Global Supply Networks and Multilateral Trade Linkages: A Structural Analysis of East Asia

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I. Introduction

- The global economy has changed patterns of trade and production in unprecedented ways.
- Two of the most salient features of this process are the animating role of private agency and global supply chain decomposition.
- With international capital allocation (FDI) and contracts, private agents have created extremely complex global supply networks
- The corresponding intermediate trade linkages are increasingly responsible for the majority of value creation

Introduction

- They also create the preconditions for independent producer and market development in recipient countries
- To assess these complex, trade mediated interactions, we have developed an international multiplier model based on the GTAP database.
- Decomposition analysis with this model reveals regional trade interactions at unprecedented levels of detail.

Part II

Overview of Global Supply Networks

Public Multilateralism: WTO

- Great Accomplishments
- Significant Limitations (some only temporary)
  - Imperfect bargaining vehicle
    - quite slow
    - diverse phase-in commitments and exceptions
  - High bindings
  - Evasive protection
    - contingent protection
    - administrative measures

Public Multilateralism: Bilateral Contagion

In part because of its imperfections, the WTO has further promoted liberalism via smaller scale agreements, especially BTAs.

Motives:

- Lock in early WTO gains with neighbors and "like minded" partners
- First-mover advantage for market entry and export access
- Blueprint for WTO accession (China, Vietnam)

Public Multilateralism: East Asia

- In this region, China will probably set the pace with its WTO initiative.
- Other economies in the region will have to come to terms with this, but its emergent internal market represents a great prize for regional exporters.
- This China Bandwagon effect will propagate liberalism across the region, regardless of other country's own WTO strategies.

Private Multilateralism: The Invisible Handshake

- Private agency is redefining trade patterns and economic structure in ways unforeseen by Ricardo
- Unlike official trade negotiation, this process is largely spontaneous and collaborative
- Globalization has been accompanied by an unprecedented proliferation of ownership and contractual networks
- The main catalyst for this process is international capital mobility and FDI

Private Multilateralism: FDI

Global capital allocation, particularly in East Asia, is animated by complex motives:

- Resource costs (the traditional explanation)
- Market access: double targeting
- Proximate markets
- Rent seeking and other institutional imperfections
- Portfolio decisions
  - risk management
  - asset allocation
  - supply chain decomposition

Supply Chain Decomposition

- As global networks expand, supply chains are decomposed into ever smaller and more specialized segments
- Intermediate linkages and intra-industry trade are accelerating much faster than final goods trade
- The entry point for a recipient country in this network depends upon their FDI "readiness"
- To a significant extent this has led an international hierarchy and competition for
  - value added in intermediate production
  - technology acquisition
  - growth externalities

Bamboo Capitalism

- Because of network externalities in local production and finance, complete markets sprout from nodes in a global root system of intermediate supply.
- This culminating aspect of global supply chain decomposition has created a diverse and vibrant population of independent local industries around the East Asian region.
- Many emergent enterprises are still bound to their roots by ownership or contracts
- But increasingly they arise independently, promoting the dynamics of global competitiveness and innovation.

III. International Database: The Global Trade Analysis Project

The GTAP dataset contains, for 66 countries/regions and 57 sectors,

1. National income and product accounts
2. Input-output tables
3. Bilateral trade flow tables
4. Protection and support estimates

for more information, see
www.gtap.org

Aggregation

Reg	Label	Name
1	chn	China
2	jpn	Japan
3	kor	Korea
4	twn	Taipei,China
5	asn	ASEAN
6	usa	United States
7	eur	Western Europe
8	row	Rest of the World

Sectoral Aggregation

No.	Label	Name
1	agr	Agriculture
2	enr	Energy and Minerals
3	pfd	Processed Food
4	txa	Textiles and apparel
5	lum	Wood products
6	ppp	Paper products publishing
7	pyc	Petroleum coal products
8	crp	Chemical rubber plastic products
9	nmm	Mineral products n.e.s.
10	met	Metals
11	mvh	Motor vehicles and parts
12	otn	Transport equipment n.e.s.
13	ele	Electronic equipment
14	ome	Machinery and equipment n.e.s.

