee and continuously improve the business environment of the FTZ
 - Let the construction process of the free trade zone itself create more development opportunities in the fields of commerce, trade, finance and professional technical services.
 - Eastern provinces, such as Jiangsu Province and Shanghai, can continue to serve as blueprints for success in managing FTZs.

4. Demographic Initiative

480. To strengthen Chinese entities' ability to attract and retain talent, the Liaoning provincial government can consider a comprehensive human capital development strategy, including the following initiatives:

1. Build small business incubators and design venture funds in universities and institutes to promote entrepreneurship.
2. Give incentives for college graduates who are employed in Liaoning province, such as cheap public rental, preferential housing loans, reduce student loans, etc.
3. Encourage employers to offer higher salaries, stock shares or sales commissions to talented individuals, particularly junior workers with superior educational attainment.
4. Liaoning can invest in and redesign higher education by either creating new majors, further developing relevant existing majors, or optimizing the vocational education system. It can optimize the vocational system by integrating information technology and a curriculum that employs hands-on training via virtual and/or simulation methods. Such a method has been successfully implemented in Romania, and can be applied to Liaoning universities as well.

5. Additional Macroeconomic Recommendations

481. Connect to the Belt and Road Initiative (BRI) - Given its unique geographical location, goods from Southeast Asia and the southeastern part of China can be shipped to Liaoning (Dalian) and transported by rail to Russia, Central and Eastern Europe, and beyond. This can cut journeys from around 35 days by sea to just 15 days. Liaoning should seize the opportunity of Belt and Road Initiative in the following ways:

482. To further improve its port and inland transportation infrastructure by developing a more complete sea-rail multimodal transportation system. By cooperating with Jilin and Heilongjiang, Liaoning can help build the China-Mongolia-Russia Economic Corridor under the Belt and Road Initiative.

483. By making full use of its coastal ports, Liaoning can also promote maritime trade with neighboring Russia and Korea. Besides developing export-oriented industries by taking advantage of its favorable location, Liaoning can also encourage the local companies to go global by investing more in countries involved in the Belt and Road Initiative.

484. Bohai Rim Integration and Cooperation - The Rim connects Beijing, Tianjin, Hebei, Liaoning, Shandong, Shanxi and Inner Mongolia, and has been labeled as one of China's economic growth poles. In a September 2015 circular (Xinhua: 2015), the State Council called for:

- Infrastructure mega-projects to establish inter-regional transportation, energy, water resources and information networks
- Collaboration towards decreasing air pollution and improving the nearshore marine environment
- Increased industrial cooperation
- Greater role of the market in determining resource allocation
- Urban-rural integration

485. The Bohai Rim faces several significant challenges, including production overcapacity, administrative barriers, resource waste, and excessive competition over cooperation. Involuntary unemployment is also very high. Addressing these may require the provincial governments to cooperate on reducing information asymmetry, better allocating resources, and matching insufficient labor market services with higher demand.

B. Transport infrastructure development and financing

486. Infrastructure PPP projects have seen a tremendous world-wide growth since the 1990's. But not all PPP projects were successful. Most PPP failures were due to a combination of factors. The two dominant factors were, firstly the *processing of "not sufficiently good projects" supported by weak feasibility studies* and secondly the *lack of adequate preparation during the transaction period before contract signing*. Mistakes can be avoided.

487. Building from the above with, "the understanding of PPP content and process", the "literature review" and the "lessons from the case studies", this section recaps the key issues and the best practices recommended for successful implementation of PPP projects.

488. With respect to transport infrastructure generally and PPP in particular, these Implementation guidelines recommend action by the Government of Liaoning province in the following six major areas:

1. Select good potential PPP projects

489. Only viable infrastructure projects likely to bring significant economic benefits and supported by comprehensive and realistic feasibility studies should be considered as potential PPP projects. Referring to PPPs in Indonesia, A. Wibisono & others (2011) wrote: “But projects were often awarded based on patronage, and government support was provided in an ad hoc manner”. One of the main reasons for PPP failures is that the feasibility study – when it exists – is carried in a superficial way with too often over optimistic forecasts. This, for instance, was noted in the PPP bridge project in Vietnam above when reviewing some case studies. The reference to problems in feasibility studies has been mentioned by many reviewers of PPP performance. “According to financial experts, most PPP failures can be attributed to inadequate or non-existent feasibility studies, including unrealistic forecasts and undefined public contribution of funds” (R. Apanaviciene (2010)). Also, the correct sequence of project identification, project pre-feasibility study and feasibility study and detailed design is often shortened in order to accelerate implementation.

490. In Asia, 60% of the future PPP projects (Ryuichi (2017)) are originally initiated by the sponsors¹⁶. This is not optimal as infrastructure projects are aimed at providing public services which should be part of the priorities and long-term planning of governments. Also, from the long list of projects in the pipeline, governments should have designed clear criteria to screen and prioritize infrastructure projects.

2. Enable proactive and fiscally responsible government support

491. On many grounds, the success of a PPP project would depend of government playing an active and supportive role at almost all the stages of the PPP cycle and providing to the private sector unwavering commitment to project realization. Firstly, governments (central governments) should enable the establishment of a strong legal framework conducive to the development of PPP projects. According to a survey conducted in Malaysia in 2011 by Ismail and other (2011), among 18 critical success factors, the 3 top ones were: good governance, availability of market finance and favorable legal framework. Some countries enact specific PPP laws to adapt PPP requirements to the existing legal framework. Instead of creating a PPP Law, some countries decided to change existing laws to accommodate PPPs. A PPP specific law can demonstrate political commitment to a PPP program and The World Bank PPP Reference Guide (World Bank (2017)) gives examples of PPP laws world-wide. In Indonesia, to strengthen the PPP program, infrastructure laws were adjusted and presidential decrees issued to accommodate the need of PPPs.

¹⁶ Only in India it is different where 90% are initiated by government.

These changes among others allow the private sector to invest in the development and operation of viable infrastructures without signing joint ventures with SOEs (A. Wibisono & others (2011). In China, MOF has drafted PPP legislation and is currently receiving opinions and comments from concerned organizations before implementing the law.

492. A PPP law is a general framework legislation; in addition, PPP projects need to follow a whole set of regulations and get numerous permits and authorization issued by many different ministries. It is therefore the responsibility of the public entity in the partnership to assist the private sector in that domain.

493. To foster development of successful public-private-partnerships, it is important that all involved government levels (central, provincial and municipal) adopt with sincerity a pro-business attitude. This implies, among other things, a willingness by governments to let investors having profitable returns on investment. In China, this means developing more PPP projects with true private sector interests instead of favoring dealing with SOEs in preference.

494. The supportive role of government or public entity in questions of project financing or risk allocation is outlined below.

3. Prepare adequately project and make use of available capacity building assistance

495. It cannot be stressed enough that one of the key factor to successful PPP project implementation is through an adequate preparation by government concerned authorities making use of available assistance provided by MDBs or their own domestic institutions. “Among all EMDE countries, one of the biggest constraints to bringing PPP projects to the market has been the lack of planning and capacity to properly prepare projects” (World Bank 2016). PPP project procurement is more complex and takes more time that the traditional public-sector delivery of infrastructure services. “PPPs often require the application of best practice and international standards, which, in concert with local standards, may provide the government with better-quality services and prepare the government for additional foreign investment as it addresses potential gaps between local and international standards” (ADB 2012). The government or public entity needs to be involved through the whole project cycle which could vary between 15 to 30 years or more. At the beginning of the project and up to contract signing and financial closure, this would involve quite a series of tasks. In the operation phase it would essentially consist of monitoring and payment activities.

496. The first task is to decide whether a project qualify to be procured under a PPP mode. This is achieved through the use of a value-for-money (VFM) analysis

through the filter of public sector comparators (PSCs). The VFM analysis is simply an extended Cost-Benefit analysis where considerations on social and environmental sustainability are included. The use of the PSC is to ensure that PPP mode brings sufficient savings to government compared to the traditional delivery method. Of course, this quantification exercise always contains a risk element¹⁷. After a positive answer to the VFM testing, the choice of a typical PPP scheme needs to be confirmed. This implies choosing among the following: Management Contract, Lease Contract, BOT and concession. The choice is often dictated by the type infrastructure and sector considered. Then, the procurement process per se starts (prequalification of bidders, preparation of bidding documents, bid evaluation and contract negotiations). In developing countries, government officials would by and large lack the skill to deal with the complexities of the process. External advisors, called transaction advisors, need to be hired through special funding mechanisms like “Project Development Fund/Facility” (PDF). For instance, India has established an Infrastructure Project Development Fund (IIPDF) with a revolving capital of Rs 1 billion. “Lack of adequate preparation of public-private partnership (PPP) projects is one of the most critical impediments affecting infrastructure development in Indonesia” (ADB 2012). Therefore, Indonesia decided to put in place a PDF which is supported by ADB and managed by BAPPENAS. IFC offers also the service of transaction advisers on a cost recovery basis. Generally, transaction adviser costs are recovered from the successful bidder. Sugden (ADB 2016) argued that PRC should seriously consider the establishment of a PDF to be managed by the CPPPPC.

497. There are now extensive knowledge, assistance and guidelines¹⁸ available for countries interested to improve their PPP procurement processing. ADB established the Office of Public-Private Partnership (OPPP) in September 2014. The Office provides transaction advisory services and manages the \$ 76 million Asia Pacific Project Preparation Facility (AP3F), a multi-donor facility (Sugden ADB 2015). ADB has recently approved a loan to Pakistan for Government of Sindh with financing of a PPP Support facility (PPPSF), a PDF and a Government viability gap fund (VGF). But probably the most noticeable efforts and assistance of MDBs came from the World Bank group. The PPP Infrastructure Resource Centre (PPPIRC) provides a series of tool kits for best practice in PPP in energy and transport. The PPP Infrastructure Advisory Facility (PPIAF) provides services on a cost recovery

¹⁷ Certain countries prefer to adopt a qualitative approach instead of risking estimating wrongly components of the analysis. For a comprehensive study of VFM, see the World Bank Value for money Analysis –Practices and Challenges (WB 2013).

¹⁸ ADB guidelines: “Public Private Partnership Operation Plan 2012-2020” (ADB 2012); World Bank: a) “Good Governance in PPP, a review guide for practitioners (WB and DFID 2009); b) “Values for Money Analysis, Practices and Challenges” (WB 2013); c) “PPP Reference Guide Version 3” (WB 2017).

basis, issue guidelines and maintains a comprehensive PPP data bank. PPPIRC and PPIAF are both part of the PPP Knowledge Lab, an organization managed by the World Bank but with the collaboration of ADB, EBRD, Global Infrastructure Hub, IDB, OECD, UNECE and ESCAP.

498. There are many tasks and aspects covered under project preparation for the public entity. Some merit special attention; they are the questions of “project risk allocation” and “government payments to the private sector in the partnership”.

4. Achieve appropriate risk allocation among partners

499. Project risks should be allocated to the contractual party best likely to be able to mitigate it and the agreed risk allocation should be enforced throughout the duration of the contract. The party which has been allocated the risk should be able to most likely carry out the three following activities: a) control the occurrence of the risk, b) control the impact of the risk on the project, and c) absorbs the risk with the least cost. There are three main categories of risks: design and construction risks, market related risks and political risks. There could be however many variants and elaborations from these three main categories¹⁹.

500. In the traditional delivery of public infrastructure, government or the public entity absorbs all (or almost all) the risks. In a PPP procurement scheme, risks are being transferred to the private sector. In the case of PPP project, there is no up-front disbursement by the public entity and therefore no immediate public debt increase impact. But, later the project brings a series of potential fiscal implications in the form of government payments, subsidies and guarantees given to the project company.

501. In PPP, not all risks can be transferred from the public sector to the private sector. This is why it is important to have a good risk management system and a clear allocation of risks as defined in the contract; otherwise it could bring a chaotic situation. For instance, the occurrence of a highly damageable risk which does not fall automatically to the project company may have been omitted in the PPP contract and, in such a case, the implied cost may cause termination of the project or the need for a major contract re-negotiation²⁰.

¹⁹ The PPPIRC of the World Bank (WB 2009) has a generic risk allocation table for toll roads with 21 types of risks; Evaluating risks on the Portuguese road sector (Fernandes 2016) has 9 types; the PPP World Bank Guidelines (2017) has 10 classes; The ADB PPP Operating Plan 2012-2020 (ADB 2012) works with 6 types only.

²⁰ A total of 75% of major infrastructure PPP contracts are renegotiated during the concession duration.

502. Risk management requires first that risks and their possible impact be identified in what is referred as Risk Register; then a Risk Allocation Matrix should be established. In some PPP projects probabilities of risk occurrence are estimated and specific implied cost are added to the contract (see the case of financial audit of Autoroute 30 in Quebec, Canada).

503. Not all risks are of the same importance and most of them could be mitigated at a cost. Insurance programs, for instance, are now available to cover political risks. However, a BOT project depending for repayment on user pay payment would always be at risk because most of the time demand forecasts in the feasibility study were too optimistic. The demand risk is probably the most serious risk for the concessionaire. Mitigation exists but would depend on the willingness of the grantor (public entity/government) to compensate the concessionaire²¹. A typical risk allocation matrix for PPP transport infrastructure projects is presented below.

²¹ For instance, in Malaysia, if toll revenues on expressways come lower than agreed in the PPP contract, government compensates the concessionaire if increases in toll rates are insufficient.

Table 50: PPP Project Risk Allocation Matrix

Type	Description/cause	Impact of risk on Outcome	Mitigation	Allocation
Site	Land acquisition & resettlement problem; faulty soil investigations; unforeseen environmental problems	Delayed acquisition of the right-of-way could significantly delay project implementation	Should have been resolved before contract signing; if occurred after adjustments to contract	Grantor
Design	Failing to complete the design process; possibility of changes in technical standards;	Change in design affects project costs & delivery schedule & demand	Joint technical inspection by both parties; independent expert review	Concession; if BOT, Grantor
Construction	Cost overruns due to: inflation in labour and material inputs, inefficient construction practices, unforeseen in geo physical conditions; delays in delivery	Increase in final infrastructure project cost; delays in delivery may imply penalties and fines paid by project company	Efficient construction management practices; provision of contract contingencies; contract adjustments	Concession
Operation	increases in costs of maintenance and operation (inflation, heavier demand than expected leading to faster deterioration)	Impact profitability and concession revenues	For roads, install weight scale stations & consider revision of tolls	Concession
Demand	Demand for service falls short from the expected forecasted level because of affordability or competition problems	Lower-than-expected revenues during the concession period with negative impact on return on equity	Market research; affordability analysis; if conditions not fully under concession, "Viability Gap Financing"	Concession

Financial	Interest and exchange rate fluctuations, capital controls restricting convertibility and transferability of profits	Loan repayment more than expected, imported goods expensive and capital control all affecting profitability	Credit Guarantee Facilities; Hedging instrument; contract re negotiation	Concession except case of capital control: Grantor
Political	Change of law leading to (i) unforeseeable conduct by government against contract modalities; (ii) expropriation of the assets of the Concessionaire.	Affects the expected return on Equity & debt service in (i) and leads to termination of concession in (ii)	Insurance against political risk Compensation and contract re-negotiation in (i); termination clause in (ii)	Grantor
Regulatory	Unexpected changes in tax legislation, tariff-setting rules, and contractual obligations; possibility that consents required from other government authorities may not be obtained or, if obtained, at greater cost	Changes in regulations would make project costlier and delayed and will affect profitability	Due diligence by concessionaire before signing; Grantor to assist concessionaire in getting authorisation/permits from all government agencies	Shared responsibility
Force Majeure	The possibility of occurrence of unexpected events that are beyond the control of the Parties (natural disasters, civil riots)	May cause major disturbances in construction and operation schedule	Insurance & Indemnity of the Concessionaire from liability for duration of Force Majeure	Shared responsibility
Asset Ownership	Risk that asset deteriorated at transfer	Implied cost to restore condition of asset as expected in contract	Grantor monitoring avoid this; cost of restoration to concessionaire	concessionaire

Source: Consultant; World Bank PPPIAF

5. Make use of available project financing alternatives

- 504.** PPP projects do not need to be only financed through bank loans. Many alternative financing instruments are now available and merit to be used. Traditionally debt was the way to finance PPP projects. Debt financing meant loans from commercial banks made available to the project investor. Presentations at the recent 3rd Annual Infrastructure Project Financing Conference in Singapore have challenged that perception arguing that many more alternatives should be considered. Of interest is also the workshop which was organized in 2015 in Beijing by ADB on the problem of PPP financing and risk management²².
- 505.** Munro (2017) noted that “non-banking institutions” like pension funds, insurance, trust funds are showing greater interest in infrastructure financing (a 113% increase from 2013 to 2017). The institution investors are active on the bond market and on the equity market. Despite emerging new financing schemes, debt financing (loans) still dominate on a world-wide perspective, but, the fund distribution among sources shows a sharp increase from the bond market from 2011 to 2016. Development Financial Institutions (EIB, EBRD, JBIC...) have seen their share decreasing between 2011 and 2016. The percentage distribution is the following with first number referring to 2011 and second one to 2016: DFI (14% and 6%), Bank loans (45%, 41%), Bonds (4%, 18%) and Equity (37%, 35%).
- 506.** Following the last global financial crisis, commercial banks have adopted a more conservative attitude hesitating in financing large infrastructure projects. Banks also prefer short term lending and may not feel comfortable with the long-life cycle of PPP projects. Bonds on the other hand are comfortable with long-term maturity but their markets are still undeveloped among developing countries. In Southeast Asia, only Malaysia has been actively using the bond market (Islamic bonds) to finance infrastructure projects. Project bonds issued by the sponsor/investor are still a new idea in Asia though it offers a lot of potential. Malek (2017) in his presentation noted how Prasarana, the SOE under MOF managed to finance the different urban rail lines in Kuala Lumpur: for instance, the Kelana Jaya & Ampang lines of RM 5.7 billion were financed conventionally (loans) + Islamic bonds, but, the line extension of RM 7 billion entirely by Islamic bonds.
- 507.** Sharma (2017) pointed out that most infrastructure projects have a credit rating lesser than AA, being rated BBB/BB and current regulations limit insurance companies and pension funds from investing in debt securities rated below AA. A credit guarantee is a de facto credit enhancement where the borrowers’ debt obligations are partially or completely guaranteed by a third party – This third party,

²² “PRC-TA 8869-International Workshop: PPP Financing and Risk Management”, ADB, 12th of June 2015 Beijing.

or guarantor, is liable to repay on default. Countries and MDBs have put in place credit guarantee facilities to help the financing of infrastructure projects. Indonesia Infrastructure Guarantee Fund (IIGF) providing risk guarantees for infrastructure projects in Indonesia. Credit Guarantee and Investment Facility (CGIF) owned by ASEAN+3 countries provide credit guarantees to entities in the ASEAN+3 regions. Nishimura (2017) gave the example of how ADB and CGIF have assisted the expansion of a geothermal power plant in the Philippines. Project cost was financed by partially guaranteed project bonds and a loan from ADB. ADB was the guarantor and CGIF risk shared the rights and obligations of the guarantor on a first loss basis up to CGIF's guaranteed exposure. Nishimura also pointed out the large potential of project bonds if they were issued in local currency instead of foreign currency.

508. Perhaps the most innovative financing scheme is the use of a value capture scheme or Transit Oriented Development (TOD). Infrastructure development brings increases in land value or property value. The idea is to capture some of that increase to contribute to the financing of the project. Amarantuga (2017) gave a few examples of “value capture” or TOD initiatives. In Kansas City 75% of a recent transport infrastructure development was financed through a value capture and sales tax. In Hong Kong, in 2012, rental of commercial stations provided 16% of MTR revenues. Also, the MTR portfolio contains 13 shopping malls and 18 office floors in International Finance Tower. At 11 stations of LRT3, Prasarana is the major retail/office/residential developer for a total gross development value of RM 10.7 billion. TOD revenues therefore would significantly reduce the debt impact of the new LRT3 urban rail development (Malek (2017)).

509. Finally, the question of Mezzanine Financing should be mentioned. Mezzanine financing is a hybrid of debt and [equity financing](#) that gives the [lender](#) the rights to convert to an ownership or equity interest in the company in case of default. There are different types of mezzanine financing. A simple case is when the grantor (public entity) directly or through a proxy company decides to take some equity in the PPP project. This has been common in transport Chinese PPP projects. Another case illustrated by Kelly (2015) is when there is a blending of EU fund (in grant form) with debt financing on infrastructure projects in Europe.

