Long Term Food Security in Developing Asia

D. Roland-Holst and Songsak Sriboonchitta[°*]

1. Abstract

Recent food price volatility reminds us that Asia remains vulnerable to food insecurity, yet the region has very substantial unrealized agrifood potential. More more determined policy action will be necessary to realize this potential and secure the livelihoods of both rural and urban poor people in the region. This report offers an up-to-date overview of the issues of agricultural capacity and food security in Asia, highlighting the region's many accomplishments as well as emergent risks. Based on our assessment of initial conditions, we apply a dynamic forecasting model to evaluate scenarios representing both external shocks and proactive policy responses to improve regional food security. Overall, our results strongly support the view that investments in productivity can realize the vast agrifood potential of the region, keep pace with rapid demand growth in resource-intensive foods, and facilitate regional convergence by promoting more equal income growth across Asia. When this process is facilitated by more widespread regional i supply chian integration and policies to reduce administrative and structural trade barriers, the benefits are much greater.

2. INTRODUCTION

Recent insabilty of food prices has drawn attention to food security issues around the world and particularly in South and Southeast Asian economies. Across the developing world an extremely high proportion of household income is dedicated to the purchase of food products. Therefore rising costs of such products disproportionately burdens lower income earners causing many such households to decrease amounts of daily caloric intake or sell productive assets for the purchase of food. This results in increased numbers of people experiencing nutrition vulnerability worldwide and worsening economic conditions in the poorest countries. Such vulnerability is concentrated among the poor, who spend much larger percentages of their real incomes on food (Figure 1).

Figure 1: Food Expenditure as a percent of Income (118 countries)
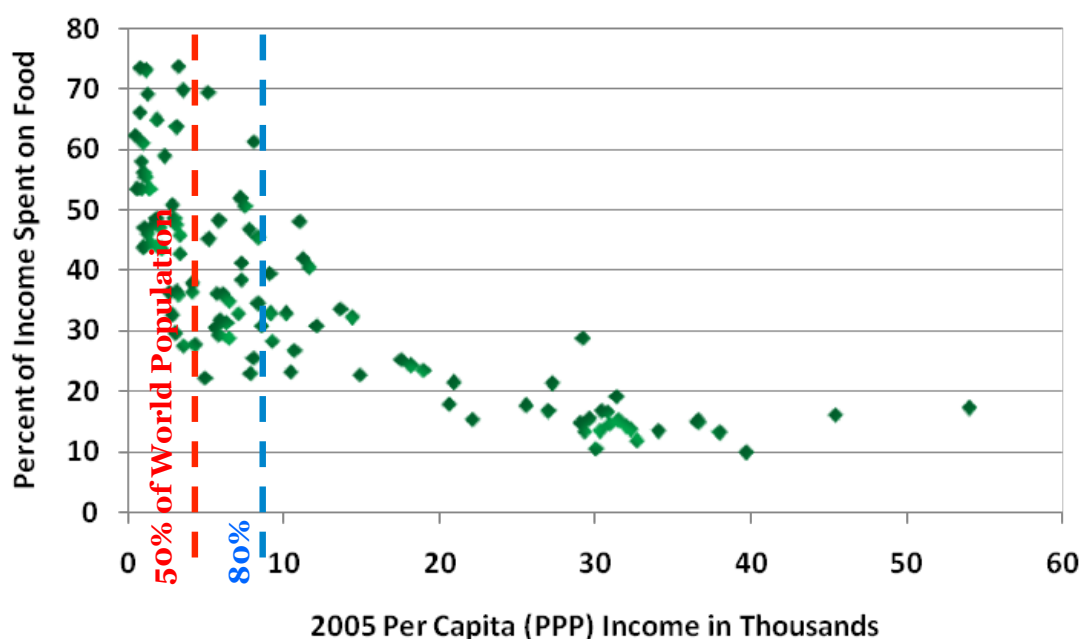
Source: FAO, World Bank.

After having fallen from their 2008 heights, global food prices again began an upward trend in tandem with the global economic recovery from mid-2010, led by demand from emerging market economies. The causes of high food prices, including rising food, feed and fuel demand, and elevated weather/climate uncertainties remain in place. Indeed, Russia's decision to ban exports widespread crop losses

from drought and fires intensified pressure on already volatile wheat prices as they reached a 23-month high in August and raised concerns about food prices worldwide. Economic welfare of poor households in developing Asian countries is highly sensitive to food prices since food spending accounts for a significant share of their budgets. Coordinated and comprehensive policy action will be necessary to mitigate the adverse impacts of future food price rises.