No.	Label	Name
15	omf	Manufactures n.e.s.
16	ely	Electricity
17	gdt	Gas manufacture distribution
18	wtr	Water
19	cns	Construction
20	trd	Trade
21	tps	Transport Services
22	cmn	Communication
23	fin	Financial services
24	obs	Business services n.e.s.
25	ros	Recreation and other services
26	osg	Public administration
27	dwe	Dwellings
28	cgd	Investment goods

IV. Block Multiplier Decomposition

- While trade flow data are revealing, they only capture direct bilateral effects.
- In the real economy, a myriad of interactions delineate the path from initial expenditure to ultimate incomes.
- This is particularly the case with trade in an era of globalization, where international supply chains are ever more elaborate and indirect linkages can represent the majority of value creation.
- To assess these effects empirically, we use the international SAM for multiplier analysis.

Social Accounting Matrix

- Consider an example of three countries, each represented by a social accounting matrix of the form

$$T_k = \begin{bmatrix} T_{kk} & F_k \\ V_k & X_k \end{bmatrix}$$

where the component matrices denote commodity flows (T), final demand (FD), value added (VA), and other domestic accounts (X).

Multilateral Social Accounting Matrix

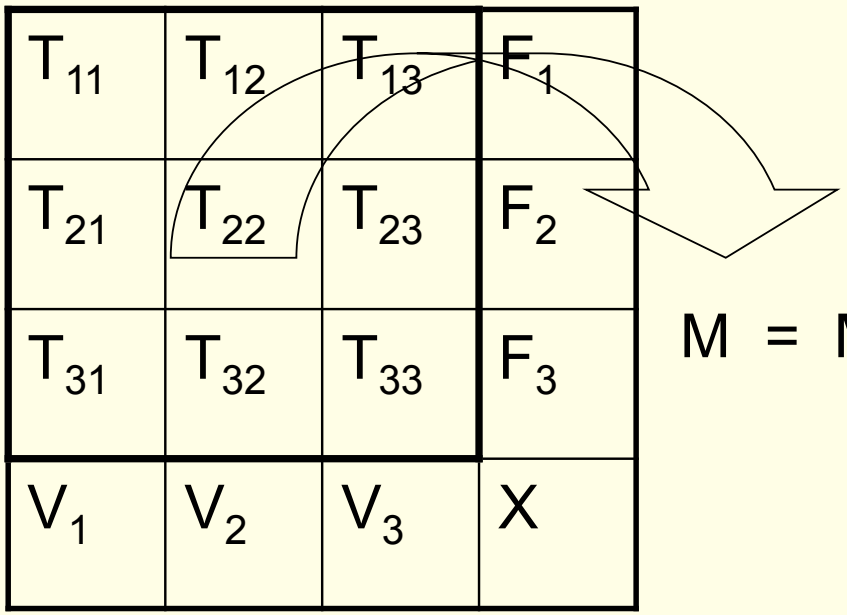
- Consider SAMs for three countries, compiled into a multilateral transactions table

T_{11}	T_{12}	T_{13}	F_1
T_{21}	T_{22}	T_{23}	F_2
T_{31}	T_{32}	T_{33}	F_3
V_1	V_2	V_3	X

where the off-diagonal T matrices (underlined) are bilateral trade flows.

Block Decomposition

To elucidate **multi-lateral** regional trade linkages, we carry out the following block multiplier decomposition:



$$M = M_3 M_2 M_1$$

Block Decomposition (cont.)