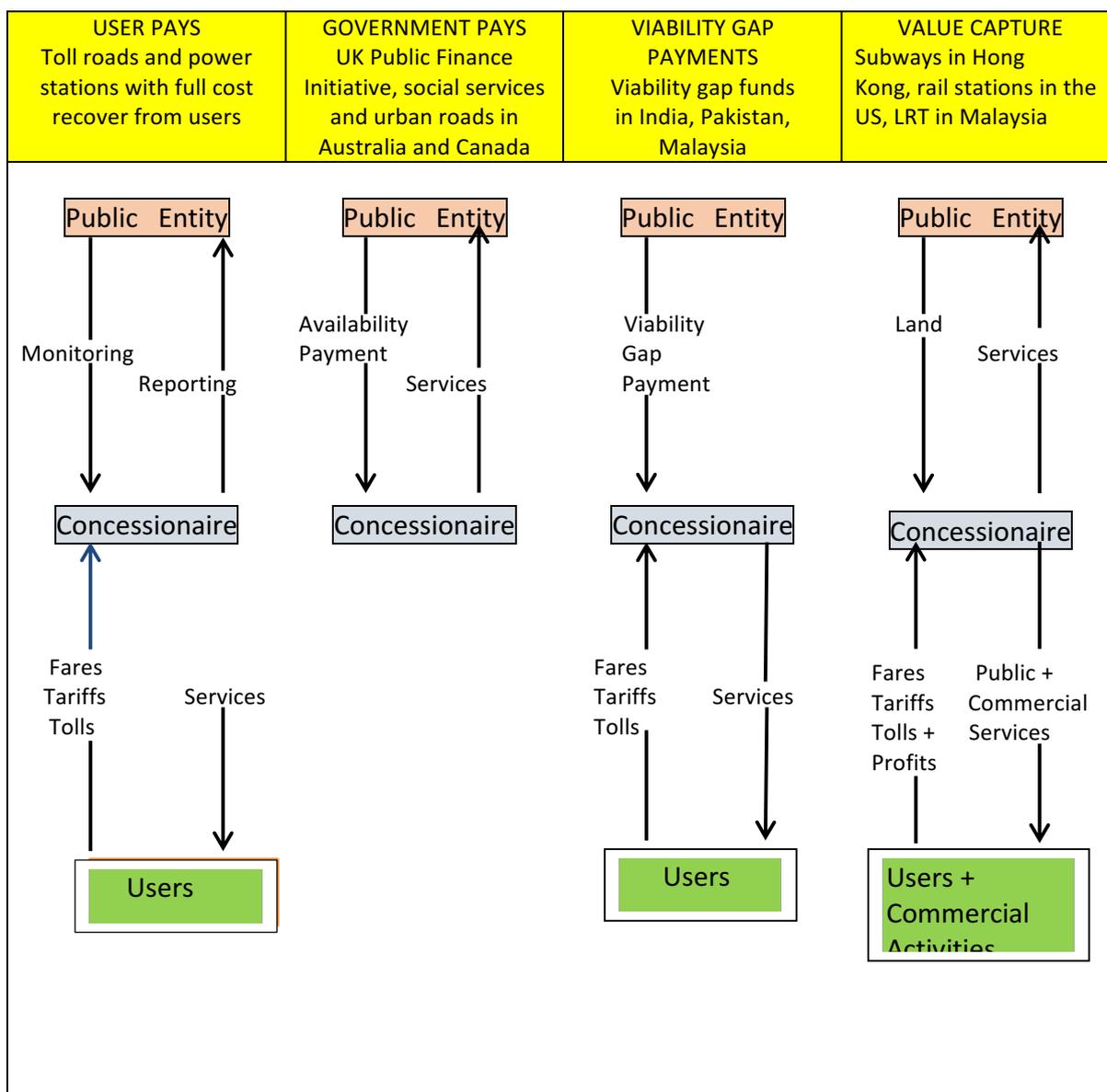
6. Ensure adequate generation of project revenues

510. Payments (revenues) to the investor/sponsor for the provision of infrastructure services would vary according to the type of PPP scheme adopted. Payments should be sufficient to ensure reasonable return on investment and this may, in certain cases, required compensation payments from government/public entity. The revenue schemes for PPP BOT could be classified according to the four following headings: “User Pay”, “Government Pays”, “Viability Gap Payments”, and

“Value Capture”. Variants exist but they would all go along the principles behind these four types.

- 511.** The Government Pays scheme has been used and continues to be used in many countries. The public entity owns the infrastructure but delegates to the sponsor/investor the responsibility to build and operate the infrastructure at his own cost. The government/public entity reimburses the concessionaire for the services provided through a “government availability payment” based on monitored performance. No user charges are levied.
- 512.** Under the User Pay scheme, all the costs during the project life cycle (concession duration) are covered entirely by the users of the infrastructure through tolls, tariffs or fares. Costs include the construction and the maintenance of the facility. Under such a scheme, the government/public entity has no obligation to pay the concessionaire for the provision of the services and only keep his role as regulator monitoring the performance of the concessionaire. They are variants of the scheme but the pure case would imply that the concessionaire has full liberty to select the optimum tariff/toll to cover his cost and ensure sufficient profitability.
- 513.** The *Viability Gap Payment* scheme is a sort of hybrid between the *User Pays* and the *Government Pays* scheme. In fact, it has all the characteristics of the “user pays” scheme but it accounts for some shortfall of revenues to the concessionaire. Because of demand lower than expected or/and because tariffs/tolls could not be increased (affordability, social reasons), revenues generated by the new infrastructure services may not guarantee financial sustainability to the concessionaire. In that case, both partners agree in the contract that compensation payments (viability gap payments) would be paid to the concessionaire by government. This form of public service subsidy is being used in toll roads in India, Pakistan and Malaysia.
- 514.** The *Value Capture* scheme is relatively new and offers a lot of potential. It is usually combined with the “user pays” scheme. New transport infrastructures like urban rail projects generate substantial new economic activities (value added). The principle is to capture some of the generated benefits and increases in property value to finance the cost of the newly built infrastructure. There are different ways of doing it. It could be either (or both) through the tax system or simply by PPP partner being an active investor in the generated commercial activities. Then in some accounting procedures the lack of revenues from infrastructure services are largely compensated from generated activities revenues.

Figure 19: Schematic of Alternative Revenue Schemes



Source: Adapted from Sugden (2015).

7. Conclusions for PPP Projects in Liaoning

515. Many PPP infrastructure projects are currently in the pipeline in the Liaoning Province, but only a few have been implemented or are in process of being implemented. This interest in PPP projects is not surprising and reflects the serious mismatch between available government funding and a continuously expanding infrastructure investment demand. With growing public debt and alarming budget deficits, provincial and local governments are less and less capable of meeting the demand and therefore public-private-partnership financing are being seen as the best desirable solution.

516. In an effort to articulate the “best practices” guidelines for PPP projects, the study went through a detailed review and analysis of the steps required. From the

lessons learnt and the stressing of the prevailing issues, a series of practical recommendations have been outlined in the section above. The recommendations should apply to Liaoning in order to put in place a coherent development of PPP projects.

- 517.** The case studies presented have all illustrated different aspects and problems often encountered in PPP projects. The case of Indonesia stressed the importance of government support to arrange financing as the issuance of a *letter of comfort* was a guarantee accepted by commercial banks to lend to the project company. The success of the Laibing Power PPP project in China was due to effective government support and a well-balanced risk allocation among partners. Having the public entity/grantor as directly involved in project financing (through equity) proved to be an excellent solution in the Port of Colombo project. PPP projects transfer responsibility and risk to the private sector but it does not mean that subsidies are no more required. As illustrated in the case of Malaysia toll roads, compensation for shortcoming in user pay are sometime required to guarantee the success of a PPP project (Viability Gap payment). Intelligent and efficient subsidy schemes were illustrated above in the case of shipping routes in Pacific island countries.
- 518.** The study has on a few occasions mentioned the active role played by the World Bank and ADB in assisting countries in their development of PPP projects. Project Development Funds (PDF) and transaction advisory services have been established by MDBs to assist developing countries to make greater use of the PPP approach. But countries themselves are putting in place institutions to assist and guide local government or public entities in PPP development. In that regard China has now a very active organization in that domain, the China Public-Private-Partnership Center (CPPPC). Liaoning should seek assistance from MDB dedicated institutions and CPPPC in its implementation of PPP projects.
- 519.** PPP projects in Liaoning are heavily SOE dominated. Efforts should be made to include a greater contribution of the private sector and extend the concession duration above 15 years which is short for transport related projects. Finally, repeating what has been said before in the report and, as a general guidelines, the implementation of PPP projects in Liaoning should proceed along the following steps: a) only implement good and needed projects supported by strong and reliable feasibility studies; b) give to the project company efficient and effective government support; c) in financing schemes, be inventive and go beyond the debt-equity option and consider alternative in terms of project bonds, value capture and direct involvement of grantor; d) seek guarantee schemes and insurances to minimize the risk; e) draft a clear contract agreement which covers all aspect of project realization and provide a fair risk allocation among partners; f) payment

structure should allow for agreed compensation if concessionaire revenues fell below expectations; g) include in contract monitoring performance indicators (KPI).

C. Industrial development for manufacturing exports

520. To achieve international development of Liaoning's equipment manufacturing industry, it needs to further support enterprises enlarging and strengthening through mergers and acquisitions and promote the linkage development with production service industry, so as to build Liaoning into a base of international equipment manufacturing industry with outstanding international competitiveness and the comprehensive supporting capacity.

1. Enhance policies supporting local, private sector innovation

a) Enhance the policy support of acceleration to push forward the process of important technological equipment to become homegrown

521. Due to courses of large strength of input of broad areas of linkage and higher requirement of talents of technology of important equipments, it is difficult to push forward R&D through single enterprise, it is necessary to organize R&D and input of large amount at governmental level. The government must increase the input of cost of R&D of important homegrown equipment, establish incentive mechanism to promote homegrown trend in order to encourage homegrown equipments are used by consumers, manufacturing enterprises develop and produce homegrown equipments actively; the state should give preferential policies of arrangement of capital and interest of credit to those engineering projects related to home • made raised by domestic equipment manufacturers and should implement priority of purchasing policy to state invested engineering project with products that domestic manufacturing industry has no competitive advantage yet even under same conditions; for state invested public construction projects, policy of priority in using domestic products should be implemented, and this policy can also be guided through fiscal subsidy of interest; the government should provide guarantee of risks for first set of domestic products. R&D of important equipment of manufacturing industry requires very high investment in general, but it is also with high risks, that is the reason of less private capital to be involved. Therefore, it is very necessary to establish risk fund to support R&D of important equipment.

b) Upgrade technological level of enterprises through various means

522. The first, attract the foreign enterprises to become shareholders with their technology to be shares, to participate the construction of domestic important programme and important engineering projects while the domestic enterprises have the controlling stake based upon the principle "With market change technology." The state should provide conditions for bidding manufacturers that they must joint tender with qualified domestic enterprises, foreign enterprises winning the bidding should transfer technology and subcontract production to

domestic enterprises. The contract of import of equipment and the contract of transfer of technology shall enter into force at the same time. It is necessary to digest a set of advanced technology through accomplishment of a project, and through the digestion and absorption of the imported technology to achieve the second development, thereby to possess the core technology with independent intellectual property rights, and master the whole process of design, R&D, testing, processing and manufacturing, installation and maintenance actively. The second, governmental departments should give preferential policies such as financial support of interest discount loan to R&D of basic components of manufacturers of basic machinery, and the manufacturer of basic machinery should establish long-term strategic coordinative partnership with enterprises in manufacture of parts and components of accessories of the basic machinery. The enterprise group of basic machinery should support the manufacturers of accessory of their basic machinery with capital and technology to strengthen their productive capability. To enhance the capacity of exploration of market and R&D through guidance and support of policies, reorganization of assets, or to establish large scale enterprise group in manufacture of basic parts and accessories through mergers. The third, encourage deepening reform of R&D institutions of enterprises, vitalize the potential of various major actors of innovation, to upgrade the initiative of technological personnel through various incentive system. Guide the enterprise to adopt the model of “Innovation by whole members”. i.e. to mobilize all employees to participate the process of innovation of technology and process through forms of bidding of technology and process, competition of innovation of technology and processing to reduce cost of production and upgrading the competitiveness of enterprises.

2. Support mergers and reorganization of enterprises

523. To build Liaoning into a world-class advanced equipment manufacturing base, we must foster a batch of large equipment manufacturing enterprise groups with a sales revenue of 100 billion CNY and above, support backbone equipment manufacturing enterprises to carry out merger and reorganization, develop large enterprise groups and support the new development of equipment manufacturing industry in Liaoning with large enterprises.

a) Accelerate the strategic restructuring of enterprises and increase industrial policy support

524. Actively expand and develop large and super large industrial enterprises, develop large enterprises with engineering contracting, system integration, international trade and financing capacity, improve industrial concentration, and enhance international competitiveness of industry. Actively promote the strategic restructuring of state-owned backbone enterprises; focus on large

backbone enterprises of machine tools, shipbuilding, marine engineering, power transmission, automotive and other industries,

525. Promote cross-regional, cross ownership and cross-industry combination and reorganization of enterprises by merger, combination and other means etc., so as to achieve the integration of resources and optimal allocation. Determine and implement rational industrial organization policies, increase support to pillar industries and advantageous enterprises, enhance the concentration of pillar industries, make big enterprises bigger and stronger to realize the maximum concentration; make the small business more specialized and more in quantity to form the most competitive situation as possible; promote and guide the coordinated development of enterprises of different scale in the industry by supporting advantageous enterprises, get the production linkage among enterprises closer and improve the professional level.

b) Focus on promoting several enterprises to reach world-class level

526. To make the equipment manufacturing industry in Liaoning becomes an international competitive industry, there should be more than one pillar enterprise of the secondary or tertiary industry with an output value or sales revenue reaching 10% of the world's industry or above.

527. At present, the shipbuilding industry in Liaoning is expected to account for more than 10% of the world's shipbuilding industry and become a world-class shipbuilding industry base. The output of machine tools and CNC machine tools in Liaoning has accounted for more than 10% of the national total, and China's machine tool production accounts for 12% of the global total; although it ranks the third in the world, the proportion of Liaoning's machine tool and CNC machine tool production out of the global total has not yet reached the level of a world-class base, and the grade of the products also needs to be further enhanced. From the view of the current trend of the global machine tool industry transfer, if it maintains the current growth momentum, after several years of efforts, it is possible for Liaoning to achieve the goal of building a world-class machine tool industry base. If the above two industries have reached the development level of a world-class base, they are bound to promote the upgrading of a number of related secondary industries and promote Liaoning to gradually become an international equipment manufacturing base.

c) Strengthen the leadership of equipment manufacturing in regional industry

528. From the late 1970s to the early 1980s, Japan's manufacturing industry formed an economic primacy, and its value added of machinery and transportation equipment manufacturing accounted for 40% of the industrial value added. The output structure of other manufacturing powers is similar –

that of Germany and the United States are both about 40%. At present, the added value of equipment manufacturing industry in Liaoning accounts for about 30% of the value added of industrial manufacturing above designated size. Compared with the structural proportion of Japan, Germany, Britain and the United States as the world equipment manufacturing industry bases, this means that if we want to build Liaoning into an international competitive equipment manufacturing base, the proportion of the equipment manufacturing industry in Liaoning accounted for the regional manufacturing industry should increase at least more than 10% (as a specialized region and the proportion of the country's structure, its main industry share should be higher).

3. Expand service value added in manufacturing

529. Post-industrialization is characterized by the continuous expansion and extension of the services of the manufacturing enterprises to the upstream and downstream sectors of the enterprise, deeming services as the source of creating new value, the constantly improving proportion of service in the sales of enterprises and even gradually becoming the main part of corporate profit beyond the equipment manufacturing.

a) Promote the integration of and interaction between producer services and equipment manufacturing industry

530. For Liaoning, which is building an advanced equipment manufacturing base, the lagging development of producer's service will become the bottleneck of enhancing the competitiveness of equipment manufacturing industry. Therefore, it must make great efforts to promote the development of producer services, give full play to its important role in upgrading the manufacturing structure, and enhance the interaction between them. Specifically, it should improve the technological innovation ability of equipment manufacturing industry through independent research and development activities, build a famous brand of manufacturing products at home and abroad through the development of the design industry, provide a stable source of funding for industrial technology innovation by the tilting support to the financial industry, improve the competitiveness of manufacturing industry through the electronic commerce and trade and reduce the operation cost of manufacturing enterprises by promoting the development of high-end third-party logistics industry.

b) Create a favorable environment for the development of producer services

531. The life services can mainly depend on the market supply; while for producer services, it should give full play to the guiding role of the government. Liaoning should create a favorable environment for the development of producer's services so as to attract investment of domestic and international

producer's services enterprises and promote the growth and expansion of local enterprises. Firstly, prepare producer's services development plan and special plans for the development of key fields, make clear the development goal, key industries and layout orientation of producer's services, give full consideration to the land needs of the development of producer services, make a reasonable arrangement of development space, and promote the development of cluster of producer's services. Secondly, accelerate the development of several producer industry cluster areas of distinctive characteristics, and promote service enterprises of common position and strong industry relationship to gather in cluster areas, achieving the centralized layout, intensive land use and industrial agglomeration. Thirdly, increase support of taxation and other policies to producer's services. Guangdong, Tianjin, Jiangsu, Sichuan and other regions have introduced preferential policies specifically for the producer's services, which do not only provide preferential policies in the supply of land, water and gas, but also in tax within the bounds of the State, e.g. increase of the pre-tax deduction in the technical development costs, employee training funds, etc. Liaoning should also make efforts to increase policy support in such areas.

4. *Improve equipment manufacturing industry clusters*

- 532.** Accelerate the innovation and development of equipment manufacturing industry in Shenyang Economic Development Zone taking Shenyang as the center and the coastal economic belt leading by Dalian, promote the in-depth cooperation of the two major areas to drive the common development of characteristic equipment industry in Northwest Liaoning, forming an industrial structure of dual core drive, coordinated development of the land and the sea and flourished development of many industrial clusters.
- 533.** Shenyang Economic Development Zone: Give full play to Shenyang's advantage of having solid industrial foundation, concentrated scientific research force and developed modern service industry, highlight the leading role of Tiexi equipment manufacturing industry cluster as a demonstration zone of national old industrial base comprehensive reform and equipment manufacturing development, focusing on intelligent equipment, new energy equipment, heavy equipment, new materials technology and equipment and other key fields, promote the Shenyang Machine Tool Group, North Heavy Industries Group, SBW, Yuanda Group, TBEA and other leading enterprises to keep up with the international first-class enterprises, and lead the industry to upgrade. Give full play to the advantages of Shenyang as the center, take Tiexi equipment manufacturing industrial cluster as the core and take Hunnan Intelligent Park as the support to drive the rapid development of characteristic industrial clusters

including Fushun intelligent equipment industrial cluster and Anshan laser electronic and automation equipment industrial cluster.

534. The coastal economic belt: Give full play to the industrial advantages, technological advantages, opening-up advantages of and port vicinity advantages of the coastal economic belt leading by Dalian, highlight the leading role of the Dalian Bay coastal equipment manufacturing industry cluster and Jinzhou equipment manufacturing industry cluster, focus on the intelligent equipment, marine engineering, large-scale petrochemical equipment, major complete equipment and other leading industries, promote Dalian Machine Tool Group, Dalian Huarui Heavy Industry Group, DSIC, CFHI Dalian Hydrogenation Reactor Manufacturing Company and other leading enterprises to keep up with the international advanced standards, and lead the industry towards the transformation and upgrading of integration, intelligence and internationalization. Take the two industrial clusters as the core to promote the rapid development of the characteristic industrial clusters including Lushun ship supporting industry and Wafangdian bearing industry. Play the leading role of Dalian to lead the common development of Dandong instrument industrial cluster, Panjin oil and gas equipment industrial cluster and Huludao marine engineering industrial cluster, and build an important growth pole of equipment manufacturing industry in line with Shenyang Economic Development Zone and new equipment manufacturing base with obvious international characteristics.

535. Northwest Liaoning. Fully improve the scale and technical level of the special industrial clusters of the Tieling special vehicles, Tieling valve, Tieling County auto parts, Tieling petroleum equipment, Kaiyuan crane, Changtu heat transfer equipment, Diaobingshan coal mining equipment and Fuxin hydraulic parts, and promote industrial restructuring and technological upgrading. Speed up the development of the automotive and parts industry, promote the development of new energy vehicles and EV batteries, realize the transformation and upgrading of the industrial economy in Chaoyang, and constantly expand the strength of industrial cluster development.

5. Accelerate the upgrading of enterprise capacity

536. To further improve the international competitiveness of Liaoning's equipment manufacturing industry, there must be a batch of leading enterprises in the aspects of producing whole sets of equipment and EPC. Considering the existing foundation in Liaoning, the following aspects should be further promoted: complete industrial chain of power transmission and transformation equipment, whole sets of metallurgical and petrochemical equipment, new energy equipment, energy-saving and environment friendly equipment, etc. The heavy equipment manufacturing industry should aim at the major and key

equipment urgently needed by the State and to achieve import substitution, strengthen the ability of independent research and innovation, actively develop the main process equipment and supporting equipment, improve the level of complete sets, so as to build Liaoning into a major equipment manufacturing base.

537. Build a complete industrial chain of power transmission and transformation equipment. Taking 1000KV AC, \pm 1100KV DC high voltage, high capacity, intelligent power transmission and transmission whole sets as the main direction, speed up the independent innovation and structural adjustment, strengthen key products including transformer, sulfur hexafluoride enclosed switchgear, transformer, high voltage bushing, wire and cable and secondary control device, and build the power transmission equipment manufacturing industry chain integrating engineering design and international logistics. Speed up the construction of Northeast China power transmission and transformation technology industry park project. Based on the brand advantage established in South and Central Asia countries, promote the development of the international market by taking advantage of “the Belt and Road Initiative”.

538. Improve the capability of manufacturing whole sets of metallurgical and petrochemical equipment. Taking the "major equipment and whole sets of high-end equipment" as the main direction, develop machines, pumps, process automation instrumentation control system for megaton ethylene unit, megaton PTA device and PX device, large liquefied natural gas equipment, large coal chemical equipment, large oil refining equipment, long distance pipeline equipment for oil and natural gas, ocean and onshore oil drilling equipment, oil fracturing unit, etc. in petrochemical equipment in key areas. In the field of whole sets of metallurgical equipment, focus on the development of whole sets of high performance ultra wide and thin magnesium alloy plate rolling equipment, medium & thick steel plate precision shearing series unit, high yield pellet firing machine, complete sets of equipment, large-type sintering machine, large-type high efficiency cold and hot rolling mill and other products. Promote cross-specialty technical exchange, enhance integrated innovation capability, and achieve efficient operation, good matching and intelligent control of complete sets of equipment. Promote the all-round and in-depth development of project general contracting, regional general contracting, re-manufacture and post service, and speed up the transformation from single machines, single sets to complete sets of equipment, general contracting and producer's services.

539. Accelerate the development of new energy equipment. Seize the opportunity of developing domestic nuclear power, promote the process of nuclear island equipment manufacturing industry alliance development, aim at the main technical direction of AP1000 and CAP1400, follow up the technology

development of Hualong One, and create the key nuclear island equipment production base with most complete industry chain and powerful technology in China. Speed up the development of 2.5 MW+ onshore wind turbines and key components and 5 MW+ offshore wind turbine and the key components, and strive to achieve a major breakthrough in wind turbine design technology, wind turbine blades, main bearings and control system development technology. Develop solar modules of high conversion rate, flexible multi terminal HVDC system, high power photovoltaic inverter, large capacity storage devices and distributed photovoltaic grid power plant products, and promote the industrial application.