At the same time, many areas of low-income Asia agricultural yields are far below potential a differential referred to as the "yield gap". Increased demand in higher income Asian economies and higher food prices has the potential to incentivize higher agrifood production in lower income countries. In low-income countries, agriculture accounts for an extremely large proportion of employment particularly in rural communities. Therefore increased production would lead to improved employment opportunities, incomes and livelihoods. Thus, such production increases may achieve the twin objectives of promoting development and improved long-term food security.

This report will explore these issues in three parts. The first will discuss food security, production and demand in various selected Asian economies. The following section will give a brief overview of the food price crisis of 2007-2008 and discuss the possibility of another such crisis in 2011-2012. Section 3 presents long term forecasts of regional agrifood growth and development, evaluated from the perspective of food security and livelihoods. The final section will comprise of a literature review focusing on theories of the links between agricultural productivity and economic growth and methods of productivity enhancement.

3. FOOD SECURITY AND PRICE VOLATILITY

A. 2007-2008 Food Crisis

Beginning in 2007 and peaking in mid-2008 food prices worldwide skyrocketed (see Figure 2). There were many factors that contributed to the price rise. Depletion of many countries' stocks of cereals became low causing increased demand, increased demand due to biofuel development and use and the declining value of the dollar. However, conditions became significantly worse when major rice exporters began

imposing restrictions on rice exports in effort to control domestic rice prices. Countries that imposed export bans or other restrictions include Viet Nam and India, the second and third-largest rice exporters respectively, mid-level rice exporters China and Egypt, and low-level exporter Cambodia (USDA, 2008). Export restrictions also triggered "distress buying" importing countries further compounding the problem and rice prices peaked at over US$1,000/tonne in April of 2008 (Brahmbhatt & Christiaensen, 2008).

Demand for food on a global basis has been increasing steadily for decades (ESCAP, 2009). One reason for sustained robust growth in demand for cereals has been increasing incomes in many countries in the Asia-Pacific region (ESCAP, 2009). With rising incomes many in the region are eating more meat which requires increasing amounts of grain-fed livestock (ESCAP, 2009). "On a world average, each kilo of beef requires eight kilos of grain" (ESCAP, 2009).

Figure 2 – **Food Price Index and Cereal Prices 2001-2011**
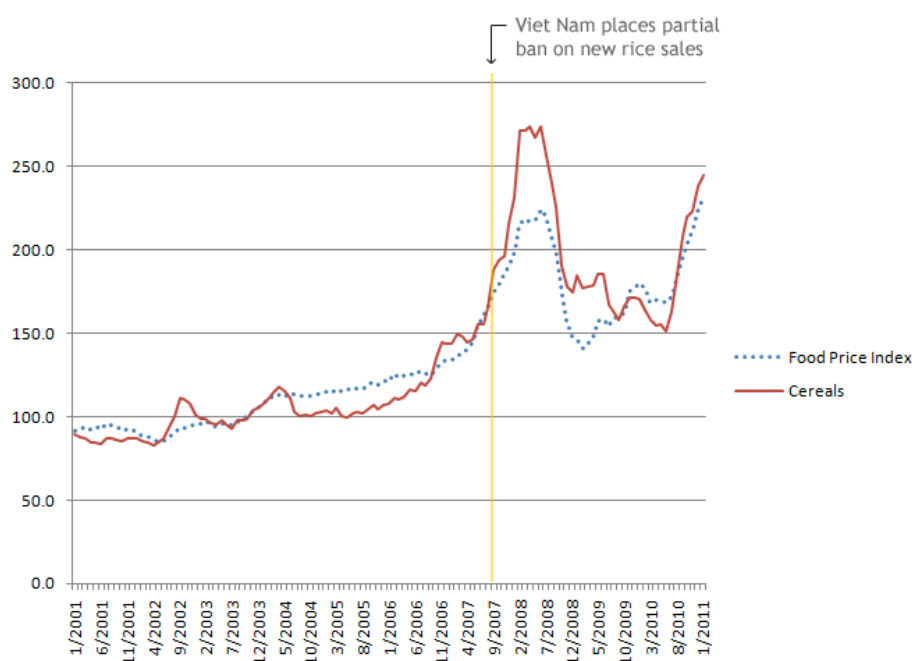
Source: FAO

Food production increases outpaced demand causing a downward trend in food prices until the 2000s when this trend reversed and production was unable to keep up with rising demand (ESCAP, 2009). World stocks of cereals declined significantly as consumption outpaced production for multiple years from 1999 into the early

2000s. During this time world stocks of wheat, maize and rice fell by 31 percent, 59 percent and 50 percent respectively resulting in the lowest level of worldwide cereal stocks in 30 years (ESCAP, 2009). This caused prices of food to begin their upward trend of the 2000s.