$M_1 =$

$(I-A_{11})^{-1}$	0	0
0	$(I-A_{22})^{-1}$	0
0	0	$(I-A_{33})^{-1}$

$M_2 =$

I	$(I-A_{11})^{-1}A_{12}$	$(I-A_{11})^{-1}A_{13}$
$(I-A_{22})^{-1}A_{21}$	I	$(I-A_{22})^{-1}A_{32}$
$(I-A_{33})^{-1}A_{31}$	$(I-A_{33})^{-1}A_{32}$	I

$M_3 =$

$I-D_{12}D_{21}-D_{13}D_{31}$	$D_{21}D_{12}$	$D_{31}D_{13}$
$D_{12}D_{21}$	$I-D_{21}D_{12}-D_{23}D_{32}$	$D_{23}D_{32}$
$D_{13}D_{31}$	$D_{23}D_{32}$	$I-D_{31}D_{13}-D_{23}D_{32}$

Linkages

Intra-country

Inter-country (bilateral)

Equilibrium Indirect

Note: $D_{ij} = (I-A_{ii})^{-1}A_{ij}$

Household Income Multipliers

		enr	txa	mvh	ele	ome
China	China	3.82	3.69	3.13	2.18	3.05
	Japan	.24	.84	.39	.42	.44
	Korea	.24	.54	.32	.31	.31
	Taipei,China	.23	.47	.30	.33	.34
	ASEAN	.27	.54	.33	.34	.35
Japan	China	2.25	2.43	2.93	3.06	2.70
	Japan	2.36	8.19	9.72	9.52	9.31
	Korea	.57	1.77	1.85	2.35	2.30
	Taipei,China	1.04	2.53	3.17	3.09	3.26
	ASEAN	1.64	2.19	3.64	2.82	3.02
Korea	China	.27	.39	.27	.33	.29
	Japan	.06	.23	.15	.18	.16
	Korea	.74	3.00	3.18	2.36	2.59
	Taipei,China	.08	.23	.19	.22	.18
	ASEAN	.15	.32	.24	.26	.20
Taipei	China	.25	.35	.25	.30	.27
	Japan	.04	.16	.11	.14	.12
	Korea	.03	.11	.07	.11	.07
	Taipei,China	.97	2.81	2.21	2.10	1.98
	ASEAN	.10	.26	.13	.17	.14
ASEAN	China	.33	.33	.29	.39	.30
	Japan	.34	.32	.28	.33	.28
	Korea	.30	.25	.22	.27	.21
	Taipei,China	.53	.33	.26	.41	.24
	ASEAN	2.30	2.30	1.85	1.47	1.21

Indirect Network in Total Effects

		enr	txa	mvh	ele	ome
China	China	4.49	5.95	6.04	9.96	6.25
	Japan	22.32	13.72	19.54	22.25	19.01
	Korea	23.12	23.20	33.18	44.03	40.74
	Taipei,China	41.75	37.94	55.82	58.87	51.98
	ASEAN	33.97	31.28	53.89	46.90	46.91
Japan	China	34.39	37.43	25.89	35.80	31.04
	Japan	16.53	11.07	6.38	8.21	7.43
	Korea	59.27	33.60	24.28	26.03	19.63
	Taipei,China	51.02	28.01	18.63	30.15	19.02
	ASEAN	23.69	33.74	14.89	24.18	19.13
Korea	China	27.21	22.75	29.66	32.42	28.49
	Japan	68.44	49.58	41.24	42.31	41.24
	Korea	5.02	2.85	1.95	3.36	2.54
	Taipei,China	70.09	42.18	41.21	48.40	46.96
	ASEAN	32.09	28.05	32.86	30.51	37.92
Taipei	China	20.10	16.77	22.17	23.86	20.72
	Japan	69.70	58.39	43.57	43.01	44.78
	Korea	85.54	60.98	66.05	54.14	68.44
	Taipei,China	4.30	2.80	2.73	3.93	3.34
	ASEAN	37.05	27.28	46.22	35.94	40.22
ASEAN	China	32.94	39.29	42.70	39.13	40.54
	Japan	9.69	31.50	22.22	22.99	23.75
	Korea	11.77	37.38	35.38	38.15	42.62
	Taipei,China	9.38	34.68	43.78	31.21	49.02
	ASEAN	3.37	5.66	7.28	9.23	9.88