540. Promote the premiumisation of engineering machinery. Based on the needs of the construction of key national projects, focus on the development of the whole section series tunnel boring machine (TBM), the cutters and control system, large-type and efficient mining equipment, large-type loaders, efficient road construction and maintenance machinery, multifunctional large wheeled crane, large all-terrain truck crane and other high-end engineering equipment. Accelerate the development of multi-purpose serialized high value-added construction machinery products. Implement a number of key projects of engineering machinery and road maintenance machinery, and focus on the development of high precision and high efficiency tamping wagon, high efficiency screening machine, high efficiency screening machine, ballast bed comprehensive treatment car, rail grinding and milling car, rail-defect detector car, comprehensive inspection car, high-speed track inspection car, etc. Strengthen the construction of supporting system, develop electro-hydraulic shift transmission, wet braking driving axle, integral multi-way valve, open-type system straight through axial plunger pump, hydraulic motor and other ancillary products, realize the localization of engineering machinery core components, enhance the independent innovation capability of high-end engineering equipment, and promote the market application.

541. Promote the development of energy saving and environmental protection equipment manufacturing industry. Focus on the development of energy efficient motors, variable frequency speed control technology, reactive power compensation technology and equipment, energy management system, high/low voltage intelligent power saving system, low loss substation technology, residual heat/pressure/energy power generation technology, and industrial wastewater, solid waste, hazardous waste and other solid waste treatment technology. Centering on the waste gas emission control of coal-fired power plants, iron smelting blast furnace, life waste incineration, etc., accelerate the development of professional treatment technology and equipment of desulfurization, denigration, demercuration, dust emission and dioxin treatment,

extend from the terminal control to the source control, and promote the systematization and complete sets of treatment equipment.

542. General contracting capacity refers to getting the related design and manufacturing enterprises together to provide turnkey projects. Liaoning still lacks world-class equipment giants such as GE, Siemens, Mitsubishi Heavy Industries and Alston, which provide full system services. Speeding up the development of large-scale equipment manufacturing enterprises with overall design, system integration, complete production and supporting services is the key link in occupying the commanding heights of competition in the international and domestic markets. Enterprises should strengthen the industrial engineering system design, equipment manufacturing, installation and commissioning, customer service services in areas such as the integration of resources, strengthen manufacturing and technical cooperation with foreign companies or large group cooperation, and joint design, improve the heat processing, heat treatment, automatic control system and the weak link of the technical level, the establishment of large engineering company has always the contracting capacity, and actively participate in international competition in the domestic market.

6. Seize the " Belt and Road Initiative" and speed up "going global"

543. In the new international economic situation, Liaoning's equipment manufacturing industry should seize the opportunity of "The Belt and Road Initiative" to speed up the "going global"; it needs to further optimize the product structure and regional layout, operation innovation and financing mode, and enhance the ability to adapt to the international expansion of enterprises and prevent risks in transnational management.

a) Push construction of sea, land and air access to the outside world

544. Open upon the connection of strategic passage related to "The Belt and Road Initiative", accelerate to construct network of interconnection and interworking, perfect the three-dimensional (sea, land, air) logistics custom system. The first is to establish linkage mechanism between zone and port. Exert fully the function of China's (Liaoning provincial) free trade experimental zone, to solve the problem of convenient custom clearance to lower the cost of logistics and storage, to establish integrated linkage mechanism among enterprises, exempt zone, and port. The second is to utilize fully the international Container Liner Trains of "Liao-Man-Ou" (Dalian-Manzhouli -Russia-Europe), "Liao-Meng-Ou" (Liaoning-Mongolia-Europe), and "Liao-Hai-Ou" (large passage from Dalian port to Bering Strait and further to nearby of Northern part of Norway and then to various ports of Europe), the network of passage of

“Economic Belt of Silk Road” will be integrated deeply. Develop the role of traffic hub and nodal cities fully, push forward planning and construction of Comprehensive Goods Field of Shenyang Railway and Shenyang’s Customs Supervisory Center Station, establish supervisory center of multimode transportation to promote free flow of goods of combined transport of sea and railway, air and land. The third is to push forward construction of high speed railway. Take Harbin-Shanghai high speed railway to be major the making connection with the ports of Dalian, Qingdao, Ningbo, Quanzhou, Putian, Shenzhen etc, to be integrated deeply into the passage net of “Maritime Silk Road of 21st Century”. The fourth, accelerate to push forward development of local aviation. Actively open the international air flight to ASEAN and Central Asia as well as increase the number of flights to Europe, thereby establish three dimensional (sea, land, air) logistics customs Clearance system the number of flights to Europe.

b) Optimize the regional structure of "going global" in manufacturing

545. Over the years, the equipment manufacturing industry in Liaoning has been expanding the international market in the transnational operation. At present, Liaoning should promote the diversification of the market and at the same time, focus on the layout of “The Belt and Road Initiative”. “Going global” of industrial equipment manufacturing in Liaoning has its internal demand, and the complementarity of industrial structure between the countries along “The Belt and Road Initiative” and Liaoning gives it the advantages of strong exogenous demand. Especially with the construction of Liaoning-Manzhouli-Europe, Liaoning-Mongolia-Europe, Liaoning-seaway-Europe routes and China-Mongolia-Russia economic corridor, countries or regions along “The Belt and Road Initiative” should become the important regional layout for Liaoning’s equipment manufacturing industry “going global”. Therefore, Liaoning should actively integrate into the opportunities brought by “The Belt and Road Initiative”.

c) Optimize the product portfolio of equipment manufacturing for export

546. Considering the advantages and disadvantages of the equipment manufacturing industry in Liaoning “going global” and the development trend of international market equipment manufacturing industry, Liaoning needs to further strengthen the close cooperation of government-industry (enterprises)-universities-scientific research institutions, and give full play to the government’s support effect, industry or enterprise, main effect the synergistic effect of universities and research institutions in the development and product innovation. Thus it can further enhance the development and product innovation ability, so that the equipment manufacturing industry in Liaoning can play, in the multinational management, its comparative advantages, and is conducive to the

strategic basis to the high-end, intelligent manufacturing equipment, and seize the high point of the world's equipment manufacturing industry.

d) Carry out extensive exploration of the middle-end international market

547. After the implementation of the re-industrialization strategy in Europe and North America, the international demand for equipment manufacturing industry has dropped, and the growth potential of China's heavy equipment manufacturing demand in Europe and North America has been limited. However, some middle income developing countries or Middle East regions, such as Brazil, India, Iran and Turkey, have been facing stiff demand for heavy equipment manufacturing because of their own construction and mining needs. After the financial crisis, they have increased the international demand for equipment manufacturing products. These countries are basically mid-end market, and because of the political, construction and other factors, their demand for equipment manufacturing products in China has been increasing. In the Middle East market, the market power of the western mainstream brands is weak, and it is easier for Liaoning's equipment manufacturing products to enter these countries' markets. On one hand, the Middle East market belongs to the middle-end market, there is a large space for growth in the product prices, and they trust the quality of Chinese products; for Liaoning's equipment manufacturing enterprises, the profits are much higher than sales in the low-end market. On the other hand, the possibility of trade friction due to products entering into the middle-end market is relatively small, and the trade environment is relatively good.

e) Innovate the operation and financing mode further

548. In the modes of enterprise "going global", especially in the foreign contracting project, the contractor's participation in overseas projects is previously reflected in the labor subcontracting, construction subcontracting and construction management general contracting mainly. Although these modes can bring considerable revenue for enterprises, but the one-time property of "evacuation upon finish" can't bring sustainable cash flow for enterprises and is not conducive to enterprises to drive their products, technology and service "going global" integrally, and it wastes a lot of resources because the enterprise income is based on the bidding and bid winning time and again. At present, many developed and developing countries make extensive use of the BOT and PPP modes for construction project, e.g. in the developed countries such as the UK, Australia, the United States, Spain, Germany and France, the scale and management of PPP have reached a considerable level, and the European PPP market is the most developed. The reality and Liaoning's integration into the "The Belt and Road Initiative" fit with each other and complement each other, and it provides an excellent opportunity to Liaoning's equipment manufacturing

industry "going global". Liaoning's equipment manufacturing industry shall seize the opportunity, take risks to innovate and explore new management modes, make full use of the new model produced by the contemporary world economy, especially the PPP mode, form a new profit mode taking the full participation including project development, design, financing, construction, equipment procurement, commissioning and operation, maintenance and management as precondition, centering on long-term, stable and sustainable development and aiming at the integrated export of products, technology and service integration, thus also achieve the enterprise role transformation from contractor to investor, which is conducive to the international expansion of enterprises.

f) Enhance the ability of enterprises to adapt to international operations

549. Enterprises are carriers of transnational operation, and everything is idle talk if the enterprises do not have the ability of transnational operation. Firstly, enterprises should set up the concept of internationalization, strengthen the global thinking, and fully understand the strategic significance of transnational operations. Secondly, enterprise should form the organizational structure which adapts to the transnational operation. The characteristics of the development of the world economy and the development of contemporary transnational corporations show that the traditional bloated and inefficient organizational structure has been impacted, reducing the level of compression, and the flat organization structure that reduces the hierarchy and size has become a trend, which reduces not only the cost but also the delay between decision and action, accelerates the response to changes in market and competition dynamics, so that the organization's ability becomes flexible and more responsive. It can be said that flexible organizational structure is necessary for enterprise's transnational operation to win in the changing environment. Lastly, enterprises should make full use of "the Internet+" strategy, and make the information resources flow freely between the parent and subsidiary companies, effectively mobilize the enthusiasm of each subsidiary within the network, and implement the global network structure deeply, so as to adapt to the complicated and changeable international market.

g) Further enhance the ability of enterprises to guard against risks in transnational operations

550. Transnational business enterprises will face many risks, including political risk of unstable political situation and regime change in host countries and the change of political relations in the source country; institutional risk of policy and legal environment changing as well as the lack of uniformity and transparency; security risks arising from war, unrest or conflict; economic risks brought by the change of international market factors and exchange rate fluctuations; social risks arising from differences in values and customs, etc. Among these risks,

some kinds of risks are predictable and controllable, so a risk early-warning mechanism should be established. In view of the different risk categories and causes, the establishment of risk monitoring, identification and evaluation mechanism, especially for key countries and key industries should be so, in order to carry out risk early warning. And for some unpredictable and uncontrollable risks, effective overseas investment protection mechanism should be established and improved.

7. Promote efficient supply chains and resolve excess capacity

551. To promote international capacity cooperation, in the short term, is an important strategic measure for Liaoning to crack down the economic growth predicament and resolve the overcapacity crisis in equipment manufacturing industry. In the long-term, it is an important way to adjust economic structure and upgrade the industrial structure of Liaoning Province, which helps to promote the opening up of Liaoning Province and further enhance the core competitiveness and the new international competitive advantage of enterprises engaged in equipment manufacturing industry.

a) Construct overseas industrial parks

552. Give full play to the competitive advantages of equipment manufacturing industry in Liaoning Province, actively encourage and guide enterprises to set up factories abroad, gradually form a number of overseas enterprise clusters and industrial parks, and constantly deepen international development. Firstly, support the elevator industry development of Shenyang Yuanda Group in Kazakhstan, and further improve the high-end manufacturing industry layout of Liaoning Kazakhstan Industrial Park. Accelerate the pace of construction of Uganda Shenyang Industrial Park, guide and help manufacturing enterprises of Liaoning Province to enter Uganda Shenyang Industrial Park and Peru Mining Park, actively promote the international expansion of Liaoning's equipment manufacturing industry with the America and Africa; secondly, promote the equipment manufacturing industry in Liaoning Province to carry out overseas plant construction work in Argentina, Russia, Indonesia, Sri Lanka, Thailand, Vietnam and other countries, accelerate the development of new overseas industrial parks and industrial clusters, and continue to expand the depth and breadth of the international expansion of Liaoning's equipment manufacturing industry.

b) Undertake foreign equipment manufacturing projects

553. Through cooperation with the central institutions and enterprises directly controlled by the central authorities, etc., actively promote the equipment manufacturing enterprises in Liaoning Province to participate in foreign railways,

high-speed railways, airports and other infrastructure construction and driven the Province's equipment manufacturing industry to go global. Actively undertake large-scale national foreign aid projects with high technical content and can drive the export of equipment in Liaoning Province, so as to drive the export of large sets of equipment in the Province. Support China Railway No. 9 Group to participate in the construction of the Erenhot-Ulan-Ude alternate railway lines project, the construction of Turkey cement plant project undertaken by North Heavy Industries Group, the project of 2 sets of 25000 kW thermal power stations in Laos contracted by Shenyang Yuanda Group, and the city water and gas supply project construction in Kenya and Zambia contracted by NEPC.

c) Acquire overseas enterprises

554. According to the requirements of the *Detailed Rules for the Reform of Foreign Exchange Management Reform in Liaoning Province*, publicize the latest overseas M&A policies to enterprises in a timely manner, coordinate and promote the acquisition of overseas enterprises by enterprises in Liaoning province using foreign exchange reserve, and fully support the competitive manufacturing enterprises of the Province to carry out overseas mergers and acquisitions. Encourage the competent equipment manufacturing manufacturers in the Province to participate in overseas mergers and acquisitions through equity participation and acquisition and other means; encourage equipment manufacturing enterprises in the Province to establish overseas research institutions and design centers by sole proprietorship, joint venture, cooperation and other ways. Focus on promoting the implementation of large state-owned backbone equipment manufacturing enterprises and high-tech overseas M&A projects.

8. Upgrade global value chain participation and enhance profitability

555. At present, many equipment manufacturing industries in Liaoning are still at a low or "peripheral" division of labor in the global value chain, namely, production and assembly links of low technology and low value added. We should change this backward position in division of labor. Liaoning's equipment manufacturing industry should expand both upstream and downstream of the global value chain, enhance downstream channels and brand capabilities and upstream innovation capabilities, reverse the disadvantage of being locked down at the low end, and then improve profitability in the global value chain.

a) Enhance downstream profitability

556. The dominant transnational corporations in the global value chain occupy an absolute advantage in the distribution of international division of labor through

occupation of critical value links, but this doesn't mean that the equipment manufacturing industry in Liaoning has to be at the bottom of the global value chain. Since 1990s, the shape of the global value chain has changed a lot. In the global value chain, the value added proportion of midstream including processing, assembly and manufacturing has been declining, and the trend of proportion increase of value added in the upstream including R&D and design and the downstream including channels and brands is increasingly evident. More importantly, there is evidence that the value-added rate of channels and brands in the downstream of the value chain exceeds the R&D link in the upstream to a certain extent. There are two main causes for the midstream and downstream of the global value chain to become the most profitable areas: on one hand, in the current international division of labor, the strength comparison between the manufacturing and the circulation industry has been reversed. In the early stage of industrialization, the circulation depends on manufacturing, while at the late stage of industrialization, it has experienced a change from the sellers' market to buyer's market, the dependence on manufacturing circulation is greatly enhanced, and the circulation rises to dominance. On the other hand, because of the transfer of profits from manufacturing to sales. Product heterogeneity and experiential value are important factors that determine the realization of value. However, both the heterogeneity and the creation of experiential value can't be separated from the value added link in the downstream.

- 557.** To change the disadvantageous position of division of labor in international competition of Liaoning's equipment manufacturing industry, we should not only emphasize the association to expand development ability in the upstream, but also need to pay attention to extension of the related link of achieving the value of innovation in the downstream, and promote the channel integration and implementation of brand strategy.
- 558.** At present, most of Liaoning's enterprises have entered into the international market by long-term contracts with overseas distributors and retailers. As overseas distributors have a very strong market power, local enterprises are often in the "capture governance model", which is easy to lose the ability to bargain. Therefore, for the Liaoning's equipment manufacturing industry, it is a feasible mode for the core enterprises to implement vertical integration of the international market through the form of property rights integration. Specifically, the following three modes can be adopted:
- 559.** Firstly, enterprises with overseas operating capacity can build their own global marketing channels to expand downstream of the global value chain. Liaoning enterprises should make full use of the resources network of overseas Chinese businessmen, establish overseas sales outlets in the form of equity

cooperation, or attract overseas Chinese to join in, and jointly operate the overseas chain management system.

- 560.** Secondly, combine the advantages of Liaoning's equipment manufacturing and the advantages of overseas companies' channels to jointly develop the international market by establishing joint ventures with foreign companies. For example, Northeast Power Transmission and Transformation Machinery Manufacturing Co., Ltd. carries out cooperation with international companies having rich experience including ABBM, Siemens and Alstom in the introduction of technical software of $\pm 500\text{KV}$ AC and DC filter, and has absorbed ABB company's $\pm 500\text{KV}$ AC filter capacitor design and manufacturing technology in the Three Gorges HVDC project and achieved good development.
- 561.** Thirdly, achieve the rapid implementation of vertical integration of overseas channels through mergers and acquisitions of overseas brands and channel operators. The acquisition of overseas brands and foreign traders with mature sales networks is an important way for enterprises to control overseas channels quickly. At present, some large enterprise groups of the equipment manufacturing industry in Liaoning have got good financial strength and rich experiences in international operations; for them, the acquisition of overseas channel resources by merger and acquisition can make the preoccupation of opportunity in international competition.
- 562.** In addition to the integration of overseas channels and the implementation of the downstream value chain profitability enhancement, it should also focus on the implementation of brand strategy to make independent brands bigger and stronger. For a long time, many enterprises in Liaoning's equipment manufacturing industry are stronger than multinational companies in production technology level and product technology, but their brand channel operation ability is poor, and therefore they can only be engaged in OEM and get a small amount of pay for processing. Therefore, Enterprises of Liaoning's equipment manufacturing industry should focus on the following aspects in implementing the brand strategy.
- 563.** Firstly, implement brand strategy, improve brand reputation, establish brand image and expand brand share. For example, Huawei Company has established development goals to become the mainstream of the world telecom brand manufacturers; in order to achieve this goal, Huawei has commissioned a famous global consulting firm to conduct a comprehensive assessment and planning of its brand, and has launched the "Oriental Silk Road", "Orient Express" and other brand plans.

564. Secondly, enterprises of Liaoning's equipment manufacturing industry should attach importance to the international promotion of their own brands, and break through the vicious circle of OEM. Insisting on the construction of private brand is an important way for the cluster and enterprise to enhance their competitive power in the international market and to promote the comparative advantage.

565. Finally, enterprises of Liaoning's equipment manufacturing industry should recognize the overseas brand merger and acquisition. In recent years, many Chinese enterprises have tried to break into the international market by merging the overseas brands, but basically failed. The acquisition of overseas brands has many problems, such as high operating costs, difficulties in cultural integration, obvious cultural conflicts and serious loss of resources. Therefore, for many enterprises of Liaoning's equipment manufacturing industry lack of international experience of operation, they should be fully aware of the risks of overseas brand M&A, have a careful analysis and make detailed plans before M&A, so as to ensure the consistency of M&A with the corporate strategy and avoid blind investment and purchase.

b) Improve upstream innovation capability

566. The innovation ability is the foundation for the survival and development of enterprises in the ever-upgrading of the equipment manufacturing industry. Without the support of research and development, even if an enterprise has established a perfect marketing channel relying on individual products, it is difficult to adapt to the long-term fierce competition in the market. Upstream innovation capability is an important cornerstone for the formation of market forces of equipment manufacturing enterprises, which has an important impact on the realization of innovation value in the downstream of the value chain. The equipment manufacturing industry in Liaoning can effectively guarantee the realization of the innovation value in the downstream, enhance the channel rights and brand value and strive for market competitive advantages through the innovation in the upstream of the global value chain. Specifically, the following two aspects should be highlighted in innovation in the upstream of Liaoning's equipment manufacturing industry.

c) Integrate and standardize global scientific and technological resources

567. In the international competition, equipment manufacturing enterprises should expand the upstream of the value chain through the integration of global R&D resources. Multinational corporations in developed countries are often occupying the R&D links to prevent technology from spreading and maintaining their market forces. Therefore, it is difficult for Liaoning's equipment manufacturing industry to obtain vertical technology spillover through

participating in vertical division of labor system. The vertical integration of overseas R&D resources is an important way to expand the equipment manufacturing industry in Liaoning from manufacturing to R&D links. There are three main ways for vertical integration of overseas R&D resources:

- Firstly, the introduction of technology through technical licensing and other means.
- Secondly, creating international R&D strategic alliances, and cooperating with partners in research and development.
- Thirdly, the implementation of outward foreign direct investment aiming at technology acquisition. Due to the strict technical monopoly of multinational corporations, it is often difficult for equipment manufacturing industry in Liaoning to adopt the first two ways to obtain advanced or core technology. Therefore, while implementing a variety of measures, it is especially important to advocate the competent industry core enterprises to implement the "technology acquisition oriented outward foreign direct investment", which is a feasible integration mode of overseas R&D resources.

568. The technology acquisition oriented outward foreign direct investment is a cross-border capital export behavior with the goal of obtaining intelligence resources, research institutions and other technical elements in host countries, by means of creating or acquiring overseas service agencies and aiming at the enhancement of the ability of enterprise's technical competitiveness and independent innovation ability. This kind of investment behavior is an effective measure for Chinese enterprises to take the initiative to cut into the high end of the global value chain in the current international division of labor. The technology acquisition oriented outward foreign direct investment has the "reverse technology spillover" effect, which can improve the innovative ability and ability to bargain of enterprises, and help enterprises of Liaoning's equipment manufacturing industry to enhance market forces in the global value chain.