In addition to a lag in production, a sharp increase in global demand for grains was augmented by a rise in demand for biofuel which Brahmbhatt and Christiaensen (2008) claim contributed significantly to increases in grain prices. Governments around the world have encouraged production and use of biofuels due to concerns regarding oil prices, energy security and climate change. Increased demand for biofuel crops (maize, soybeans and palm oil) led to land use changes and reduced planting of wheat which resulted in depletion of world wheat stocks and sharp increases in world wheat prices (Brahmbhatt & Christiaensen, 2008). Increasing use of land for biofuel production, combined with increasing energy-intensity of agriculture and the use of natural gas as a primary input for fertilizer production has caused food prices to become increasingly linked to the prices of oil and gas (ESCAP, 2009).

According to studies by the World Bank rising energy and fertilizer costs and the decline in value of the dollar have contributed to some 35 percent of food price rise (Brahmbhatt & Christiaensen, 2008). Higher fuel costs to supply agricultural machinery, irrigation system and transport increase the cost of agricultural production as does the increase price of fertilizers in whose production energy is a major input (Brahmbhatt & Christiaensen, 2008). Other studies have claimed that decline in the value of the dollar increases dollar commodity prices with an elasticity of 0.5 to 1.0 (Baffles, 1997; Brahmbhatt & Christiaensen, 2008).

Food price increases were 9 percent in 2006, 23 percent in 2007 and 51 percent "between January-June 2007 and January-June 2008" (ESCAP, 2009). The most rapid increases of late 2007 and January-April of 2008 were largely due to export restrictions of rice exporting countries. In September of 2007 Viet Nam, the second-largest rice exporter placed a partial ban on new sales. India, the third-largest exporter, followed with an imposed minimum export price in October. In December, China, a mid-level exporter imposed a tax on rice exports. At the height of the crisis

in March of 2008 Viet Nam, India, Egypt and Cambodia all imposed or reimposed bans on rice exports (USDA, 2008).

This sequence of rice export restrictions had a massive impact on world rice prices. Imposing export restrictions or export taxes may be a first response of a food-exporting country facing a rapid increase in food prices. The purpose of such policy is to control domestic rice prices and secure domestic rice supply. This may benefit domestic consumers however it will adversely affect domestic producers and consumers in food-importing countries and more broadly it will have a negative impact on regional and global food security (ESCAP, 2009). This also creates a "domino effect" provoking other exporters to also implement such policy and "distress buying" by importers which causes prices to rise further (Brahmbhatt & Christiaensen, 2008).

High prices benefit the terms of trade of countries that export agricultural products and improve trade balances of such countries as was seen in the case of Thailand. However groups such as the rural landless and urban poor are negatively impacted by such price rises. Within such groups 50 percent or more of income may be spent on food and price increases will heavily impact such family budgets. The high prices of food impact lower income countries most heavily. During the 2007-2008 crisis such high prices contributed to "social turbulence or even food riots in over 30 countries from Bangladesh to Indonesia and contributed to the fall of at least one elected government" (ESCAP, 2009).