V. Path Decomposition

- Block decomposition reveals the generic sources, but not the actual bilateral chains of income determination.
- To summarize the methodology:
  - An ***arc*** is a pair ***<i,j>*** of indices in the SAM accounts
  - A ***path*** is a sequence s of indices ***s=<i,k,l,...,m,j>*** decomposable into consecutive arcs <*i,k*>, <*k,l*>,...,<*m,j*>.
  - The influence of *i* on *j* through path *s* is denoted ***(i->j)s***
  - To estimate the income effect along <*i,j*>, before economywide linkages are taken into account, we have:

$$\frac{\partial y_j}{\partial y_i} = a_{ji}$$

Path Decomposition

- For any given path *s*=<*i,k,...,m,j*> the ***Direct*** income influence the composite

$$D_{(i\to j)s} = a_{ki}\ldots a_{jm}$$

- In any given path *s* there may exist feedback effects among its indices, each of which can be represented by a multiplier $[M]_s$ (actually the ji entry in the multiplier matrix M.
- All of these feedback effects taking place along the path amplify the direct influence to produce ***Total*** influence:

$$T_{(i\to j)s} = D_{(i\to j)s}\mu_s$$

Path Decomposition

- Finally, note that more than one elementary path may span two indices *i,j*. Therefore the ***Global*** income effect must sum total effects over all paths:

$$G_{(i\to j)s} = \sum_{s\in S} T_{(i\to j)s} = \sum_{s\in S} D_{(i\to j)s}\mu_s$$

- ***Direct***, ***Total*** and ***Global*** influence are three distinct components that make up the transmission mechanism underlying income determination.

Example 1: Linkages from Japanese Electronics to Japanese Households

- Please see the handout.

Example 2: Chinese Electronics to Japanese Households

Path	Global Effect	Direct Effect	Path Mult	Total Effect	% of Global
1. chn-ele -> jpn-ele -> jpn-Usk -> jpn-hhs	3.059	0.018	13.242	0.234	7.6
2. chn-ele -> jpn-ele -> jpn-Skl -> jpn-hhs		0.011	13.242	0.144	4.7
3. chn-ele -> jpn-ele -> jpn-Cap -> jpn-hhs		0.019	13.242	0.258	8.4
4. chn-ele -> jpn-ele -> jpn-gov -> jpn-hhs		0.002	18.748	0.030	1.0
5. chn-ele -> jpn-ele -> jpn-crp -> jpn-Cap -> jpn-hhs		0.001	13.538	0.015	0.5
6. chn-ele -> jpn-ele -> jpn-met -> jpn-Usk -> jpn-hhs		0.001	15.195	0.021	0.7
7. chn-ele -> jpn-ele -> jpn-met -> jpn-Cap -> jpn-hhs		0.001	15.195	0.020	0.7
8. chn-ele -> jpn-ele -> jpn-trd -> jpn-Usk -> jpn-hhs		0.002	13.488	0.033	1.1
9. chn-ele -> jpn-ele -> jpn-trd -> jpn-Skl -> jpn-hhs		0.002	13.488	0.021	0.7
10. chn-ele -> jpn-ele -> jpn-trd -> jpn-Cap -> jpn-hhs		0.001	13.488	0.017	0.6
11. chn-ele -> jpn-ele -> jpn-obs -> jpn-Usk -> jpn-hhs		0.002	13.799	0.021	0.7
12. chn-ele -> jpn-ele -> jpn-obs -> jpn-Skl -> jpn-hhs		0.001	13.799	0.014	0.5
13. chn-ele -> jpn-ele -> jpn-obs -> jpn-Cap -> jpn-hhs		0.002	13.799	0.032	1.1
14. chn-ele -> jpn-ele -> jpn-osg -> jpn-Usk -> jpn-hhs		0.004	13.886	0.053	1.7
15. chn-ele -> jpn-ele -> jpn-osg -> jpn-Skl -> jpn-hhs		0.002	13.886	0.031	1.0
16. chn-ele -> asn-ele -> jpn-ele -> jpn-Usk -> jpn-hhs		0.001	17.867	0.023	0.8
17. chn-ele -> asn-ele -> jpn-ele -> jpn-Cap -> jpn-hhs		0.001	17.867	0.025	0.8