569. Among the enterprises of Liaoning's equipment manufacturing industry, Shenyang Machine Tools Group is a model of relying on overseas R&D resources to integrate and enhance market forces. At present, it has set up overseas R&D institutions in Sweden, Stockholm, the United States and other places, which collaborate with domestic R&D institutions and together constitute a global R&D network. Taking the R&D of Huawei NGN for example, the research institute in Dallas is mainly responsible for international cooperation, tracking the latest technical and NGN overall system analysis and design, the research institute in Bangalore is mainly responsible for protocol stack and

software development for soft exchange of NGN core technologies and the domestic institutes in Shenzhen and Beijing is mainly responsible for customization design against for the operator's network features and the transition of solutions.

d) *Build patent networks and create independent standards.*

570. Liaoning's equipment manufacturing industry must attach great importance to the basic work of patents in order to occupy the upstream of the global value chain. Patent applications should become an important means for enterprises to protect technological achievements and maintain their dominant position, and enterprises should devote themselves to raising the amount of patent applications, especially in raising the proportion of patent applications for inventions.

571. In recent years, enterprises of Liaoning's equipment manufacturing industry have formed a certain degree of independent standards in some key technical fields. However, these standards are still facing many obstacles to integrate into the international market. Many domestic enterprises' multi-standard competition makes the limited research and development resources of China's local enterprises scattered, resulting in duplication and waste of resources allocation. The technical and economic characteristics of the modern equipment manufacturing industry make it impossible to have all patents under a product standard only by one enterprise's own research and development. Therefore, enterprises of Liaoning's equipment manufacturing industry must strengthen cooperation and form a joint force, achieve complementary advantages through the construction of patent alliances, promote the standardization of intellectual property rights, and achieve the establishment of independent standards. Enterprises of Liaoning's equipment manufacturing industry should form "de facto standards" through the realization of large scale in the domestic market, and launch independent standards before foreign technical standards can be established in China as far as possible, so that they can have the strength and qualification to carry out related intellectual property exchange with foreign multinational companies and enhance their control of the market.

9. Accelerate development of priority areas for international expansion

572. There are five priority subsectors of equipment manufacturing industry identified in Liaoning provincial equipment manufacturing industry: the aerospace equipment, the energy saving and new energy vehicles, the marine engineering equipment and high end ships, the intelligent manufacturing equipment, and rail transport equipment. Descriptions of them include many

technical terms, only the front two subsectors will be described in the following for illustrative purpose.

a) *Speed up the development of aerospace equipment*

- 573.** Promote the R&D and manufacturing of trunk and regional aircraft. Focus on promoting R&D of the whole trunk and regional aircraft assembly and key equipment manufacturing, and R&D and industrialization of the trunk and regional aircraft large structural parts manufacturing technology. Promote the construction of Q400 Final Assembly Project and Boeing Completion Center Project to be settled, promote the projects of C series to be up graded from large parts subcontract manufacturing to regional aircraft assembly, and form the integrated industrial chain of production of parts, assembly manufacturing, development of new models, etc. Promote the R&D and production of components and related spare parts of Chinese-made ARJ21 regional aircraft and C919 large aircraft, and speed up the R&D and construction of new model aircraft manufacturing bases.
- 574.** Promote the R&D and manufacture of general aviation aircraft. Focus on promoting the R&D and design of common aero vehicle, parts of production, assembly manufacturing, flight trials and training. Develop the supporting industry of maintenance, tourism and leisure, convention and exhibition of general aviation aircraft,, form the whole industrial chain of general aviation. Promote the construction of general aviation industrial cluster. Speed up the construction of SAC-10, Tektronix and other final assembly and test flight projects, and promote the construction of Shenyang Shenbei New Area General Aviation Airport and Liaoning United Airlines Shenyang Aircraft Manufacturing Base.
- 575.** Promote the R&D and manufacture of aircraft engines and gas turbines. Develop aero engines suitable for large aircraft, regional aircraft, general aircraft and other models of aircraft relying on military engine technology, focus on construction of large-scale transport aircraft engine and CF34-10A engine projects, and form capabilities of high-bypass turbofan engine research and development. Promote the construction of gas turbine industry base, adhere to the pattern of simultaneous development of both the light and heavy industry in serialization and echelon, aim to increase efficiency and reduce emissions, break through the core aspects, expand the application areas and speed up the gas turbine market applications and industrialization.
- 576.** Promote the R&D and manufacturing of aviation spare parts and related equipment. Promote the R&D and production of components and related spare parts of Chinese-made ARJ21 regional aircraft and C919 large aircraft. Expand

the scale of production of subcontracting parts for Boeing, Airbus, Bombardier, GE, Rolls Royce and other aviation manufacturing enterprises by undertaking international and domestic aviation manufacturing outsourcing, and integrate into the international aviation manufacturing industry chain. Speed up the dual-use air core key products supporting capacity building, and improve the ability of aircraft parts transformation from peacetime to wartime. Focus on enhancing the development and supporting capabilities of core equipment such as avionics, communications and navigation systems and drive the development of related industries in the Province.

577. Strengthen the development and application of space technology. Integrate the satellite system resources including Beidou navigation and Mapping Satellite remote sensing, develop satellite data applications, integrate the technological achievements into the new-generation information industry and build a long-term and sustainable spatial and temporal information cloud computing, cloud storage and cloud application system by relying on the Shenbei New Area National Navigation and Location Service Industrial Park and Northeastern University Supercomputing Center. Start the sea-based mobile space launch platform demonstration, testing and construction project by relying on the technical advantages of marine engineering equipment manufacturing in Dalian.

b) Speed up the development of energy-saving and new energy vehicles

578. Cultivate leading enterprises actively. Focus on transformation and expansion of the existing automobile enterprises, enhance the production capacity of new energy vehicles, and make appropriate control of new projects of new energy vehicle enterprises to prevent low-level investment and redundant construction. Actively promote the large-scale production of EV batteries and other core components, speed up the cultivation and development of leading enterprises with continuous innovation capability of EV batteries, drive motors, efficient transmission and vehicle control systems.

579. Promote enterprise collaboration and supplementing. Promote the construction of new energy automotive industry alliance, adhere to the principle of being government-guided, enterprise-based, voluntary participation and mutual cooperation, strengthen the industrial chain supporting and cooperation, give full play to the advantages of each enterprise, and enhance the overall strength of the industry chain by integration. Determine the goal and direction of industrial development through the industry alliance, guide enterprises to carry out cooperative research, develop technical standards, build and share common infrastructure of research, production and testing, carry out demonstration applications, and expand the market cooperatively.

- 580.** Enhance the level of core components. Speed up the technological innovation of EV batteries, drive motors, battery control systems and vehicle control systems and industrialization of high-tech achievements, and improve the safety, reliability and stability of core components. Promote the industrialization of new materials, structures and technologies for high-energy-density EV batteries. Support the R&D and industrialization of the drive motor system and core materials, new energy vehicle powertrain control system, body bus control system and vehicle control system.
- 581.** Speed up the pace of popularization and application. Actively guide and promote the popularization and application of new energy vehicles including battery electric vehicles, plug-in (including extended-range) hybrid vehicles and fuel cell electric vehicles. Give priority to the popularization and application of new energy vehicles in the urban transport system, taxi and urban logistics, encourage the use of new energy vehicles as postal services, sanitation, law enforcement and other special service vehicles, and promote the moderately advanced construction of infrastructure for EV charging.

10. Change outdated concepts, deepening the reform and opening

- 582.** It is necessary to change the outdated concepts in the first. The crucial area of international expansion of Liaoning's equipment manufacturing industry is to push forward continuously the liberalization of concepts, abolish the consciousness of "Officialdom Standard" and governmental intervention of the economy decisively. Establish the concepts of focusing on the perfection of China's market economy, opening to outside world and reform. It is necessary to follow the rules of market economy, put importance of institutional constrains and establishment of legalization, and actively perfect the institution and mechanism of marketization. The second, it is necessary to deepen the reform and opening. Continuously reduce the dominant influence of state owned large equipment manufacturing enterprises, encourage private capital to enter into the area of general equipment manufacturing and become the supporting enterprises of manufacturing enterprise to match the manufacturer of large scale main machinery actively. Strengthen the reform of cooperative mechanism among enterprises based on the principle of division of industrial chain and competitiveness in complement, abolish property right blockade and protection among enterprise. Accelerate the perfection of modern enterprise system, deepening the internal reform of equipment manufacturing enterprises, establish effective incentive and supervisory mechanism, innovate management mode, optimize organizational structure. Actively pursue the mutual interaction with Beijing, Tianjin, Hebei province, Russia, Mongolia, South Korea and Japan,

increase the opening to outside world, actively induce the flow of factors of production such as capital, technology and talented people outside of Liaoning province.

11. Enhance organization and leadership

583. Organization and leadership are the crucial factors to accelerate the steps of international expansion of Liaoning provincial equipment manufacturing industry. The CCP Provincial Party Committee of Liaoning province and Provincial Government should master closely the strategic opportunity of “The Belt and Road Initiative” to organize a leading group of development of internationalization. This group should cover the Provincial Development and Reform Commission, Department of Foreign Trade and Economic Co-operation, Economic and Information Commission, Reform Commission, Bureau of Public Finance, Financial Office, State Capital Committee, Bureau of Industry and Commerce, Custom and the Bureau of the Entry Inspection and Quarantine etc. This leading group should co-ordinate the organization to prepare the development planning of international expansion of high end equipment manufacturing industry of Liaoning province, make support policies, establish data base of key enterprises and projects of international production of Liaoning’s high end equipment manufacturing industry, clarify key points and key regions of international expansion of high end equipment manufacturing industry based upon overall deployment of international expansion of the central authority, Guiding directory of countries and industries for China’s FDI, industrial policy of overseas investment and developing reality of high end manufacturing industry of Liaoning province. This group should also do a good job in the assessment of environment of overseas investment, guide enterprises to avoid risks and coordinate the solution of relevant problems.

12. Building information resources

584. Liaoning province should keep close ties with state related ministries and commissions and Chinese embassies and consulates abroad to acquire relevant information of latest policies and projects of international development of the state on the one side, and also the related information of targeting country of investment to support the source of projects and political security in the implementation of the international expansion for provincial high end equipment manufacturing enterprise. Through the events of the visit of leaders to abroad, and opening of international economic and trade forum, extends continuously the network of governmental service, upgrades the governmental capacity of collection of information of laws, regulations and policies of targeting countries and regions of development of internationalization; on the other side, it is

necessary to integrate various resources of information, establish platform of public service of development of internationalization. Strengthen the studies of legal system, regulations and policies of targeting Countries in the processes of international expansion of Liaoning province. Develop forecasting of the market, to supply information of reliable and authoritative market demand, investment environment and laws and regulations for provincial enterprises carrying out development of internationalization. Enhance matching support service of asset evaluation, law, accounting and evaluation of investment risks; establish foreign intermediary system with features of marketization, socialization and internationalization. Guide the enterprises to utilize arbitration and other non-litigation means to deal with dispute over transnational investment.

13. Implementation of fiscal, taxing and financial support policy

- 585.** First, it is necessary to strengthen the supporting strength of public finance and taxation. Study to create special funds for international expansion of high end equipment manufacturing industry of Liaoning province, to give appropriate subsidies to those construct projects of public service guarantee system which are favorable to the promotion of international expansion of high end equipment manufacturing industry, to support important projects of high end equipment manufacturing industry of international expansion by means of interest and guarantee subsidies. The second, it is necessary to expend the financing channels. Establish investment fund of high end equipment manufacturing industry of Liaoning province. This fund will support overseas investment of Liaoning provincial dominant high end equipment manufacturing enterprises, by attracting shares of social capital and taking of equity investment, utilize the leverage of the fund to prize the private capital. The third, implement the financial support policies. Encourage the development of financial leasing and financial leasing companies, assist provincial high end manufacturing enterprises to expand the scale of policy based loans, promote syndicate loan, export credit and project financing. Apply for the national foreign and preferential loans and preferential export buyer's credit. In order to provide long-term low cost foreign exchange loan for implementation of high end equipment manufacturing enterprises of development of internationalization, financing service platform of Silk Road Fund, China Africa Fund, ASEAN Fund etc. should be well utilized. Lastly, there is need to strengthen the export credit guarantee service. Implement subsidiary policy of export credit guarantee and insurance premium for enterprise carrying out development of internationalization, and coordinate China's Export and Credit Insurance Corporations to prolong the period of underwriting, and expand coverage of insurance.

14. Cultivating talents for International expansion

586. Talents are important guarantee to carry out international expansion smoothly. Liaoning province should set up training classes for all kinds of personnel in a planned way. Proceed systematic training of insurance, credit and other knowledge relate to international expansion of high end equipment manufacturing industry. Create a team of transnational management interdisciplinary talents with the ability of development of international market, these talents should understand rules of international economic operation well, and they should also be familiar with local laws and regulations.

D. Sea-Rail Multimodal Transportation

587. Based on the study, the study team makes the following implementation recommendations for more effective long-term development of sea-rail multimodal transport in Liaoning province.

1. Develop both bulk cargo and container multimodal transport

588. According to the industrial structure and demand of import and export trade in Liaoning province, it is suggested to develop bulk cargo and container sea-rail multimodal transport together. Liaoning province is a traditional base for heavy industry and a main agricultural producer in China with a variety of grain, ore, coal, and oil products. In addition, located in the center of Northeast Asia economic region, the province has gradually become more engaged in economic and trade cooperation with Japan, Korean Peninsula, and the Russian Far East. The Northeast Asia economic region is an economically active region with huge potential, which is suitable to develop the bulk cargo and container sea-rail multimodal transport together.

589. Currently, Dalian port and Yingkou port are the two main ports in Liaoning province engaging in sea-rail multimodal transport. The early start in Dalian port has enabled Dalian port to have inherent advantages to develop container sea-rail multimodal transport and the port has experienced rapid development in the early development stage of sea-rail multimodal transport. Dalian port is the port with the largest proportion of sea-rail multimodal transport in China. However, from the long-term point of view, the economic development and industrial structure of the inland area in northeast China, especially Liaoning province as the core economic hinterland of Dalian port, will ultimately determine the momentum and prospect of the sustainable development of sea-rail multimodal transport in Liaoning province.

2. Determinants – the economic and product structures of Liaoning

590. The study team put together the annual gross domestic product of Liaoning province in the past eight years. It can be seen from Table 51: Annual GDP of Liaoning Province that from 2009 to 2014, the economy in Liaoning province saw rapid growth with a steady GDP growth. However, from 2014 to 2015, the economic development slowed down with only a RMB 4.3 billion increase in GDP. In 2016, Liaoning's GDP was RMB 2203.79 billion, ranked the 14th in the country but with a growth rate of -2.5%, making it the only province with a negative growth rate in China.

Table 51: Annual GDP of Liaoning Province

Economic sectors	Total GDP (RMB 100 million)							
	2009	2010	2011	2012	2013	2014	2015	2016
GDP	15212.5	18457.3	22226.7	24846.4	27213.2	28626.6	28669.0	22037.9
Primary industry	1414.9	1631.1	1915.6	2155.8	2216.2	2285.8	2384.0	2173.0
Secondary industry	7906.3	9976.8	12152.2	13230.5	13963.9	14384.6	13042.0	8504.8
Tertiary industry	5891.3	6849.4	8159.0	9460.1	11033.1	11956.2	13243.0	11360.0

591. The study team has summarized the output of major agricultural and industrial products in Liaoning province for the past eight years (see Table 52: Liaoning's Main Agricultural and Industrial Product Output). The team found that from 2009 to the present, the major agricultural products with the highest yield in Liaoning are all grains, with an output of 15 million tons, followed by fruits, aquatic products and meat products, each with an output of about 5 million tons. As a traditional industrial base, Liaoning Province has a large output of industrial products. Over the past eight years, the production of finished steel products was the highest, which topped at 63.376 million tons in 2015. Steel output was ranked in the second place, with an output of over 47 million tons for the past eight years, and reached 58.949 million tons in 2015. This is followed by the cement output, which was higher than 47 million tons for the past eight years, and even reached more than 60 million tons in 2013. The output of crude oil was ranked the fourth place with an output of 10

million tons for the past 8 years. It can be hence concluded that, as an important economic hinterland of Liaoning's sea-rail multimodal transportation network, Liaoning Province has a huge output of finished steel, steel, crude oil, grain, etc.

592. The study team also studied issues such as natural resources, industrial structure, and the reform of enterprise ownership in Liaoning province. Liaoning province has rich land resources, mineral resources, water resources, forest resources, and wildlife resources, which provides extraordinary foundation for the development of national economy. The province has a total land area of 145,900 km², of which 41,600 km² is arable land, 5,981 km² is fruit and vegetable gardens, 56,200 km² is forestland, 3,850 km² is grazing grassland, and 10,800 km² land used for cities, towns, villages, industries, and mines. With 5.674 million hectares of land designated to develop forestry, Liaoning province has extremely rich forest wildlife resources. Liaoning province is also rich in mineral resources. A wide range of minerals scatter across the province. However, mining features long history, large scale, high intensity, and high degree of depletion. Over 70 types of minerals have already been discovered in 692 sites with a potential value of RMB 1.6 trillion. The abundant land resources and mineral resources in Liaoning provide superior conditions for the development of primary and secondary industry.

593. After the founding of the People's Republic of China, an industrial system dominated by steel, machinery, oil, and chemical engineering was gradually formed in northeast China, creating a strong industrial foundation, especially in equipment manufacturing. Northeast China is major equipment manufacturing research and production base in China and plays an irreplaceable role in the manufacturing of heavy machinery and large complete sets of equipment, CNC machine tools, power generation and transmission equipment, automobile and parts, ship, and rail transport equipment. Currently, two equipment manufacturing industrial clusters in northeast China have been formed surrounding Liaoning coastal economic belt and Shenxi Industrial Corridor. With equipment manufacturing, metallurgy, petrochemical industry, and agricultural products as the four pillar industries, Liaoning province enjoys obvious competitive advantages in the export of labor and resource-intensive products such as fiber, chemicals, and household appliances.

594. Liaoning province is home to a significant portion of state-owned assets and large and medium-sized enterprises. In recent years, the state has made it a priority to push forward the restructuring and reform of state-owned enterprises in northeast China. Liaoning province has seen the following restructuring and reform: Anshan Iron and Steel Group and Benxi Iron and Steel Group were merged into Anben Iron and Steel Group, Dalian Shipbuilding Industry Co., Ltd. and Dalian New Shipbuilding Industry Co., Ltd. merged to become Dalian Shipbuilding Industry Co., Ltd., Shenyang Heavy Machinery Group Co., Ltd. restructured superior assets such as Shenyang Low-Voltage Switch Factory (Shenyang

Diyakaiguanchang) and Shenyang Mechanical and Electrical Research and Design Institute (Shenyang Jidianyanjiuyuan), Aluminum Corporation of China Limited acquired Fushun Aluminum Company Limited, China National Building Material Co., Ltd. restructured Shenyang Heavy Machinery Group Co., Ltd. and Shenyang Mining Machinery Group Co., Ltd. into Northern Heavy Industries Group Co., Ltd. China North Industries Group Corporation Limited (NORINCO Group) restructured North Huajin Chemical Industries Group Corporation, the old Shenyang Blower Works merged with Shenyang Pump Works and Shenyang Gas Compressor Co., Ltd. and formed the new Shenyang Blower Works Group Corporation. Through restructuring and reform, a large number of state-owned enterprises have been transformed from being big to being strong, which has advanced the economic development in Liaoning province.

Table 52: Liaoning's Main Agricultural and Industrial Product Output

Indicator	Unit	Total output						
		2009	2010	2011	2012	2013	2014	2015
Output of major agricultural products								
Grain	10,000 tons	1591.0	1765.4	2035.5	2070.5	2195.6	1753.9	2002.5
Fruits	10,000 tons	477.2	521.6	574.4	632.9	661.4	592.1	601.5
Meat	10,000 tons	389.2	406.7	408.2	418.7	420.3	429.2	429.4
Aquatic products	10,000 tons	534.7	429.1	453.9	480.8	504.9	515.7	523.7
Output of major industrial products								
Cloth	100 million meters	5.0	7.2	7.2	4.6	4.1	6.8	3.5
Machine-made paper and paperboard	10,000 tons	77.2	88.5	76.2	73.3	48.8	41.2	36.0
Household refrigerator	10,000 pieces	96.2	87.8	102.2	101.5	84.8	157.0	147.1
Color TV	10,000 pieces	441.4	576.9	557.5	500.4	440.6	338.2	287.9
Crude oil	10,000 tons	1000.0	950.0	1000.0	1000.0	1001.0	1021.9	1037.1
Steel	10,000 tons	4783.2	5202.7	5424.8	5178.4	6356.5	6507.8	5894.1
Finished steel products	10,000 tons	4943.4	5669.4	5761.1	5924.2	6863.0	6962.2	6337.6
Cement	10,000 tons	4704.8	4785.8	5791.1	5809.0	6066.3	5875.6	4751.6

Data source: Liaoning Provincial Yearbook 2016

The study team also did research on the countries and regions with which Liaoning Province Liaoning Province had import and export trade and the total volume (

- 595.** Table 53) in 2016. For the past three decades, Liaoning's foreign trade partner countries and regions have been relatively concentrated and stable. Taking 2016 as an example. In 2016, the foreign trade in Liaoning Province totaled 571.253 billion yuan, of which exports totaled 208.478 billion yuan and imports amounted to 2,871.75 billion yuan. The region's top five importers and exporters in 2016 were the European Union, Japan, ASEAN (10 countries), South Korea and the United States, each with an amount of 96,030.4 million yuan, 84,050.62 million yuan, 68,727.3 million yuan, 52,891.79 million yuan and 51,993.64 million yuan respectively. In terms of exports, the top five countries are ASEAN (10 countries), the EU, Japan, the United States and South Korea, each with an amount of 54.39651 billion yuan, 51.60089 billion yuan, 37.80171 billion yuan, 31.05014 billion yuan and 26.62087 billion yuan respectively. In terms of imports, the top five countries are the EU, Japan, South Korea, the United States, Australia and the Russian, each with an amount of 58.22833 billion yuan, 32.44973 billion yuan, 26.27092 billion yuan, 20.943.5 billion yuan, 198.1954 billion yuan and 16.65641 billion yuan respectively. Except for the case of Chinese Taipei, Liaoning Province's exports to other parts of the world dropped in 2016, with a total decrease of 9.625% in total exports, while the total imports increased by 2.3006%, among which Saudi Arabia, Australia, Russia and Japan were the major contributors to such growth.
- 596.** During the "12th Five-Year Plan" period (2011-2015), the trade-to-GDP ratio of Liaoning province was 17% lower than the national average; the export was characterized by small volume and irrational structure; the scale of equipment manufacturing "going global" was small, which means it did not drive enough export; foreign investment structure was yet to be optimized and the business environment was still undesirable. In 2015, the total import and export volume of Liaoning province was USD 96.08 billion, 1.2 times that in 2010. The total export volume in 2015 was USD 50.84 billion, 1.4 times that in 2010, and the total import volume was USD 45.24 billion in 2015, 1.2 times that in 2010. The export trade of Liaoning province in 2015 was ranked the 9th nationally; the provincial trade-to-ratio of 22%, ranked the 11th nationally. However, in 2016, Liaoning province saw a total volume of import and export of RMB 571.253 billion, 3.999% down from the same period of time in the previous year.
- 597.** It can be hence concluded that Liaoning Province's major trade partners are Japan, South Korea, the United States, the European Union, ASEAN (10 countries), etc.; Liaoning has registered a relatively balanced trade in imports and exports; and also, the imports and exports in Liaoning Province have not been growing all the time.
- 598.** The study team had also conducted a survey on the main imported and exported commodities of Liaoning Province (see Table 15 and Table 16). Since 2009,

Liaoning Province, the main imported goods are iron ore and concentrate, crude oil, coal and so on. Among them, the imports of iron ore and its concentrates were 30 million tons annually; imports of crude oil were 15 to 25 million tons annually; while the coal imports were on the rise, as the imports were 6.15 million tons in 2009 and 14.244 million tons in 2015. Other main imported goods include synthetic filament yarn woven fabrics, cotton fabrics, motors and generators. Liaoning's main exported commodities are industrial products, such as steel, refined oil, crude oil and so on. Among them, the export of steel products continued to rise from 2.915 million tons in 2009 to 13.201 million tons in 2015; the export of refined oil products remained stable at 5 million tons and reached 5.992 million tons in 2015; the export of crude oil was 289,000 tons in 2015, which remained still from 2010 to 2014 but increased dramatically in 2015, reaching 2,222,000 tons. Other major exports include bearings, aquatic and sea products, paraffin, talc, motors and generators, transformers, metal processing machines and so on.

As the revitalization of the old industrial base goes on in Liaoning, Liaoning's import and export trade will have the following trends in the future: first, the bulk goods import and export volume will continue to increase. In particular, as the new capacity in heavy industry such as Anshan Iron and Steel Group and Benxi Iron and Steel Group is gradually put into production, iron and steel enterprises in Liaoning province will see increasing import demand for high-quality ores with low impurities. From 2009, the import of iron ore and iron ore concentrates has been exceeding 25 million tons consecutively in Liaoning province. The import was 25.275 million tons in 2015. Though it was lower than the 31.368 million tons in 2014, the absolute number was still on the top in the list of imported goods in Liaoning province. In addition, Liaoning province imported 14.244 million million tons of coal in 2015 and the import of coal has seen a steady rise for many many years. Second, the import demand for bulk liquid such as crude oil will be on the rise. There is not much oil reserves in Liaoning province, which means that that the demand for oil import will surge as the economy develops. In 2015, the import volume of crude oil in Liaoning province was 25.243 million tons and the number has been increasing year by year (

599. Table 54). Third, the percentage of containerized import will continue to rise. The continuous upward trend in economic growth has led to continuous increase in goods import and export. The rapid growth of trade in finished goods and semi-finished goods (Table 55) has expanded the supply of goods suitable for container transport and led to continuous increase in the percentage of containerized goods in international trade. As the economy continues to develop in Liaoning province and the province sees closer trade with the global market, the trade of finished goods and semi-finished goods will play a more and more important part in the province's international trade. Therefore, the percentage of container goods in Liaoning's international trade will continue to increase.

Table 53: Liaoning Trade by Country and Region, 2016

	Total export and import		Export		Import		
	January 2016 – December 2016		January 2016 – December 2016		January 2016 – December 2016		
Country of destination	RMB (100 million)	Year-on-year comparison (%)	RMB (100 million)	Year-on-year comparison (%)	RMB (100 million)	Year-on-year comparison (%)	
Total	5,712.53	-3.999	2,840.78	-9.625	2,871.75	2.3006	
Asia	3,003.50		-6.4959	1,818.06	-7.1216	1,185.44	-5.5197
Hong Kong	102.4174		-20.2132	98.7578	-20.0944	3.6596	-23.2903
Japan	840.5062		6.9992	516.0089	-1.6758	324.4973	24.461
South Korea	528.9179		-2.2316	266.2087	-5.2884	262.7092	1.074
ASEAN (10 countries)	687.273		-12.8856	543.9651	-16.3615	143.3079	3.43
Taiwan	117.5878		89.9592	84.7241	161.534	32.8637	11.3775
Iran	79.518		-25.6497	25.4244	-14.9086	54.0936	-29.8138
Saudi Arabia	83.2793		14.0968	11.5039	-46.3027	71.7754	39.1901
Africa	173.5465		-18.7891	53.423	-43.2858	120.1235	0.5204
Europe	1,221.71		-0.1461	440.8759	-7.4135	780.8371	4.4846
Russia	215.0174		14.551	52.4534	-9.3808	162.5641	25.2214
European Union (28 countries)	960.3004		-3.5118	378.0171	-7.3221	582.2833	-0.8657
Latin America	427.9705		4.1472	131.6661	-7.3949	296.3044	10.2536
North America	603.0637		-5.5312	351.7584	-11.8326	251.3053	4.9698
Canada	81.7241		-2.9526	41.2503	-2.4138	40.4738	-3.4957
The US	519.9364		-6.0025	310.5014	-12.9494	209.435	6.6111
Oceania	282.3234		12.3097	44.9979	-39.4711	237.3256	34.0533
Australia	229.6328		13.566	31.4374	-45.9521	198.1954	37.601
New Zealand	34.5283		3.9987	5.9884	-18.4393	28.5399	10.3698

Data source: Statistical Data of Dalian Customs of the PRC

Table 54: Liaoning's Imports of Major Commodities

Product	Unit	2009	2010	2011	2012	2013	2014	2015
Soybean	ton	113.0	214.5	195.0	225.0	236.0	231.2	287.9
Edible vegetable oil	ton	1437.0	3487.5	1514.7	2858.0	3929.0	14052.5	14036.8
Sugar	ton	2250.7	28143.1	35910.7	115558.0	603324.0	593851.8	1006821.0
Natural rubber	ton	33988.0	402533	41909.0	34158.0	53731.0	61282.8	66582.1
Pulp	ton	23902.0	19226.7	3595.4	66929.0	101957.0	105933.5	88020.5
Cotton	ton	15424.0	24078.9	23700.6	29169.0	19624.0	14104.4	3711.7
Iron ores and concentrates	10,000 tons	2915.0	2920.7	3105.6	2592.0	2800.0	3136.8	2527.5
Coal	10,000 tons	610.5	643.7	794.4	952.0	1762.0	1393.4	1424.4
Crude oil	10,000 tons	1728.8	1552.1	1166.6	1348.0	1573.0	1855.2	2524.3
Oil products	10,000 tons	47.2	87.1	121.6	159.0	154.0	175.1	161.0
Paper and paperboard	ton	28784.0	34344.5	36916.5	30932.0	32019.0	27935.0	28971.4
Cotton woven fabric	10,000 meters	1075.8	1180.4	1147.7			1189.2	1129.2
Synthetic filaments woven fabric	10,000 meters	5934.4	6925.5	7895.4	5912.0	6246.0	4938.5	4334.9
Billet and locking	ton	227156.0	37134.1	16981.5	6401.0	9327.0	18399.3	1984.7
Rolled steel	ton	649117.0	756953.4	932075.6	728949.0	667890.0	822510.4	803242.2
Metal working machine	piece	14876.0	16677.0	3825.0	2579.0	1796.0	2541.0	2220.0
Motor and generator	10,000 pieces	5099.1	4778.9	4514.8	4733.0	3460.0	2675.3	2844.4
Printed circuit board	10,000 pieces	34084.8	60204.5	90389.5	65988.0	51329.0	43193.1	32456.3
Automobile and automobile chassis	piece	7734.0	10788.0	6847.0	19071.0	12059.0	14905.0	7243.0

Data source: Liaoning Provincial Yearbook 2016

Table 55: Export Quantity of Main Commodities in Liaoning Province

Product	Unit	2009	2010	2011	2012	2013	2014	2015
Frozen chicken	ton	17925.0	32393.8	30840.9	19416.0	31172.0	37250.5	42510.5
Aquatic products	ton	395516.0	441945.7	572674.5	627047.0	680007.0	734760.1	690619.7
Corn	10,000 tons	1.6	2.3	2.3	14.0	1.3	0.8	0.6
Apple	ton	59390.0	61846.9	60582.1	56032.0	62798.0	53704.5	48151.9
Soybean	ton	176835.0	82412.2	85979.0	171288.0	121952.0	116834.9	81972.7
Vegetable oil	ton	46443.0	25521.0	23742.6	34615.0	74529.0	57377.7	34753.4
Natural honey	ton	4323.0	5831.5	3571.8	4326.0	9304.0	10453.5	11799.0
Canned mushroom	ton	9956.0	17171.6	16376.3	15467.0	16239.0	16647.0	10528.7
Flue-cured tobacco	ton	3784.0	1818.1	2986.8	1678.0	2657.0	3079.6	1811.6
Soapstone	ton	144826.0	208655.3	246540.2	260084.0	268570.0	281720.8	291103.7
Crude oil	10,000 tons	28.9	7.6	8.9	11.0		24.0	222.2
Oil products	10,000 tons	534.6	487.1	426.3	315.0	475.6	534.9	599.2
Paraffin	ton	306405.0	284712.2	279939.0	293996.0	299684.0	323606.7	409261.9
Synthetic organic dyes	ton	9304.0	8853.2	6367.9	6408.0	4672.0	5290.0	4370.5
Paper and paperboard	ton	4249.0	5916.0	6963.8	15481.0	35670.0	20913.8	13676.4
Synthetic staple fibers and cotton blended woven fabric	10,000 meters	3066.2	4131.5	4359.5	3962.0	3605.0	4008.8	3513.9
Concrete	10,000 tons	4.4	11.8	14.5	14.0	10.0	20.6	30.0
Rolled steel	10,000 tons	291.5	567.1	593.0	739.0	818.0	1275.1	1320.1
Metal-working machine	piece	22267.0	29339.0	28206.0	28332.0	22827.0	25427.0	12720.0
Bearing	10,000 pieces	2713.0	4284.9	5092.4	5224.0	4634.0	5241.8	5834.8
Motors and generators	10,000 pieces	21684.8	32271.6	29258.2	26232.0	20515.0	19242.0	17265.6
Transformers	10,000 pieces	8215.2	11468.0	8802.8	5788.0	4844.0	6098.3	4903.7
TV	10,000 pieces	450.4	561.9	470.0	421.0	396.0	370.7	256.0
Automobile and automobile chassis	piece	13828.0	16523.0	19026.0	24924.0	24653.0	38512.0	23351.0
Ship	piece	8487.0	10194.0	11433.0	18846.0	20163.0	8969.0	85.0
Leather clothing	10,000 pieces	85.4	61.6	60.5	85.0	53.0	43.1	44.1
Shoes	10,000 pairs	2665.7	3503.9	3695.4	6559.0	11265.0	5835.2	2967.0

Data source: Liaoning Provincial Statistical Yearbook 2016

3. Determinants – development of speed and level

a) Macroeconomic development

600. In recent years, although Liaoning province has seen a high overall GDP, which is above the national average level, the growth rate has been slow. Liaoning province is rich in resources, which is an advantage to develop resource-intensive industries and serious path dependence is likely to occur in its industrial development. Given this, to revitalize northeast China, the transformation needs to accelerate from the dominance of heavy industry to light industry, do does the industrial structure transformation from traditional heavy industry to modern industry and agriculture. However, it should be noted that the state-owned economy has seen remarkable improvement and greater vitality after its restructuring and reform. From the longitudinal perspective of the overall economy, logistics and transport industry is more prosperous and developed; however, the proportion of Liaoning's overall economic output in the whole country is still not high, which means that the economic development in Liaoning province still lags behind developed regions in China. This, to some extent, has restricted the rapid development of logistics and transport industry in Liaoning province.

b) Analysis of the economic and industrial structure

601. The economic development in northeast China focused on agriculture and resource-based industry in the early stage. With the restructuring of national economy, in recent years, equipment manufacturing industry has already become a new economic industry in northeast China. Modern equipment is bulk goods and suitable for container transport and the logistics mode and channels of container sea-rail multimodal transport. The import and export trade in modern equipment has also increased its variety, which plays an irreplaceable role in the development of sea-rail multimodal transport in Liaoning province. Although the percentage of container goods in the import and export trade will continuously increase in Liaoning, the study team also has found that the goods suitable for bulk cargo sea-rail multimodal transport such as ore, crude oil, steel, and grain also accounts for a substantial percentage in Liaoning's import and export trade.

602. Although the overall economic and industrial structure in Liaoning province has somewhat been transformed, the overall economic structure is still dominated by state-owned economy and heavy industries. Due to unfavorable policy environment and the overall economic development in northeast China, private enterprises and light industries, which normally have relatively high flexibility and freedom in trade, have not seen desirable development, which in turn affects the

sustainable development of logistics and transport industry including sea-rail multimodal transport in Liaoning province.

4. Further Integration of Internet Plus

603. In order to develop sea-rail transport in Liaoning province, it is necessary to further integrate Internet Plus into the development of sea-rail multimodal transport in Liaoning province to break through information bottlenecks in port shipping and railway transport. The port shipping enterprises and railway departments in China have already kept up with the era of information. In terms of hardware and software technologies, there is no insurmountable barrier to achieve information connectivity between the shipping ports and railways in container sea-rail multimodal transport. However, the key is to make administrative breakthroughs to make the information open and enable data exchange. Recommendations to promote information connectivity are as follows:

604. First, allow international container sea-rail multimodal transport hubs to get and use the real-time data of TMIS (Transportation Management Information System). If this becomes a reality, it would greatly help advance arrangement of transloading and production and improve transloading efficiency.

605. Second, guide the adoption of cross-platform third-party value-added service for sea-rail multimodal transport and continuously improve the service. Compared to a designated information agency under a certain enterprise or department, a third-party legal entity has obvious advantages in terms of professionalism and information security to provide data integration and coordination services.

606. Third, further standardize the data from cross-platform transmission and operation of the sea-rail multimodal transport information. The first step to share information between the port and railway is to determine a “world language” – message standard. Data standardization is the basis for cross-platform information transmission and operation and the key to improve the operation efficiency of the information system. Therefore, it is imperative to complete related work to standardize the information as soon as possible. It is suggested that Liaoning province organize research institutes to cooperate with the port and railway to make message standards and actively apply to the state to make them national standards.

607. It's not enough only to set up the standard. A bridge is also needed for communication – a channel to exchange electronic data. From the perspectives of the Internet of things and information engineering, it is necessary to establish a unified and shared platform for multimodal transport, and the establishment of a joint inspection and coordination mechanism for port logistics can further improve

the efficiency of customs clearance. Related railway agencies should push forward the use of containers for goods suitable for container transport, build a self-circulation operation system of shipper's own containers based on market need, and push forward the integration of the standards to balanced weight distribution within the container to achieve seamless convergence of the standards in rail, water, road, and air transport. After several studies with evidence, the study team members think that a three-tier structure should be designed to take various aspects into consideration, namely, " Railway platform – Liaoning provincial sea-rail multimodal transport platform – Liaoning provincial port public information platform ."

608. However, message standards and data exchange are invisible to customers. In order to truly "implement" message standards and data exchange, it is necessary to develop an application system to solve practical problems. The application system allows customers to more intuitively and directly understand the information they need. For example, the sand table system of train dynamics can accurately track the flow of goods. Simply by entering the rail car number, freight invoice number, or the name of the cargo, a customer can do various delegations through the sand table, inquire into the dynamic status of the cargo, and complete real-world trade transactions in the small simulated world.

609. Fourth, actively promote the logistics support system that serves global trade, marketing network and cross-border e-commerce. To Support enhanced cooperation among advantageous logistics enterprises, and build the service network for international logistics to achieve full-load transport in the logistics network is of great importance. With safe and highly efficient railway transport and highly developed sea routes for foreign trade, an economic, stable, and highly efficient sea-rail multimodal transport channel can surely be built, the "One Belt, One Road" strategy will be further implemented, and diversified multimodal international logistics will be more developed.

5. Management Reform Proposals given Multiple Supporting Policies

610. Currently, Liaoning province is implementing multiple development policies at the same time, including the establishment of Liaoning FTZ, revitalization of the old industrial bases in northeast China, and so on. Also, Liaoning has already made the overall plan for the development of sea-rail multimodal transport. Spatially, it plans to develop toward the north by land to fully integrate with the China-Russia-Mongolia economic corridor and the south through sea to develop sea channels in the Asia Pacific region. The development strategy of "one core, two wings, three axes, and multiple nodes" is formed as the province optimizes its opening up and reform. Under this development pattern, the central and southern part of Liaoning province is the core for opening up; the Eurasian Land Bridge starting from the

coastal economic belt and maritime shipping channel starting from the coastal port cluster are the two development wings; the development of the central part, western part, and eastern part of Liaoning towards Russia, Mongolia, and Europe are the three axis; the multi-layer, multi-field, and multifunctional platforms for opening up to the outside world are the multiple nodes.

611. The following are specific measures are proposed:

- First, speed up the building of the three comprehensive transport channels. The trains operating on the shipping channels of “Liaoning-Manzhouli-Europe” , “Liaoning-Mongolia-Europe”, and “Liaoning-Bering Strait-Europe” will form a comprehensive transport network connecting Liaoning to its north and south and connecting China to other countries, achieve connectivity with Russia and Mongolia and build the railway transport and distribution network connecting Central Asia, the Far East, and Europe.
- Second, transform and upgrade the ports in Liaoning and spare no efforts to open new sea-rail shipping routes. Liaoning province should form a multi-layer port development pattern with Dalian port and Yingkou port as the major ports and Jinzhou port, Dandong port, Panjin port, and Huludao port as regionally important ports. Meanwhile, it is imperative for all ports to improve the infrastructure design and construction to improve transport efficiency in all aspects and transform the ports in Liaoning province from ports of destination to transit ports.
- Third, build an integrated multimodal transport system for seamless connection of sea-rail transport. Efforts should be made to build Dalian Northeast Asia International Shipping Center, sea-rail transport system in Yingkou port, and cross-border railway channel in Shenyang, develop important hubs for international major sea-rail multimodal transport channels, and actively push forward economic cooperation with Northeast Asia in all aspects.
- Fourth, support the establishment of a supervisory center for multimodal transport and build Shenyang-Yingkou land-sea multimodal transport system. Support should be provided to the pilot FTZ to carry out cooperation and exchanges on customs, inspection and quarantine, certification and accreditation, and standard measurement with countries along “One Belt, One Road” , and to explore cooperation with these countries on trade facilitation.

612. The existing “One Belt, One Road” initiative, and policies on the development of Liaoning FTZ and the rejuvenation of old industrial bases are related and overlapping with each other. To implement these policies, Liaoning province should tackle and manage the problem of lack of connectivity in the sea-rail transport

system. Sea-rail multimodal transport is a comprehensive systematic project. Besides the port and railway agencies, it also involves many other parties such as the customs, entry-exit inspection and quarantine bureau, freight forwarders and cargo owner companies. Therefore, it is imperative to have an authoritative agency to conduct the overall organization and coordination of sea-rail multimodal transport. The study team believes that seamless connection is required among a series of processes in sea-rail transport including packaging, loading, transport, marshalling, transloading, customs clearance, and distribution. For the long-term development of sea-rail multimodal transport, the Ministry of Transport and the Ministry of Railway should accelerate the reform of the sea-rail transport management system, set up an organization responsible for the overall planning and coordination among all involved parties.

613. To ensure fast, convenient, and safe transport, it is necessary to strengthen the overall planning and the development of policies and regulations of sea-rail multimodal transport, formulate and issue supporting policies as soon as possible, clearly define the respective rights and responsibilities of all involved parties. Unified coordination should be applied in solving the problems that occur in container multimodal transport. Sea-rail transport involves many parties such as the port, railway station, customs, the shipping company, etc. It is a very complex and systematic project. Liaoning province should break the segmented management system, improve freight rate system, and establish a comprehensive organization to conduct overall organization and coordination of port sea-rail transport. To be specific, the study team suggests to set up a joint meeting system led by port administration agency in Liaoning province and participated by Liaoning customs, Liaoning Entry-Exit Inspection and Quarantine Bureau, Liaoning Railway Administration, freight forwarding enterprises, cargo owner enterprises, and port enterprises to solve problems faced in the development of sea-rail multimodal transport in Liaoning and promote healthy and orderly development of the transport.

614. Efforts should be made to actively cultivate market players for sea-rail multimodal transport and use preferable policies to guide and attract a number of shipping companies, shipping agencies, freight forwarders, port and railway enterprises to participate in the transport, thus improving the market structure of sea-rail transport. Players such as the railway, port, freight forwarder, shipping agency, and so on should joint hands in the market to encourage and support shipping companies to carry out operations of sea-rail transport in inland areas and to bolster business integration of water shipping companies and railway shipping companies in container use management, empty container allocation, freight space, the SI cut-off date and so on.

6. *Expand Market Goods Supply and Step up Service Quality*

615. The operation of sea-rail multimodal transport is influenced by many factors. Goods supply is one of them, which is necessary for expand the development of sea-rail transport. In terms of the structure of goods supply, the main import and export goods in inland hinterland in northeast China are resource-based products, industrial equipment and finished goods, which are suitable for sea-rail multimodal transport. Therefore, on one hand, Liaoning province should coordinate with relevant government agencies on a strategic level to increase their support for the development of sea-rail transport. On the other hand, it needs to strive to explore sources of goods and improve the all-round services to tap potential customers to change their transport modes of import and export to make sea-rail multimodal transport bigger and stronger.