Example 3: Chinese Electronics to Japanese Electronics

Path	Global Effect	Direct Effect	Path Mult	Total Effect	% of Global	Cum %
chn-ele>jpn-ele	0.379	0.125	1.884	0.236	62.3	62.3
chn-ele>kor-ele>jpn-ele		0.003	2.143	0.007	2.0	64.3
chn-ele>twn-ele>jpn-ele		0.006	2.120	0.013	3.4	67.7
chn-ele>asn-ele>jpn-ele		0.009	2.546	0.023	6.2	73.9
chn-ele>chn-ome>jpn-ome>jpn-ele		0.000	3.641	0.001	0.2	74.1
chn-ele>kor-ele>asn-ele>jpn-ele		0.000	2.885	0.001	0.2	74.2
chn-ele>twn-ele>kor-ele>jpn-ele		0.000	2.420	0.000	0.1	74.3
chn-ele>twn-ele>asn-ele>jpn-ele		0.001	2.860	0.002	0.5	74.9
chn-ele>asn-ele>kor-ele>jpn-ele		0.000	2.885	0.001	0.2	75.1
chn-ele>asn-ele>twn-ele>jpn-ele		0.000	2.860	0.001	0.2	75.3
chn-ele>asn-ele>asn-ome>jpn-ome>jpn-ele		0.000	3.878	0.000	0.1	75.4

Example 3: Chinese Motor Vehicles to Japanese Skilled Labor

Path	Global Effect	Direct Effect	Path Mult	Total Effect	% of Global	Cum %
chn-mvh>jpn-mvh>jpn-Skl	0.635	0.009	3.817	0.034	5.4	5.4
chn-mvh>chn-crp>jpn-crp>jpn-Skl		0.000	5.528	0.001	0.2	5.6
chn-mvh>chn-met>jpn-met>jpn-Skl		0.000	7.227	0.003	0.4	6.0
chn-mvh>chn-ome>jpn-ome>jpn-Skl		0.001	6.127	0.004	0.6	6.6
chn-mvh>jpn-mvh>jpn-crp>jpn-Skl		0.001	4.253	0.003	0.4	7.0
chn-mvh>jpn-mvh>jpn-met>jpn-Skl		0.001	4.795	0.004	0.6	7.6
chn-mvh>jpn-mvh>jpn-ele>jpn-Skl		0.001	4.370	0.003	0.4	8.0
chn-mvh>jpn-mvh>jpn-ome>jpn-Skl		0.000	4.254	0.001	0.1	8.1
chn-mvh>jpn-mvh>jpn-trd>jpn-Skl		0.001	6.030	0.007	1.0	9.2
chn-mvh>jpn-mvh>jpn-tps>jpn-Skl		0.000	4.786	0.002	0.3	9.5
chn-mvh>jpn-mvh>jpn-fin>jpn-Skl		0.000	4.475	0.001	0.1	9.6
chn-mvh>jpn-mvh>jpn-obs>jpn-Skl		0.001	5.207	0.003	0.4	10.0
chn-mvh>jpn-mvh>jpn-osg>jpn-Skl		0.001	5.313	0.007	1.0	11.1
chn-mvh>jpn-mvh>jpn-crp>jpn-osg>jpn-Skl		0.000	5.597	0.001	0.1	11.2
chn-mvh>jpn-mvh>jpn-ele>jpn-osg>jpn-Skl		0.000	5.817	0.001	0.1	11.3
chn-mvh>jpn-mvh>jpn-gov>jpn-osg>jpn-Skl		0.000	5.916	0.003	0.4	11.7
chn-mvh>jpn-mvh>jpn-Usk>jpn-hhs>jpn-trd>jpn-Skl		0.000	12.720	0.005	0.8	12.5
chn-mvh>jpn-mvh>jpn-Usk>jpn-hhs>jpn-osg>jpn-Skl		0.000	13.105	0.001	0.2	12.8
chn-mvh>jpn-mvh>jpn-Cap>jpn-hhs>jpn-trd>jpn-Skl		0.000	12.720	0.005	0.8	13.5
chn-mvh>jpn-mvh>jpn-Cap>jpn-hhs>jpn-osg>jpn-Skl		0.000	13.105	0.001	0.2	13.7