616. The following are specific suggestions:

- Liaoning sea-rail multimodal transport ports should set up a designated marketing department specializing in market development and marketing. Its function is to explore more customers through in-depth market development and greater marketing efforts and to change the often fixed transport and import and export modes of some goods sources.
- Efforts should be made to improve the marketing system connecting Liaoning sea port and land port to thoroughly implement the development strategy and marketing strategy made by the sea-rail transport ports related to sea-rail multimodal transport and vigorously develop the sea-rail transport market.
- As sea-rail multimodal transport ports vigorously develop the market, they also need to strengthen information exchange and business communication with relevant enterprises such as freight forwarding companies, shipping companies, shipping agency and so on and to develop and expand inland cargo supply market by using relevant information and supplementary marketing channels.
- Sea-rail multimodal transport port customer service center should provide high-quality services to customers and continuously improve its service quality and philosophy. Through studying business knowledge related to sea-rail transport, the center can expand its service scope, successfully handle bad impact of customer complaints, and sum up customer needs to improve sea-rail multimodal transport business.

7. *More Investment in Infrastructure*

617. Infrastructure construction is the precondition for the existence and development of sea-rail multimodal transport. The development experience in

major ports in Europe, the US and China shows that only by constructing and improving infrastructure can sea-rail transport operation maintain and further sustainable and rapid development.

618. First, step up the construction of port railway stations to advance the development of international multimodal transport. Building port railway station connecting the railway and the port can strengthen their horizontal cooperation and increase connection and coordination between the two types of transport to achieve mutual benefit and win-win result and advance the development of sea-rail multimodal transport. Step up the construction of port logistics and distribution system especially the marshalling yard so that the railway will get to the port area to achieve fast and convenient transport and distribution. Promote the “integration of the port and railway station”, and realize seamless connection between railway cargo station and port terminals.

619. Second, increase the investment in railway construction to expand the capacity of the sections with transport stress and increase the quantity of trunk lines to improve the comprehensive transport capacity of the railway network and create railway transport conditions. Speed up technological innovation, build vehicles specifically for containers and double-decker trains, remold existing containers, and unify the standards to balanced weight distribution within the container to meet the requirements of container transport specialization and standardization and achieve seamless convergence of the standards in rail, water, road, and air transport. Build container freight railway stations and build a number of them simultaneously. Run direct special trains between these stations to achieve overall network advantage and the economies of scale, thus promoting the development of sea-rail multimodal transport.

8. *Marketization of Domestic Sea-Rail Multimodal Transport System*

a) *Marketization*

620. A freight rate-based market mechanism is a key factor to guarantee the normal operation of sea-rail multimodal operation. Currently, all participants in the sea-rail transport market are actively carrying out their business, which is a great basis for further development of sea-rail transport. However, it cannot be ignored that there are interest conflicts among the market participants. Now the development of sea-rail transport market is still at the cultivation stage. Local governments should strengthen cooperation with railway departments to explore how to build a flexible freight-rate pricing mechanism that adapts to the market to reflect the market need and increase market competitiveness.

621. A flexible freight rate pricing system is an important means with which countries all over the world compete for goods supply. It can help attract more customers to

use sea-rail multimodal transport for freight transportation, which in turn will promote the development of sea-rail transport. For example, the US and Japan have adopted a flexible pricing strategy, which has greatly developed their railway freight transport. A flexible pricing system should be allowed for railway transport in sea-rail multimodal transport. Relevant mathematical models can be built based on different products, transport amount, and distance according to the principle that price should reflect the supply-demand relationship to calculate and make customized freight rate. In this way, freight rate can play its role in allocating transport capacity. At the beginning of the marketization process, the railway freight rate can be allowed to go up and down within a certain range to eventually realize full marketization of sea-rail multimodal freight rate in Liaoning province.

b) Promote “two points with one line” transport mode

622. Open and efficient sea-rail multimodal transport mode is not only an important carrier for forming the cooperative and win-win market pattern, but also one of the effective ways to improve coordination and consistency of the sea-rail transport system. The mode of “two points with one line” includes the following three aspects: first, build dry port station into public platform to become part of the public service platform for the sea-rail multimodal transport, achieving information connectivity and sharing between railway TMIS and DMIS (Dispatch Management Information System) and port EDI and gathering freight forwarder, cargo owners, and goods sources of shipping companies through information connectivity; second, improve the system consistency of business entities in sea-rail multimodal transport to enhance cooperation among the port, railway bureau, shipping companies, and freight forwarder; third, build an environment for efficient customs clearance procedure to gradually build the mode of direct clearance.

9. *Encourage and Guide the Participation of More Private Capital*

623. In China, private capital has huge investment potential, which will be one of the main financing channels for the development of sea-rail multimodal transport in Liaoning province. In order to activate the idle private capital and motivate its investment, Liaoning provincial government should improve corresponding policies, rules, and regulations as soon as possible to create a favorable investment environment for private capital and protect investors' interests.

a) Improve investment environment

624. First, strengthen institutional improvement to make relevant policies and regulations better. Transport agencies should enhance institutional improvement with other government agencies on various aspects such as policy support, supervisory system, financing system, franchising, etc. to guarantee the operability and effectiveness of all kinds of capital operation. Second, optimize administrative

review and approval for private capital investment. The competent authorities of transport should coordinate with other departments to deepen the reform of administrative review and approval system to facilitate investment and entrepreneurship, streamline administrative review and approval matters involved private capital, simplify the procedure within the scope permitted by policy, and improve administrative efficiency. Third, provide a favorable investment environment for private capital. For projects that require a large amount of investment, long construction period, and high entry threshold and are difficult for private capital to enter, the government should provide corresponding support in all aspects to build a supportive investment environment. For projects with relatively good returns, preference should be given to attract private capital. Support should be provided to actively help investors coordinate various matters to reduce investors' concerns. Fourth, enhance government's quality supervision. Besides giving full autonomy and decision-making rights to investors from various aspects including financing policies and environment, the government should step up its effort in project implementation and management, provide experienced and able professional technical specialists for free to manage the whole process of the project, coordinate the relationship with other relevant departments, and supervise the quality and progress of the project. In this way, when the government successfully attracts private capital to a project, it not only enables private enterprises to benefit, but also guarantees to deliver high quality project to the society to benefit the country and society.

b) Improve service system

625. First, strengthen the planning and guidance for private capital. When making medium and long-term development plan and annual plan, relevant departments should give full consideration to projects that can use private capital. Second, build an industrial information platform. Put more efforts to build carriers and platforms to promote the development of private investment to regularly publish information on development plan, industrial policy, industry trends, scientific technology, project cooperation, and business and investment attraction to guide private investment. Third, build the system of communication and coordination. In the process of planning, investment introduction, and operation and be fully open to the opinions and suggestions of private investors, provide high-quality consulting services, and establish a sound system of communication and coordination. Fourth, reinforce the guidance of industrial associations. Actively improve the development of industrial associations such as road association, road transport association, navigation association, ship owner's association, port association, and so on, and make the private enterprises that participate in the development of these associations' members to give full play to the guiding and monitoring role of the associations.

c) *Implement supporting policies*

626. First, set up the system of fiscal subsidy of interest. There are mainly three channels to implement fiscal subsidy of interest: special fiscal subsidy of interest to give priority to the development of emerging industry and advantageous industries; public welfare projects and projects financed with special bonds such as ordinary roads, trunk waterways, and so on; entrusted loans for infrastructure. Second, improve land use policy. Attract private capital by giving land subsidy, e.g. allowing commercial development of land resources of transport hubs, selling the land to build transport industry parks at a low price, etc. Third, establish tax subsidy. Tax subsidy measures mainly include tax deductions, tax credit, tax incentives, and tax refund. For example, favorable tax rate is granted to eligible enterprises that invest in emerging transport industries. Fourth, establish and improve private capital entry and exit system. On one hand, the government should take more efforts to encourage and support private capital to enter the transport industry; on the other hand, it should make concrete and feasible exit system for private capital such as loan recovery and stock repurchase, especially for private investment in the construction of transport infrastructure.

E. Port Management

1. *Integrate with Belt and Road and Promote RCI*

627. The national "One Belt One Road" initiative (OBOR) emphasizes "interconnection and interworking". It connects the whole system just like the meridians and blood vessels connect all organs in our body. Integration into the OBOR initiative enables port logistics companies to give full play to the "interconnection and interworking" advantage of infrastructure facilities and to ensure the smooth progress of transportation, warehousing and distribution of industrial products, raw materials, and products from processing trade and other fields, which will help to ease the pressure resulting from overcapacity. Economic development is closely related to the interaction between various industries, and it becomes empty talk without industrial support. Similarly, any industry will be like water without a source and a tree without roots if there are no such factors as policies, environment (natural environment, social environment, etc.), and human resources in the economic development system to jointly facilitate industrial upgrading and development. To actively participate into the national initiative, Liaoning Province should focus on integration and connection between industries. The port logistics industry along coastal areas in Liaoning have natural resources and geographical advantages, and should play a supporting role in implementing the strategy of "Maritime Silk Road in the 21st Century" during the "13th Five-Year Plan" period. Qualified ports and logistics companies should conduct extensive international cooperation, to strengthen infrastructure construction, and to adapt to the pace of constructing terminals for coal, oil products and chemicals, with a focus on building terminals for public use and strengthening the construction of public fairway, breakwater and pavement. They should also develop rail-water combined transport and water to water transit and constantly enhance the leading role of ports in driving regional economic growth.

628. The OBOR initiative brings both new opportunities and intensified competition to ports in Liaoning:

629. Firstly, active application of PPP as an investment and financing mode. PPP (public-private-partnerships) is a cooperative arrangement between government, profit-making enterprises and non-profit enterprises based on a certain project. Through this form of cooperation, win-win results can be achieved. In recent years, under the guidance of the OBOR initiative, the ports in Liaoning have achieved

rapid development and have also made great efforts in ports construction. To speed up China's ports construction and development and to broaden the investment and financing channels, it is particularly important to diversify the investment and financing modes. PPP is suitable and feasible as an innovative investment and financing mode for ports construction projects.

630. Secondly, promotion of interactive business between port industrial clusters. According to the International Bureau of Information, there is a large port in China about every 500 km, which also applies in Liaoning province. There are currently two large ports with similar capacity in the port groups in Liaoning—Dalian Port and Yingkou Port. Problems such as price wars and redundant construction of infrastructure will occur without coordination and proper division of labor between those ports. In this round of NEA Revitalization, the port logistics industry must seize the opportunity, burn the bridges and take the initiative to integrate into the OBOR initiative. The industrial transformation and upgrading must be integrated with the coordinated development of regional economy to revitalize Liaoning and break the bottleneck of development.

2. Innovate to Improve Operating Efficiency of Ports in Liaoning

631. Shifting from "management-oriented" to "service-oriented" method, priority should be given to efficiency and service innovation to promote economic transformation and upgrading in the port areas and serve the new economy.

632. Institutional innovation. First, it is proposed to establish the Liaoning Port Development Authority to comprehensively push forward the development of ports business in Liaoning. Priority must be given to consolidate administrative resources in the port areas. Second, it is suggested to establish Liaoning Ports Group to build a network of port service platform. Internal coordination mechanism must be established to unify the service standards, service charges, as well as supervision actions. The third is to establish integrated development mechanism between Liaoning Port Group and industrial zones surrounding the ports and build Liaoning Port-Surrounding Industrial Investment Group. It is also advised to establish a linkage mechanism between provinces and cities by consolidating such factors as capital and land. The relations between ports and cities must be properly handled and terminals for public use must be constructed. In addition, Liaoning province need to further develop the expressway and special harbor-highway to provide access to ports area and make efforts to alleviate the disturb caused by cargo

loading and unloading to the cities. It is also important to speed up the construction of major port-bound railways, in particular the special railway in the downstream of Mengdong Coal, major port-bound railways in new port area and proper expansion of existing port railway marshalling stations.

633. Model innovation. The first is to vigorously promote the construction of an international shipping center based on the development and fixation of block train and linear shipping routes. The second is to build a network of port and shipping service platform. The third is to push forward technological application of Internet of things to achieve innovation in integrated online and offline service. Coastal ports are the nodes of comprehensive transportation network and also important hubs for international and domestic exchanges. As the transit point of sea and land transport and a key node of modern logistics, the port links the surrounding integrated transportation system as a platform and gives full play to various modes of transportation. To fully improve the competitive edge of the ports areas, effective linkages must be established between various modes of transport such as roads, railways, aviation and pipelines. It is suggested to establish a scientific and rational comprehensive transportation planning and management system to ensure that all modes of transportation carry out their own planning in an integrated and coordinated way; besides, scale effect is encouraged to improve operating efficiency.

634. Service innovation. First, innovation is encouraged in the whole chain of port logistics services. Second, it is advised to develop an integrated port logistics service and management platform. Third, new technologies should be applied to enhance the efficiency of port logistics services. A set of unified transport service standards should also be formulated. The division between various industries results in different standards. Therefore industry associations must be involved to help achieve seamless transit in the cargo shipping process by creating favorable conditions for the coordinated development of various modes of transport such as forming a unified transportation management system, and balancing the interests of all parties including railway companies, cargo owners, port companies and shipping companies, etc. In short, we must carry out reforms of the current port management system and unified planning of port groups. In exploring the new model of port development and management, we should fully learn from the experience and lessons of old port areas, set up the main function of ports according to their own advantages, and encourage all ports to reallocate resources so as to achieve positive interaction and optimize the division of labor between

ports. On the one hand, municipal governments should establish an institutional partnership with port groups to avoid excessive government interference. On the other hand, local governments need to make investment to support port development, but such support must be based on measurable performance indicators of ports development with specified criteria for failure and termination clause.

635. With the acceleration of economic globalization, the port development has demonstrated a trend of "information-based management, deep construction, more logistics businesses, port privatization and diversification of business operations". Privatization of ports has a crucial impact on its future development. Port enterprises should strengthen the control and decision-making power of private capital in port operations in Liaoning province through such forms as leasing, contracting and joint ventures. It will make the port industry more market-oriented and expand its business scope. Meanwhile, we should optimize the capital structure of port enterprises by improving the investment mechanism and mixed financing so as to reduce investment risks. Diversified operation is an important measure to improve the performance and handling capacity of port enterprises. Enterprises need to build large-scale and specialized logistics center, port logistics infrastructure to attract more ships. On condition of a thorough understanding of its own business and capacity, those enterprises may also consider acquiring promising new business from outside to expand its existing business scope, enhance operational efficiency and achieve better development.

3. Optimize port resource allocation for scale and technical efficiency

636. Liaoning should set up a leading group at provincial-level for port resources consolidation, headed by provincial government leaders and consisting of government leaders of port cities and division heads from related provincial authorities including the Department of Transportation, SASAC, Department of Marine and Fishery, Department of Finance, and the Financial Service Office. From the strategic and planning level, the main functions, development direction and key construction projects of all ports in the province should be clearly defined and relevant policies should be formulated so as to provide general ideas and frameworks for the consolidation of port resources and mergers and acquisitions.

637. In recent years, China attaches great importance to consolidating superior industrial resources in its top-level design. On the one hand, it aims to give full play

to resources and technological advantages by "joining forces" and make the industry bigger and stronger and adapt to the trend of globalization. On the other hand, supply side reforms are carried out to reduce the heavy burden caused by overcapacity and to gradually eliminate backward production capacities. In fact, as early as in 2014, the Ministry of Transport issued the *Guiding Opinions on Promoting the Transformation and Upgrading of Ports*. The intent is to give play to the market economic mechanism, encourage the port logistics enterprises to consolidate resources via multiple channels and across broad fields, and develop industrial clusters with economies of scale as well as regional industry leaders. Ports in coastal cities in Liaoning Province exhibit uneven development level of the logistics industry as well as supporting services and infrastructure facilities. Disordered competition and homogeneous construction of berths within the port groups are all serious problems. The ports clusters in Liaoning are still at a disadvantage against other top port groups in China in terms of infrastructure construction and handling capacity. Therefore, all ports should be properly positioned and, priority should be given to improve the competitiveness of the smaller port groups without undermining the overall development. For example, the development of Jinzhou Port helps drive the development of Huludao Port into a special export port of mineral resources. Yingkou Port and Panjin Port can co-develop the new port area in Panjin in the form of joint venture. Meanwhile, Dalian Port may inject capital into Dandong Port to help it grow stronger. When the scale effect of major port groups have been achieved to some extent, focus should be given to developing Dalian into the "International Shipping Center in Northeast Asia". The momentum of joint development of ports in Liaoning should be maintained to reduce disordered competition and internal friction, and to compete with other regions as a team. In addition, cooperation mechanism must be formed between the port groups in the east of Liaoning and the port groups in the west of Liaoning. All ports need to further cooperate in the capital market, port logistics development and construction and eventually form the most competitive port group in Liaoning. It is suggested to stick to the development pattern with Dalian and Yingkou port as the cores, Dandong Port and Jinzhou Port as the inland supporting ports, and Panjin Port, Huludao Port and Suizhong Port as sub line supporting ports.

- 638.** Optimizing the allocation of port resources and speeding up the consolidation of high-quality port resources in Dalian Port, Yingkou Port and Jinzhou Port will help join the advantageous resources of many enterprises and enhance their core competitiveness so as to give full play to their advantages and complement each

other in such fields as natural resources, financial capital, technological innovation and scientific management, forming a concerted effort to accelerate the regional integration of port logistics resources.

4. Learning from international best practices in port service efficiency

639. In recent years, the international growth rate has slowed down. However, many foreign ports are still able to operate in an orderly manner with high economic benefits. This is closely linked to their stable operation modes and high-quality services. We study the experience of well-known foreign ports such as New York Harbour, the Port of Rotterdam, the Port of Hamburg and the Port of Singapore Port and come to the following conclusions: first of all, all these well-known ports are committed to infrastructure construction, which is the guarantee for port logistics. It is also an important sign of professionalization; second, the coordinated development of supporting industries facilitates the industrial restructuring and upgrading of the port logistics industry; thirdly, the city where the port is located does not develop the logistics industry alone. Instead, it forms an interactive and interdependent relationship with the port. As a result, it not only becomes the port center, but also the regional political, economic and cultural center. New York Harbor and the port of Singapore are both typical representatives of regional coordinated development. In addition, we should pay attention to the construction of the information service system, which has become a trend of modern logistics industry. Based on the experience above, Liaoning Province should improve its port infrastructure, focus on the coordinated development of port logistics and other industries, and form an interactive relationship between the city and the port. It should also pay attention to the construction of the information service system in order to realize industrial transformation and upgrading, as well as rapid economic development in Liaoning. Against the backdrop of increasing economic downward pressure in Northeast China, industrial transformation and upgrading has become increasingly pressing in the development of Liaoning. As for professional shipping services, we must introduce more ship management companies and shipping agencies such as ship-owner agents, protection proxies, and charterers' agents. Regarding shipping-related financial services, we need to accelerate the concentration of the relevant institutions, with priority given to introduce financial institutions such as shipping insurance providers. The public financial service platform for the shipping industry should be developed to provide financing,

clearing, leasing, insurance and other innovative financial services to relevant shipping companies.

5. Accelerate industrial and IT upgrading of port enterprises

640. IT Application is the main trend of modern port development. Port enterprises in Liaoning Province should get rid of the extensive development mode of relying solely on handling capacity and snatching cargo supply to hinterland as soon as possible. Instead, it needs to cultivate new economic growth points in an all-round way, and greatly enhance the port financial and information service level. It is also necessary to gradually develop modern shipping services in various fields including ship freight forwarding, crew services, ship management, shipping consulting and education, maritime insurance and arbitration, and build a whole industrial chain in the port area. At the same time, it is necessary to develop the port economy based on the sea and promote various forms of cooperation between the port enterprises and the petrochemical, metallurgical, power and shipping enterprises, so as to extend the port service industrial chain and achieve win-win result in both port and industrial growth. Relevant departments of Liaoning Provincial Government may encourage port enterprises in their region to participate in the construction of a comprehensive information network and improve the level of information exchange and sharing among all ports. In promoting the construction of the information network, we must not only form a systematic and standard structure, but also enforce unified standards in the process of information tracking, exchange and processing. The Liaoning Provincial Government needs to integrate the information of all government departments, logistics enterprises, shipping companies, financial institutions and legal service agencies into one information platform and integrate the standard database into the port information. Meanwhile, standardized and modular software products must be developed to ensure timely and effective information sharing and communication within the whole industry. In addition, the port groups should adopt an innovation-driven attitude, and follow closely the progress of latest information technology. They should also pay attention to applying new information technology to ensure the technological leadership of information projects. In the process of IT Application, technical breakthroughs must be made in key steps including network transmission, data mining, and intelligent processing. Application and innovation of Internet of Things, mass storage and cloud computing must be strengthened to comprehensively improve the level of IT Application in the port areas.

V. References

- ADB (2012), Public Private Partnership Operation Plan 2012-2020, Asian Development Bank, Manila 2012;
- ADB (2017-a), Meeting Asia Infrastructure Needs, Asian Development Bank, Manila, 2017;
- ADB (2017-b), Case Studies in Private Sector Participation: Franchise Shipping, ADB Paper & briefs February 2017, <https://www.adb.org/publications/private-sector-participation-franchise-shipping>;
- Ahmad Ethishan & others (2014), Involving the Private Sector and PPPs in Financing Public Investments: Some opportunities and challenges, LSE, Asia Research Centre Working Paper 67;
- Alfan Ervina (2010), The Malaysian Public-Private Partnership (PPP): Financing the Tolled Highway Projects, Asian Journal of Business and Accounting, 3(2), 2010
- Alfen Hans Wilhem (2009), PPP Infrastructure Development: Case Studies from Asia and Europe, Bauhaus-Universitat Weimar 2009;
- Ali A I, Seiford L M(1990), Translation invariance in data envelopment analysis [J], Operations Research Letters, 1990,9:403- 405.
- Amaratunga Sudath (2017), Innovative funding and financing for transport Infrastructure, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore
- Amiti, Mary, Beata Smarzynska Javorcik. 2008. Trade costs and location of foreign firms in China, Journal of Development Economics, Volume 85, Issues 1-2, February, Pages 129-149. Amiti, Mary 和 Beata Smarzynska Javorcik, 2008, 中国外国企业的贸易成本和位置, 发展经济学杂志, 第 85 卷, 第 1-2 篇, 2 月, 129-149。
- and Mainland China, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Andersen, B, Fagerhaug, T. Performance (2003), Measurement of Logistics Processes [J]. Journal of operations management. 2003(20):19-32
- Anderson, J.E., and D. Marcouiller. 2002. Insecurity and the pattern of trade: An empirical investigation. Review of Economics and Statistics 84, no. 2: 342-52.

- Anderson J.E. and D. Marcouiller, 2002, 不安全感 and 贸易模式: 实证调查, 经济学和统计学评论 84, 第 2 篇: 342-52。
- Apanaviciene Rasa (2010), Analysis of evaluation methodologies for public-private-partnership (PPP) projects in infrastructure construction, Faculty of Engineering Vilnius Gediminas, Technical University, Lithuania;
- Baccetta, M. et al. (2009). "Exposure to External Shocks and the Geographical Diversification of Exports." In R. Newfarmer, W. Shaw, and P. Walkenhorst (eds.). Breaking into New Markets – Emerging Lessons for Export Diversification. World Bank. Baccetta M.等人 (2009), “遭受外部冲击和出口的地理多样化”, R. Newfarmer, W. Shaw 和 P. Walkenhorst (主编), 打入新兴市场——出口多元化带来的新教训, 世界银行。
- BAI Xuemei. The Great Tumen Initiative from Theory to Reality. Window of Northeast. 2015:56-56. 白雪梅, 大图们从理论到现实, 东北之窗, 2015: 56-56。
- Baldwin R (2007) The spoke trap: Hub-and-spoke bilateralism in East Asia. In: Eichengreen B, Park YC, Wyplosz C (eds) China, Asia, and the New World Economy, Oxford University Press Baldwin R (2007), 轮辐陷阱枢纽双边主义在东亚, Eichengreen B, Park YC, Wyplosz C (主编), 中国、亚洲和世界经济, 牛津大学出版社。
- Baldwin R, Lopez-Gonzalez J (2013) Supply-chain trade: A portrait of global patterns and several testable hypotheses. NBER Working Paper 18957 Baldwin R 和 Lopez-Gonzalez J (2013), 供应链贸易: 描绘全球模式和若干可检验假说, 美国国家经济研究局 (NBER) 工作文件第 18957 号。
- Bellak, C., et al. “Policies to Attract Foreign Direct Investment: An Industry-Level Analysis.” Organization for Economic Cooperation and Development, www.oecd.org/investment/globalforum/40301081.pdf. Bellak C. 等人, “吸引外商直接投资的政策: 产业层面的分析”, 经济合作与发展组织, www.oecd.org/investment/globalforum/40301081.pdf。
- Bernard, Andrew B. and J. Bradford Jensen, 2004. "[Why Some Firms Export](#)," [The Review of Economics and Statistics](#), MIT Press, vol. 86(2), pages 561-569, May Bernard, Andrew B. and J. Bradford Jensen, 2004, “为什么一些企业选择出口,” 经济学和统计回顾, 麻省理工学院出版社, 第 86 卷 (2), 561-569, 5 月。
- Brooks, Douglas, David Roland-Holst, and Fan Zhai. 2008. "[Behavioral and Empirical Perspectives on FDI: International Capital Allocation across Asia](#)," [Journal of](#)

- [the Asian Economies](#), 19 (2008), 40-52. Brooks, Douglas, David Roland-Holst 和范翟, “关于外国直接投资的行为和实证研究: 亚洲国际资本分配”, 亚洲经济杂志, 第 19 期 (2008), 40-52。
- Carlos Pestana Barros (2005), Decomposing growth Portuguese seaports frontier cost approach.maritime[J], *Economics & Logistics*,2005,07:297-315.
- Carrieri, F., Errunza, V. & Hogan, K. 2007. Characterizing World Market Integration through Time, *Journal of Financial and Quantitative Analysis*, 42, 915-940. CarrieriF., Errunza V.和 HoganK. 2007, “通过时间说明世界市场一体化特色”, “金融与数量分析期刊”, 第 42 期, 915-940。
- Charnes A,Cooper W W,Rhodes E(1978), Measuring the efficiency of efficiency of decision making units[J].*European Journal of Operational Research*,1978,2:429-444.
- CHEN Kun, ZHANG Zhengze. Rejuvenate Old Industrial Bases in the Northeast: Striving for the Development of Regional Economy [J]. *Academic Communication*,2004, (8):91-94.陈坤, 张正则, 振兴东北老工业基地:着力发展区域经济[J], 学术交流, 2004, (8): 91-94。
- Chen, Celia. “Ports in China's Liaoning province rally on integration plan.” *South China Morning Post*, 14 June 2017, www.scmp.com/business/china-business/article/2098280/port-operators-chinas-liaoning-province-see-shares-rally Celia Chen, “中国辽宁省港口为一体化计划集结”, 南华早报, 2017 年 6 月 14 日, www.scmp.com/business/china-business/article/2098280/port-operators-chinas-liaoning-province-see-shares-rally
- Chen, F. (2017). Vigorously solve institutional and mechanism issue in economic development transformation in northeast China. *Economic Review*, (12), 99-100.
- Chen, H. (2011). The influence mechanism of the Internet on supply chain management, *China Business & Trade*, (18), 45-46.
- Cheung, Y.-W., Chinn, M.D. & Fujii, E., 2005. Dimensions of Financial Integration in Greater China: Money Markets, Banks, and Policy Effects, *International Journal of Finance and Economics*, 10, 117-32. Cheung Y.-W., Chinn M.D.和 Fujii E., 2005, “大中华区金融一体化的维度: 货币市场、银行和政策效应”, 国际金融和经济期刊, 10, 117-32。
- China News, “The provincial government promotes counterpart cooperation between Shanghai and Dalian and conducts a research.” Dalian City Government,

16 May 2017, en.dl.gov.cn/News/ChinaNews/19361.jhtml. 中国新闻：“省政府推动上海与大连之间的对口合作并进行调研。”大连市政府，2017年5月16日，en.dl.gov.cn/News/ChinaNews/19361.jhtml

Coelli,T(1996), .A Guide to DEAP Version 2.1 :A Data Envelopment Analysis(Computer) Program[J].CEPA Working Paper,1996.139-151

CPPPC (2017), China Public Private Partnership Center, Quarterly Report, Beijing 2017;

CUI Jun. Accelerate the Project Docking Between International Cooperative Development Project of Tumen River Region and Strategy of GTI Member Countries [J]. Journal of Jilin Economic Management Cadre Institute,2016, (4):5-6. 崔军，加快图们江区域国际合作开发项目与GTI成员国实施战略对接[J]，吉林经济管理干部学院学报，2016，（4）：5-6。

Cui, H. (2017). Strategic options for rejuvenating old industrial bases in northeast China. *International Business and Economics*, (11), 89.

Dai, Tian. “China moves to boost foreign investment in manufacturing.” China Daily, 15 February 2015, www.chinadaily.com.cn/business/2017-02/15/content_28211947.htm. 戴天，“中国将推动对制造业的外资投入。”中国日报，2015年2月15日，www.chinadaily.com.cn/business/2017-02/15/content_28211947.htm

Dai, Y., Bao, L. & Sun, T. (2017). SWOT analysis of international multimodal transport under “One Belt, One Road” initiative. *Railway Transport and Economy*, (1), 59-61.

Daudin G, Riart C, Schweisguth D (2011) Who produces for whom in the world economy? *Canadian Journal of Economics* 44(4):1403-1437 Daudin G, Riart C 和 Schweisguth D (2011)，在世界经济中谁为谁生产？加拿大经济学杂志 44 (4) : 1403-1437

De Benedictis L, Tajoli L (2011) The world trade network. *World Economy* 34(8):1417-1454 De Benedictis L 和 Tajoli L (2011)，世界贸易网，世界经济 34 (8) : 1417-1454

Dedrick J, Kraemer K, Linden G (2010) Who profits from innovation in global value chains? A study of the iPod and notebook PCs. *Industrial and Corporate Change* 19(1):81-116 Dedrick J, Kraemer K 和 Linden G (2010)，谁是全球价值链创新的受益者？针对 iPod 和笔记本电脑的研究，工业与企业变革，9 (1) : 81-116。

- Della Croce, R., Yermo, J., (2013), Institutional investors and infrastructure financing, OECD Working Papers on Finance, Insurance and Private Pensions, No.36, OECD Publishing.
- Diao Xiuhua and Zhang Tingting. SWOT analysis and Strategic Positioning for Liaoning's Participation in Northeast Asia Regional Cooperation. *Journal of Dongbei University of Finance and Economics*. 2011,(3):36-43.刁秀华, 张婷婷, 辽宁参与东北亚区域合作的 SWOT 分析及战略定位[J], 东北财经大学学报, 2011, (3) : 36-43.
- Diao Xiuhua and Zhang Tingting. The Current Status and Future Prospect of Trade and Investment Cooperation Between Liaoning and Northeast Asia. *Siberian Studies*. 2011,(1):15-18.刁秀华, 张婷婷, 辽宁省与东北亚各国贸易、投资合作现状及前景[J], 西伯利亚研究, 2011, (1) : 15-18.
- Dong, Jing, and Tongjian Dong. "Liaoning Government Seeks Bailout for Troubled Dandong Port." *Caixin*, 3 Nov. 2017, www.caixinglobal.com/2017-11-03/101165553.html. 董菁, 董同建, “辽宁政府寻求困境中的丹东港的救助方案”, 财新, 2017 年 11 月 3 日, www.caixinglobal.com/2017-11-03/101165553.html.
- Dong, Jing, and Tongjian Dong. "Liaoning Government Seeks Bailout for Troubled Dandong Port." *Caixin*, 3 Nov. 2017, www.caixinglobal.com/2017-11-03/101165553.html. 董菁, 董同建, “辽宁政府寻求困境中的丹东港的救助方案”, 财新, 2017 年 11 月 3 日, www.caixinglobal.com/2017-11-03/101165553.html.
- EIU (2014), *Infrascope PPP Index, Evaluating the environment for PPP in Asia Pacific*, EIU 2014;
- Estache A, Gonzalez M, Trujillo L (2002), Efficiency Gains from port reform and the potential for yardstick competition: lessons from Mexico[J], *World Development*, 2002, 30 (4): 545-560.
- Fan, L, Wilson, W. W & Tolliver, D. (2010). Optimal network flows for containerized imports to the United States. *Transportation Research Part E: Logistics & Transportation Review*, 46(5), 735-749.
- Fan, L, Wilson, W.W. & Tolliver, D. (2010). Optimal network flows for containerized imports to the United States. *Transportation Research Part E Logistics and Transportation Review*, 46(5), 735-749.

- Fan, Peilei, and Chihiro Watanabe. "Promoting industrial development through technology policy: Lessons from Japan and China." *Technology in Society*, vol. 28, no. 3, Aug. 2006, pp. 303-320., doi: <https://doi.org/10.1016/j.techsoc.2006.06.002>. 范培蕾, 渡边千寻, “通过技术政策促进产业发展: 来自日本和中国的经验教训”, 第 28 卷, 第 3 篇, 2006 年 8 月, 303-320, doi: <https://doi.org/10.1016/j.techsoc.2006.06.002>.
- Farrell, M.J(1957), The Measurement of Productive Efficiency[J], *Journal of the Royal Statistical Society*,1957,120(3):11-28.
- Feenstra, R. and H. L.Kee (2004). Export Variety and Country Productivity. NBER WP no. 10830, Cambridge MA.Feenstra R.和 H.L. Kee (2004), 出口多样化和国家生产力, 美国国家经济研究局 (NBER) 工作文件第 10830 号, 马萨诸塞州剑桥市。
- Feenstra, Robert and J. Bradford Jensen. 2009. —Evaluating Estimates of Materials Offshoring from U.S. Manufacturing. Paper presented at the National Academy of Public Administration conference —Measurement Issues Arising from the Growth of Globalization, November 6-7.Feenstra, Robert 和 J. Bradford Jensen, 2009, “评估美国制造业材料离岸的估量”。11 月 6 日至 7 日, 在国家公共管理学院会议发——“全球化发展带来的衡量问题”。
- Fernandes Mario Correia (2016), *Evaluating Risks in Public-Private Partnerships: The Case of Portuguese Road Sector*, *Arabian Journal of Business and Management Review*, 2016;
- Firmandi Ari (2017), *Indonesia infrastructure guarantee fund (IIGF), 3rd annual infrastructure project financing*, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Foster-McGregor N, Stehrer R (2013) Value added content of trade: A comprehensive approach. *Economic Letters* 120(2):354-357 Foster-McGregor N 和 Stehrer R (2013), 贸易的附加值内容: 一种全面的方法, *经济快报* 120 (2): 354-357。
- Gan, J., Tan, X. & Li, Y. (2016). Change and reconstruction: rely on “Internet Plus” to upgrade transport service. *World of Transport Manager*, (3), 52-55.
- Grossman, G. and E. Rossi-Hansberg (2008). —Trading Tasks: A Simple Theory of Offshoring, *American Economic Review*, 98:5, 1978-1997. Grossman G.和 E. Rossi-Hansberg (2008), “交易任务: 离岸的简单理论”, *美国经济评论*, 98: 5, 1978-1997。

- Hamed, M. & Flynn, F.C. (2006). Rail & truck transport of biomass. *Applied Biochemistry and Biotechnology*, 3(1), 88-103.
- Harding, T. (2009). 'Infrastructure and diversifying through better products.' In R. Newfarmer, W. Shaw, and P. Walkenhorst (eds.). *Breaking into New Markets – Emerging Lessons for Export Diversification*. World Bank. Harding T. (2009年), “基础设施和通过更好的产品实现多样化”, R. Newfarmer, W. Shaw 和 P. Walkenhorst (主编), 打入新兴市场——出口多元化的新教训, 世界银行。
- Hausmann, R. et al (2008). *The Atlas of Economic Complexity – Mapping Paths to Prosperity*. MIT Univ. Press. Hausmann R.等人 (2008), 经济复杂性图集——繁荣的路径图, 麻省理工大学出版社。
- HE Jun, ZHANG Xiangjian. What are the Dilemmas of the Free Trade Zone Development in China? – An Analysis from Free Trade Zone[J]. *Contemporary Economic Management*, 2016, (11):30-34.何骏, 张祥建, 自贸试验区发展的困境究竟在哪里? ——自贸试验区调研总结[J], 当代经济管理, 2016, (11): 30-34。
- Hoekman, Bernard, and Selina Jackson. 2013. *Shifting Focus in Trade Agreements – From Market Access to Value-Chain Barriers*, Discussion Paper, The World Bank, Washington. Hoekman, Bernard 和 Selina Jackson, 2013, 在贸易协定中转移焦点——从市场准入到价值链壁垒, 讨论文件, 世界银行, 华盛顿。
- Hummels D, Ishii J, Yi KM (2001) The nature and growth of vertical specialization in world trade. *Journal of International Economics* 54(1):75-96 Hummels D, Ishii J 和 Yi KM (2001), 世界贸易中垂直专业化的性质和增长, 国际经济学杂志 54 (1) : 75-96。
- Ismail Suhaiza & S.R. Ajija (2011), *Critical Success Factors of PPP Implementation in Malaysia*, International Islamic University, Malaysia 2011;
- Janic, M. (2006). Modelling the full costs of an intermodal and road freight transport network. *Transportation Research Part D*, (121), 33-34.
- Jansen, B., Swinkels, P. & Teeuwen, G. (2004). Operational planning of a large-scale multi-modal transportation system. *European Journal of Operational Research*, 56(1), 41-53.
- Javorcik, Beata Smarzynska. “Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages.” *American Economic Review*, vol. 94, no. 3, 23 July

2003, pp. 605–627., doi: 10.1257/0002828041464605. Javorcik 和 Beata Smarzynska, “外商直接投资是否会提高国内企业的生产率？通过后向链接寻找溢出效应。”，美国经济评论，第 94 卷，第 3 篇，2003 年 7 月 23 日，605-627, doi: 10.1257/0002828041464605

Ji Xinhua (2016), Analysis of Realistic Foundations for Solving PPP Financing Difficulties and Countermeasures, (translated from Chinese), Shanghai Municipal Finance Bureau 05-2016;

Joen, J., Oh, Y. & Yang, Y., 2005. Financial Market Integration in East Asia: Regional or Global?, Korea Institute for International Economic Policy. JoenJ., OhY.和 YangY., 2005, 东亚金融市场一体化：是区域性的还是全球化的？，韩国国际经济政策研究所。

Johnson RC, Noguera G (2012a) Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics* 86(2):224-236
Johnson RC 和 NogueraG (2012a)，核算中间产品：产品分成和贸易附加值，*国际经济学杂志* 86 (2) : 224-236

Johnson RC, Noguera G (2012b) Proximity and production fragmentation. *American Economic Review* 102(3):407-411
Johnson RC 和 Noguera G (2012b)，接近性和生产分散性，*美国经济评论* 102 (3) : 407-411。

Johnson, Robert, and Guillermo Noguera. 2010. — Accounting for Intermediates: Production Sharing and Trade in Value-added, Paper presented at NBER ITI Program Meeting, Boston, MA. August. Johnson, Robert 和 Guillermo Noguera, 2010, 核算中间产品：产品分成和贸易附加值，美国国家经济研究局 (NBER) ITI 计划会议上发表的论文，马萨诸塞州波士顿，8 月。

Kali, R. and J. Reyes (2006). The Architecture of Globalization: A Network Approach to International Economic Integration. *J. of International Business Studies*. 38 (4): 595-620. KaliR.和 J. Reyes (2006)，全球化的体系结构：国际经济一体化的网络方法，*国际商业研究杂志*，38 (4) : 595-620。

Kam Jacob (2017), Financing Models for Railway Infrastructure - Practical Insights from Hong Kong

Karim Raja Abd (2012), Malaysia's BOT method implementation for highway development projects, Msc Thesis, Ritsumeikan Asia Pacific University, 2012;

Kim Narae & Hong Carrie (2017), China's Public-Private Projects Pose State Debt Risks, Bloomberg 2017;

- Kong Yuan(2013), Study on the Evaluation of Operational Efficiency of China's Logistics Enterprises and Influencing Factors - Based on SORM, MALMQUIST Index and TOBIT Model [J], Logistics Technology, 2013,07: 181-185.
- Koopman R, Powers W, Wang Z, Wei SJ (2010) Give credit where credit is due: Tracing value added in global production chains. NBER Working Paper 16426
Koopman R, Powers W, Wang Z 和 Wei SJ (2010), 在信贷到期时给予信贷: 追踪全球生产链上的附加值, 美国国家经济研究局 (NBER) 工作文件第 16426 号。
- Koopman, Robert, Zhi Wang and Shang-Jin Wei. 2010. —A World Factory in Global Production Chains: Estimating Imported Value Added in Exports by the People's Republic of China,II in Robert Barro and Jong-Wha Lee, eds, Costs and Benefits of Economic Integration in Asia, Oxford University Press.
Koopman, Robert, Zhi Wang 和 Shang-Jin Wei, 2010, 全球生产链中的世界工厂: 估计中国出口的进口增值, Robert Barro 和 Jong-Wha Lee (主编), 亚洲经济一体化的成本与收益, 牛津大学出版社。
- Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2008. —How Much Chinese Exports Is Really Made in China?—Assessing Foreign and Domestic Value-added in Gross Exports. NBER Working Paper 14109. Koopman, Robert, Zhi Wang 和 Shang-Jin Wei, 2008——中国的出口商品有多少是中国制造? ——对出口总额国内外增加值的评估, 美国国家经济研究局 (NBER) 工作文件第 14109 号。
- KPMG (2008), Value-for-Money analysis of the public-private partnership for the completion of Autoroute 30, KPMG Audit report to Quebec Ministry of Transport, 2008;
- Lee, Hiro, and David Roland-Holst. 1998. [Economic Development and Cooperation in the Pacific Basin: Trade, Investment, and Environmental Issues](#), with Hiro Lee, Cambridge: Cambridge University Press Lee Hiro 和 David Roland-Holst, 1998, “太平洋盆地的经济发展与合作: 贸易、投资与环境问题”, 剑桥: 剑桥大学出版社。
- Li Hui, Jia Xiaowei. Research on the short board of Liaoning export trade and reinforcing measures. Journal of Liaoning Normal University (Social Science Edition). 2017,(5):44-49.李辉, 贾晓薇, 辽宁出口贸易的短板及加强措施研究 [J], 辽宁师范大学学报 (社会科学版), 2017 (5) : 44-49。
- Li Xiaomei(2013), An Empirical Analysis of Local Technological System and Industrial Efficiency [J], Industrial Economic Research, 2013,02: 56-64

- Li, M. (2016), *SWOT Analysis of international multimodal transport under the Belt & Road*. Modern Education Publishing Company. 9-12.
- Li, Yan, and Xiaofang Tan. "Empirical Study on Impact of FDI on Liaoning Equipment Manufacturing Industrial Clusters." 2011 International Conference on Management and Service Science, Aug. 2011, doi: 10.1109/icmss.2011.5998517. 李艳, 谭小芳, 外商直接投资对辽宁装备制造业集群影响的实证研究, 2011 年度国际管理与服务科学大会, 2011 年 8 月, doi: 10.1109/icmss.2011.5998517。
- LIN Sen. Path Analysis of Interaction and Synergistic Development Between Coastal Economic Belt and Hinterland in Liaoning Province—Based On the Perspective of Regional Economic Integration[J]. *Research on Financial and Economic Issues*, 2009, (10):119-123. 林森, 辽宁沿海经济带与腹地互动协同发展的路径分析——基于区域经济一体化的视角[J], *财经问题研究*, 2009 (10): 119-123。
- Ling, L. (2013). Development Status, bottlenecks, and solutions of Ningbo sea-rail multimodal transport. *Water Transport Management*, (10), 104-108.
- LIU Liang. The Intergovernmental Cooperation around the Bohai Region since Reform and Opening-up: History, Performance Appraisal and Challenge[J]. *Journal of North China Electric Power University (Social Sciences)*, 2017, (2):59-70. 刘良, 改革开放以来环渤海地区的政府间合作: 历史、绩效与挑战[J], *华北电力大学学报 (社会科学版)*, 2017 (2): 59-70。
- LIU Liangzhong, LIU Xinhua, XU Qingzhao. The Innovation Pattern of the Integration Development of the Region Encircling the Bohai Sea—The Preferential Development Strategy of Shandong and Liaodong Peninsula[J]. *Journal of Lanzhou Business School*, 2009, (4):43-50. 刘良忠, 柳新华和徐清照, 环渤海区域经济一体化发展创新模式——山东和辽东半岛次区域优先发展带动战略探讨[J], *兰州商学院学报*, 2009(4): 43-50。
- LIU Wei, Li Guohui, Zhang Chengjun. The Supply Constraints and the Path to Development of the Industrial Development System in Liaoning Free Trade Zone [J]. *Local Financial Research*, 2017, (11):99-104, 112. 刘巍, 李国辉和张成俊, 辽宁自贸区产业发展制度供给约束与脱困路径[J], *地方财政研究*, 2017, (11): 99-104, 112。
- Liu Z N(1995), The comparative performance of public and private enterprises: the case of British ports[J], *Journal of Transport Economics and Policy*, 1995(9): 263-274.