Example 4: Chinese Electronics to ASEAN Electronics

Path	Global Effect	Direct Effect	Path Mult	Total Effect	% of Global	Cum %
chn-ele>asn-ele	0.216	0.097	1.617	0.157	72.8	72.8
chn-ele>jpn-ele>asn-ele		0.005	2.546	0.013	5.9	78.7
chn-ele>kor-ele>asn-ele		0.002	1.839	0.004	1.8	80.6
chn-ele>twn-ele>asn-ele		0.008	1.824	0.014	6.4	87.0
chn-ele>jpn-ele>twn-ele>asn-ele		0.000	2.860	0.000	0.2	87.2
chn-ele>kor-ele>jpn-ele>asn-ele		0.000	2.885	0.000	0.2	87.4
chn-ele>twn-ele>jpn-ele>asn-ele		0.000	2.860	0.001	0.3	87.7

Example 5: Chinese Motor Vehicles to Japanese Skilled Labor

Path	Global Effect	Direct Effect	Path Mult	Total Effect	% of Global	Cum %
chn-mvh>jpn-mvh>jpn-Skl	0.635	0.009	3.817	0.034	5.4	5.4
chn-mvh>chn-crp>jpn-crp>jpn-Skl		0.000	5.528	0.001	0.2	5.6
chn-mvh>chn-met>jpn-met>jpn-Skl		0.000	7.227	0.003	0.4	6.0
chn-mvh>chn-ome>jpn-ome>jpn-Skl		0.001	6.127	0.004	0.6	6.6
chn-mvh>jpn-mvh>jpn-crp>jpn-Skl		0.001	4.253	0.003	0.4	7.0
chn-mvh>jpn-mvh>jpn-met>jpn-Skl		0.001	4.795	0.004	0.6	7.6
chn-mvh>jpn-mvh>jpn-ele>jpn-Skl		0.001	4.370	0.003	0.4	8.0
chn-mvh>jpn-mvh>jpn-ome>jpn-Skl		0.000	4.254	0.001	0.1	8.1
chn-mvh>jpn-mvh>jpn-trd>jpn-Skl		0.001	6.030	0.007	1.0	9.2
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chn-mvh>jpn-mvh>jpn-obs>jpn-Skl		0.001	5.207	0.003	0.4	10.0
chn-mvh>jpn-mvh>jpn-osg>jpn-Skl		0.001	5.313	0.007	1.0	11.1
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chn-mvh>jpn-mvh>jpn-Cap>jpn-hhs>jpn-trd>jpn-Skl		0.000	12.720	0.005	0.8	13.5
chn-mvh>jpn-mvh>jpn-Cap>jpn-hhs>jpn-osg>jpn-Skl		0.000	13.105	0.001	0.2	13.7

VII. Conclusions

Supply chain decomposition is changing the landscape of East Asian regional:

1. Capital allocation
2. Production patterns
3. Trade
4. The development process

Capital Allocation

FDI over the supply chain is driven by:

- Resource costs (the traditional explanation)
- Market access: double targeting
- Proximate markets
- Rent seeking and other institutional imperfections
- Portfolio decisions
  - risk management
  - asset allocation
  - supply chain decomposition

Production Patterns: Regional Hierarchy and FDI Competition

- Regional hierarchies are being expanded according to the detailed characteristics of FDI.
- Countries are increasingly FDI-quality conscious
- They are competing for FDI with complementary policies toward human capital and infrastructure

Trade: Multilateralism in Bilateralism

- Our results indicate that over one third of total value creation in bilateral ties actually arises from multilateral network linkages.
- This is due mainly to trade in intermediates.
- Intermediate trade is growing faster than final goods trade, and will ultimately dominate as it does in the EU.

Development Process: Bamboo Capitalism

- From the nodes in an ever expanding root system of intermediate supply, independent producers and even complete local markets emerge to join the dynamic of regional competition and innovation.
- Microeconomic replication of this kind is accelerating more balanced growth and overcoming exactly the specialization tendencies dictated by traditional comparative advantage.