- Lourdes Trujillo,Tovar(2007), The European port industry :an analysis of its economic efficiency[J], *Maritime Economics & Logistics*,2007,(9)2:148-171.
- Lu, H. (2016). On the influence of Internet Plus on the transformation of traditional logistics. *Modern Commerce*, (34), 18-19.
- Ma Yueyue, Wang Weiguo(2015),Total Factor Productivity of Logistics Industry in China under the Heterogeneous Production Technology [J], *Systems Engineering*, 2015,10: 63-72.2013,02:56-64.
- Malaysia (2009), Public Private Partnership (PPP) Guideline, Public-Private Partnership Unit
- Malek Ezwan H.A. (2017) Prasarana, Designing Financing Strategies to Bridge Funding Gap for Rail Projects, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Mooney, Turloch. “More Chinese port consolidation on tap for 2017.” JOC, 20 June 2017. www.joc.com/port-news/asian-ports/more-chinese-port-consolidation-tap-2017_20170620.html.MooneyTurloch, “2017 年挖掘更多中国港口整合的机会”，JOC，2017 年 6 月 20 日，www.joc.com/port-news/asian-ports/more-chinese-port-consolidation-tap-2017_20170620.html
- Munro Gavin (2017), Societe Generale, Capitalizing on the evolving financial landscape to accelerate infrastructure development, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Nishimura Kiyoshi (2017) CGIF, Unlocking the potential of project bonds and securitization, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- NRDC, “China's Ports Play Major Role in Country's Air Pollution Problems.” Natural Resources Defense Council, 15 Dec. 2016, www.nrdc.org/media/2014/141028. 中国发改委, “中国港口在国家空气污染问题中发挥主要作用”, 自然资源保护委员会, 2016 年 12 月 15 日, www.nrdc.org/media/2014/141028
- Pan Hong. The Promotion Research of Northeast Asia Regional Trade Cooperation to the Northeast Old Industrial Base of the Open Economy Development. *Journal of Industrial Technological Economics*. 2014,(12):81-87.潘宏, 东北亚区域贸易合作对东北老工业基地开放型经济发展的推动研究[J], *工业技术经济*, 2014 (12) : 81-87。

- Pastor J(1996), Translation invariance in data envelopment analysis: A generalization [J].*Annals of Operation Research*,1996,66:93- 102.
- Pathak Kalpesh (2017), Brescon, Financial Engineering to Revive Struggling Infrastructure Projects, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Port Technology, “Chinese Ports to Merge Operations.” 16 June 2017, www.porttechnology.org/news/chinese_ports_to_merge_operations. 港口技术, “中国港口的合并运营”, 2017年6月16日, www.porttechnology.org/news/chinese_ports_to_merge_operations.
- Prime Minister Department PUTRAJAYA, 2009;
- Public-Private Infrastructure Advisory Facility (PPIAF) 2013;
- Public–Private Partnership, ADB East Asia Working Paper no2, 2016;
- PWC (2017), Price Waters Coopers, Infrastructure Project Financing PPP-Day 3, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Qin, L. (2017). Review of the strategy of sea-rail multimodal transport and evaluation, *Logistics Technology*, (5), 84-85.
- Qiu Ailian, An Yumei. Research on relationship between inward FDI and foreign trade in Liaoning Province. *Journal of Shenyang University of Technology (Social Science Edition)*. 2015,(3):217-224.邱爱莲, 安玉梅, 辽宁省内向外商直接投资与对外贸易关系研究[J], 沈阳工业大学学报(社会科学版), 2015(3): 217-224。
- Ray Shubhomoy (2015), Infrastructure Finance and Financial Sector Development, ADBI-WP 522, March 2015;
- Roland-Holst, David, and John Weiss. 2004. “[ASEAN and China: Export rivals or partners in regional growth?](#),” with J. Weiss, *The World Economy*, Volume 27, Number 8 (August 2004) pp 1255-1274. Roland-Holst, David 和 John Weiss, 2004年, “东盟与中国: 是出口竞争对手, 还是地区性增长的合作伙伴?”, J. Weiss, 世界经济, 第27卷, 第8篇(2004年8月), 1255-1274。
- Roland-Holst, David, and John Weiss., 2005. “[People’s Republic of China and Its Neighbors: Evidence on Regional Trade and Investment Effects](#),” *Journal of Asia Pacific Economic Literature*, Winter, 2005, 18-35. Roland-Holst, David 和

John Weiss, 2005, “中华人民共和国及其邻国：区域贸易和投资效应的证据”，“亚洲太平洋经济文学杂志”，2005年冬季刊，18-35。

Roland-Holst, David, Guntur Sugiyarto and Yinshan Loh. 2010. "[Asian Regional Income, Growth, and Distribution to 2030](#)," *Asian Development Review*, Vol. 27, No. 2, pp. 57-81. Roland-Holst, David, Guntur Sugiyarto 和 Yinshan Loh, “到 2030 年为止的亚洲地区收入、增长和分配”，“亚洲发展评论”，第 27 卷，第 2 篇，57-81。

Roland-Holst, David. 2003. “Emergent China: Challenges and Opportunities for East Asia,” in M. Yoshitomi (ed.), *Post-Crisis Development Paradigms in Asia*, Asian Development Bank Institute, Tokyo, 2003. Roland-Holst 和 David, 2003, “崛起的中国：东亚面临的挑战与机遇”，M. Yoshitomi（主编），亚洲危机后发展范式，亚洲开发银行研究所，东京，2003 年。

Roland-Holst, David. 2003. “Regional Trade Arrangements and Trade Patterns by Skill Content,” in M. Yoshitomi (ed.), *Post-Crisis Development Paradigms in Asia*, Asian Development Bank Institute, Tokyo, 2003. Roland-Holst 和 David, 2003, “区域贸易布局和按照技术含量划分的贸易模式”，M. Yoshitomi（主编），亚洲后危机发展范式，亚洲开发银行研究所，东京，2003 年。

Roland-Holst, David. 2005. “East Asian Trade Relations in the Wake of China’s WTO Accession,” invited address at *Evolution of Trade and Foreign Direct Investment in the Asia-Pacific*, Center for Global Partnership (CGP), Tokyo. Roland-Holst 和 David, 2003, “中国入世之后东亚地区贸易关系”，关于东京亚太地区贸易与外商直接投资的邀请稿，东京全球合作中心（CGP）。

Roland-Holst, David. 2005. “Global Supply Networks and Multilateral Trade Linkages: A Structural Analysis of East Asia,” in Harvie, Charles, Fukunari Kimura, and Hyun-Hoon Lee, *New East Asian Regionalism: Causes, Progress, and Country Perspectives*, Cheltenham: Elgar, 2005. Roland-Holst 和 David, 2003, “全球供应网络与多边贸易联系：东亚的结构分析”，Harvie, Charles, Fukunari Kimura 和 Hyun-Hoon Lee（合著），“新东亚地区主义：成因、进步和国家视角”，切尔滕纳姆：埃尔加出版社，2005 年。

Roland-Holst, David. 2008. "[China’s Real Exchange Rate and Implications for East Asian Regional Trade and Investment Flows](#),” in B. Fleisher, N. Hope, A. Pena, and D. Yang (eds.), *Policy Reform and Chinese Markets*, Elgar, London. Roland-Holst 和 David, 2003, “中国的实际汇率对东亚区域贸易和投资流动的影响”，载于 B. Fleisher, N. Hope, A. Pena 和 D. Yang（主编），政策改革与中国市场，埃尔加出版社，伦敦。

- Roland-Holst, David. 2009. "[Infrastructure as a Catalyst for Regional Integration, Growth, and Economic Convergence: Empirical Evidence from Asia](#)," in Zhai Fan (ed.), *From Growth to Convergence: Asia's Next Two Decades*, Palgrave Macmillan, New York, 2009. Roland-Holst 和 David , 2003, “基础设施是区域一体化、增长和经济趋同的催化剂：来自亚洲的实证证据”，翟凡（主编），“从增长到收敛：亚洲未来的二十年”，2009年，帕尔格雷夫麦克米伦出版社，纽约，2009。
- Romero Paulo (2017), RATPDEVTRANSDEV Asia, Seoul Metro Line 9 Learnings from Korea's first metro PPP project, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Ryuichi Kaga (2017), Asia faces challenges attracting infrastructure investment, ADB OP-ED/Opinion;
- Samuel Danny (2017), ITNL Pte Ltd, Financing for Sub-Sovereign Infrastructure Projects in Underdeveloped Economies, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Santos, B F, Limbourg, S. & Carreira, J. S. (2015). The impact of transport policies on railroad intermodal freight competitiveness—the case of Belgium. *Transportation Research Part D: Transport & Environment*, (34), 230-244.
- Schueller Margot (1997), Liaoning with the burden of the past, in *China's Provinces in Reform: Class community and political culture*, book edited by Peter Goodman, Routledge 1997;
- Sharma Vivek (2017), CRISIL, Challenges and Solutions in Infrastructure Finance, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Shi Chunyang. Analysis on Present Situation and Development Countermeasures of Liaoning's Import and Export Trade with Russia. *Northeast Asia Economic Research*. 2017,(4):88-93. 史春阳，辽宁对俄罗斯进出口贸易现状分析及发展对策[J]，*东北亚经济研究*，2017（4）：88-93
- SHI Jinfang, WU Qi, WU Xueyan. Comparative Study On the Construction of Liaoning Free Trade Zone[J]. *Journal of Dongbei University of Finance and Economics*, 2017, (4):83-90. 施锦芳，吴琦和吴学艳，辽宁自贸区建设比较研究[J]，*东北财经大学学报*，2017（4）：83-90
- Shika Jha, David Roland-Holst, Songsak Sriboonchitta, and Drew Behnke. 2010. “Regional Trade Opportunities for Asian Agriculture,” in John Gilbert (ed.), [New](#)

- [Developments in Computable General Equilibrium Analysis for Trade Policy](#), London: Emerald, pp. 273-302. Shika Jha, David Roland-Holst, Songsak Sriboonchitta 和 Drew Behnke, “亚洲农业的区域贸易机会”, John Gilbert (主编), “贸易政策的可计算一般均衡分析新发展”, 伦敦: 翡翠集团出版社, 273-302。
- Song, G. & Feng, R. (2017). Research on coordinated development mode of the structure of Liaoning logistics and industry. *Reform and Opening up*, (5), 23-25.
- Su, D. & Qu, Y. (2005). Status and outlook of Dalian port container sea-rail multimodal transport. *Chinese Port*, (12), 48-50.
- Sugden Craig (2016), People's Republic of China: a model project development fund for
- Sun Liang, Gao Yanfeng, Shi xiumei. Progress, Contribution and Prospects of FDI in Liaoning Province---With the database from 1979 to 2015. *Journal of Dalian Minzu University*. 2016,(6):564-568. 孙梁, 高艳锋和时秀梅, 辽宁省 FDI 的历程、贡献与展望——基于 1979-2015 年数据分析[J], 大连民族大学学报, 2016 (6) : 564-568。
- Tang, N. & Yang, J. (2016). Comparative study on the support policy of sea-rail multimodal transport at home and abroad. *Port Economy*, (4), 21-24.
- Tang, R. & Sun, H. (2012). Areas and main forms of introducing private capital into the Transport industry. *Transportation Accounting*, (8), 10-16.
- Tang, Z. (2009). Status and development strategy of container sea-rail multimodal transport. *Containerization*, (20), 6-11.
- Tao, X. & Zhang, R. (2012). Experience and implications of Ningbo container sea-rail multimodal transport. *Comprehensive Transport*, (6), 45.
- Thieriot Hubert & Dominguez Carlos (2015), IISD, Public-Private Partnerships in China on 2014 as a landmark year, with past and future challenges, 2015;
- Tong, X. (2014). Development Strategy of Dalian international sea-rail multimodal transport. *Master`s Thesis of Dalian Maritime University*.
- UNDP (2012), Colombo, Sri Lanka, Case Study of Port Expansion, UNDP Special Unit for South-South Cooperation, November 2012;
- Venkataraman Shobana (2017) IFC, Bankable PPPs in Emerging Markets, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;

- Violet Rosa (2003). RFID in China (White Paper). Fudan University, Department of microelectronics, Auto-ID Center.
- Vishwanathan Rajiv (2017), DBS Bank, Gaining Investors' Confidence in Infrastructure Financing, 3rd annual infrastructure project financing, a Marcus Evens Conference 24-26 July 2017 Singapore;
- Wang Shouqing & Ke Yonjiang, Laibin B Power Project –The First State Approved BOT Project in China, chapter in “PPP Infrastructure Development: Case Studies from Asia and Europe”, Bauhaus-Universitat Weimar 2009;
- Wang Weiguang, Gao Hongwei, Bai Xuefei(2011), An Empirical Study on the Localization of Technological Innovation System for Large Enterprises in China - An Analysis Based on Regional Level, *China Industrial Economy*, 2011, 12: 67-77.
- Wang Weiguang(2012), Three-Dimensional Institutional Innovation and Competitiveness of Large Enterprises, Economic & Management Publishing House, 2012.125-139.
- Wang, J. (2015). Development opportunities and measures of Qingdao port sea-rail multimodal transport. *Port Economy*, (11).
- Wang, J. (2015). Study on innovation of Internet Plus marketing models. *Modern Marketing*, (10), 52.
- Wang, Y. (2012). The economic organization model and its implications of the sea-rail container transport in EU countries. *Comprehensive Transport*, (11), 82-87.
- WEI Yuzhi, FENG Xiaotong. Research on the Regional Integration Development Strategy of Liaoning Coastal Economic Belt[J]. *Journal of Liaoning Administration School*,2011, (11):104-105.魏玉芝, 逢晓彤, 辽宁沿海经济带区域一体化发展策略研究[J], *辽宁行政学院学报*, 2011 (11) : 104-105
- World Bank (2009), Good Governance in Public-Private Partnerships a Resource Guide for Practitioners, World Bank and DFID, 2009;
- World Bank (2013), Value-for-Money Analysis—Practices and Challenges: How Governments Choose When to Use PPP to Deliver Public Infrastructure and Services, World Bank Institute (WBI) and
- World Bank (2014), Check List for PPP Projects, Washington 2014;
- World Bank (2017), Public-Private Partnerships Reference Guide Version 3, Washington 2017;

- World Bank. 2007. Connecting to compete. Trade logistics in the local economy. Washington, DC: World Bank. 世界银行, 2007, 连接竞争, 本地经济中的贸易物流, 华盛顿特区: 世界银行。
- Wu Hongyuan & Others (2017), The Cat-and-Mouse Game in China's Fight against Debt Addiction, CAIXIN June 5 2017;
- Wu, T. & Zhu, X. (2011). Research on Development plan of container sea-rail multimodal transport. *Academic Journal of Beijing Jiaotong University (Social Science Section)*, (2), 27-32.
- Wu, X. (2016). Research on development strategy of China sea-rail multimodal transport under "One Belt, One Road" initiative - take Ningbo port sea-rail multimodal transport as an example. *Navigation*, (1), 63-68.
- Xing Junwei. Research on Industrial Structure Upgrade in Liaoning Old Industrial Bases after the Implementation of Revitalization Strategy. *Science & Technology for Development*. 2015,(4):530-536.邢军伟, 实施振兴战略后辽宁老工业基地产业结构调整升级研究[J], 科技促进发展, 2015(4): 530-536。
- Xinhua (2016), Chinese government to promote PPP to boost private investment, Beijing, Xinhua 07-2016.
- Xinhua, "China Focus: Guideline on regional cooperation and growth in Bohai Rim." Xinhua, 27 Sept. 2015, news.xinhuanet.com/english/2015-09/27/c_134664844.htm. 新华社, "中国的关注重点: 环渤海地区区域合作与发展指导意见", 新华社讯 2015年9月27日, news.xinhuanet.com/english/2015-09/27/c_134664844.htm
- Xiong, Feng. "Analysis on the Causes and Countermeasures of the Economic Predicament in the Northeast China." *Modern Economy*, vol. 07, no. 09, 2016, pp. 1014-1019., doi: <http://dx.doi.org/10.4236/me.2016.79103> 熊凤, "东北地区经济困境成因与对策分析", 现代经济, 第7卷, 第9篇, 2016年10月10日, 1014-1019, doi: <http://dx.doi.org/10.4236/me.2016.79103>
- Xu, L. (2017). Evolution and transformation path of economic growth impetus in Liaoning old industrial bases. *Journal for Party and Administrative Cadres*, (11), 43.
- Yang Dongliang. Evaluation of China's Northeast Revitalization Policy and Policy Implications: Based on National Comparison of Total Factor Productivity Growth. *Northeast Asia Forum*. 2011,(5):99-108. 杨东亮, 东北振兴政策评价与

- 政策启示——基于全要素生产率增长的全国性比较[J], 东北亚论坛, 2011 (5): 99-108。
- Yang, Min. "Shenyang FTZ proves to be roaring success." China Daily, 28 Apr. 2017, www.chinadaily.com.cn/m/liaoning/investinshenyang/2017-04/28/content_29133376.html. 杨敏, “沈阳自由贸易区证实了巨大的成功。”中国日报, 2017年4月28日, www.chinadaily.com.cn/m/liaoning/investinshenyang/2017-04/28/content_29133376.html.
- Yang, W. (2016). Development Strategy of Dalian international sea-rail multimodal transport under “One Belt, One Road” initiative. *Modern Trade and Industry*, (2), 41.
- Yao, Kevin. “China unveils new steps to revive rustbelt northeast.” Reuters, 17 Mar. 2017, uk.reuters.com/article/uk-china-economy/china-unveils-new-steps-to-revive-rustbelt-northeast-idUKKBN16O1F2. Yao Kevin, “中国公布了重振低迷东北的新举措。”路透社, 2017年3月17日, uk.reuters.com/article/uk-china-economy/china-unveils-new-steps-to-revive-rustbelt-northeast-idUKKBN16O1F2.
- YE Xiuqun. Free Trade Zone and Regional Economic Growth: Empirical Analysis Based On China's Provincial Panel Data [J]. *Journal of Beijing Technology and Business University (Social Sciences)*, 2017,32(3):44 -53. 叶修群, 自由贸易区与区域经济增长——基于中国省级面板数据的实证分析[J], 北京工商大学学报(社会科学版), 201732(3): 44-53。
- Yin, Y. & Zhou, L. (2016). Issues on sea-rail container multimodal transport development and solutions in China. *Navigation*, (4), 77.
- Yu, Yang, et al. “Foreign Direct Investment in Liaoning Province (2016).” 于洋等, 辽宁省外商直接投资(2016)。
- Zhang Chi, Zhou Pingping. On economic and trade cooperation between Liaoning and North-Eastern Asian countries based on complementarities. *Journal of Shenyang University of Technology (Social Science Edition)*. 2008,(4):301-304. 张弛, 周萍萍, 从互补性看辽宁与东北亚国家的经贸合作[J], 沈阳工业大学学报(社会科学版), 2008(4): 301-304。
- Zhang Fu Ming, Meng Xian Zhong(2010). Empirical Study on the Efficiency of Logistics Enterprises in China and its Sustainability Evaluation [J], *Industrial Engineering and Management*, 2010,02: 46-49.

- Zhang Meihua. The Empirical Study on The Effect of Liaoning's Trading with Korea and Absorbing Korean Investment. *Journal of Liaoning Normal University (Social Science Edition)*. 2007,(1):48-51. 张美华, 辽宁对韩贸易与吸收韩资效应的实证分析[J], *辽宁师范大学学报(社会科学版)*, 2007(1): 48-51。
- Zhang Pingyu. 2008. Revitalizing Old Industrial Base of Northeast China: Process, Policy and Challenge. *China Geographical Science*. 18(2). pp. 109-118. 张平宇, 2008, 振兴东北老工业基地: 进程、政策和挑战, *中国地理科学*, 18(2), 109-118。
- Zhang Yi, Li Jingfeng, Niu Chonghuai(2013), Study on the Diversification Strategy and Performance of China's Listed Logistics Companies and the Role of Cost-Efficiency Intermediary [J], *Management Review*, 2013,02: 167-176.
- Zhao, Y., He, S. & Li, H. (2010). Research on sea-rail transport development mode and transport organization. *Railway Transport and Economy*, (6), 23-24.