B. Short Term Risks of another Food Crisis in the Region

Food prices eased as the global economy slowed into recession in 2008 and by early 2009 prices were back down to levels of 2006 (in real terms) (ESCAP, 2009). However, it is widely speculated that as the global economy comes out of recession, oil and food prices are likely to rise again. The final quarter of 2010 and January 2011 have already seen rapidly rising food prices (see Figure 2). Escalation across the year has been a norm in recent years (except for unwinding in 2008), and 2011 is beginning at very high levels (Figure 3). Moreover, trends in the last year have
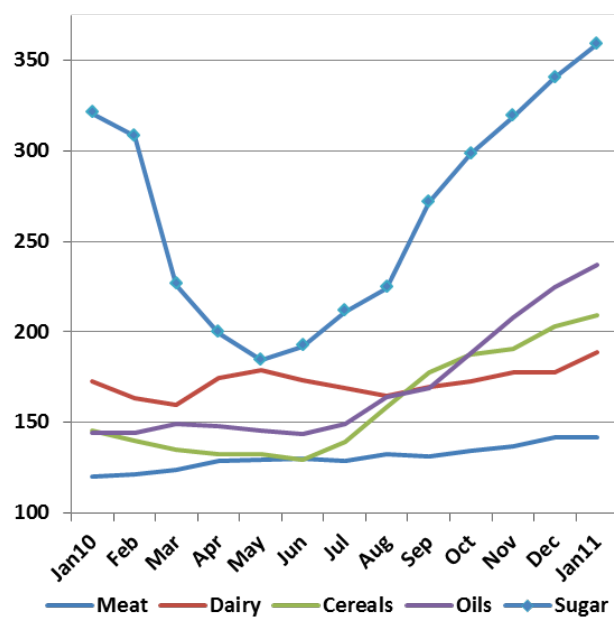
been sharply higher than the first half of the decade across most major staples (Figure 4).

Figure 3: Monthly Food Price Trends by Year
(2002-2004 = 100)
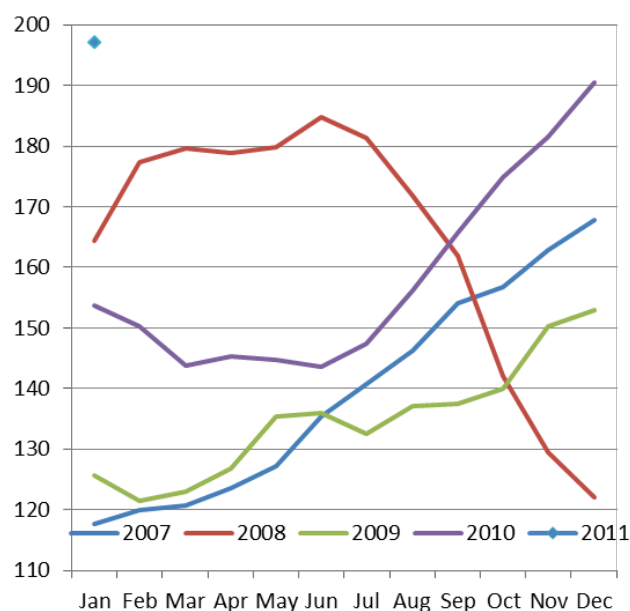
Source: FAOSTAT

Figure 4: Monthly Food Prices from 2010
**(2002-2004 = 100)**

Source: FAOSTAT

The current wheat outlook does not appear to be favorable. Sustained export bans in Russia, last year's flooding in Canada, and drought conditions in China may converge to put considerable upward pressure on global wheat prices. Such concerns were articulated in a recent FAO (2011e) *GIEWS Special Alert*. Low precipitation in the major wheat producing areas of China has endangered the potential harvest and the impact could be devastating. If China is required to meet a significant proportion of its domestic needs with imports the demand shock to the world market will be felt worldwide.

C. Long term Risks to Food Security

Although agrifood prices over the last decade have exhibited volatility for a variety of reasons, long term global capacity to meet nutritional needs will be determined by more fundamental issues. Among these, the most prominent are population growth, technological change, and the capacity of the natural resource base to sustain food production in concert with demand growth. As Figure 5 makes clear, our historic successes in this regard have come from a stable resource base and ever rising agricultural yields.

As Table 4 indicates, the world managed its food security with relatively modest annual productivity increases, averaging 2-2.3 percent per annum since the 1970s. Whether or not this will be sufficient for the future depends on several factors. The first of these will be population growth, which is slowing globally, but at varying speeds (Table 6). If humankind can moderate its growth to total about 9 billion people, this growth will have converged to about 1% per annum. In this case, food production for today's diets could be sustained with historical yield growth. However, large emerging economies are rapidly changing their food consumption patterns, in particular shifting toward meat and specialty crops. These agrifood products are much more resource intensive, and if such trends are to be sustained much higher yield growth may be required. This the main threat to food security from the demand side is not really the standards Malthusian challenge of population but changing taste and rising purchasing power.

Figure 5: Total World Grain and Oilseeds

Index: 1975 = 100
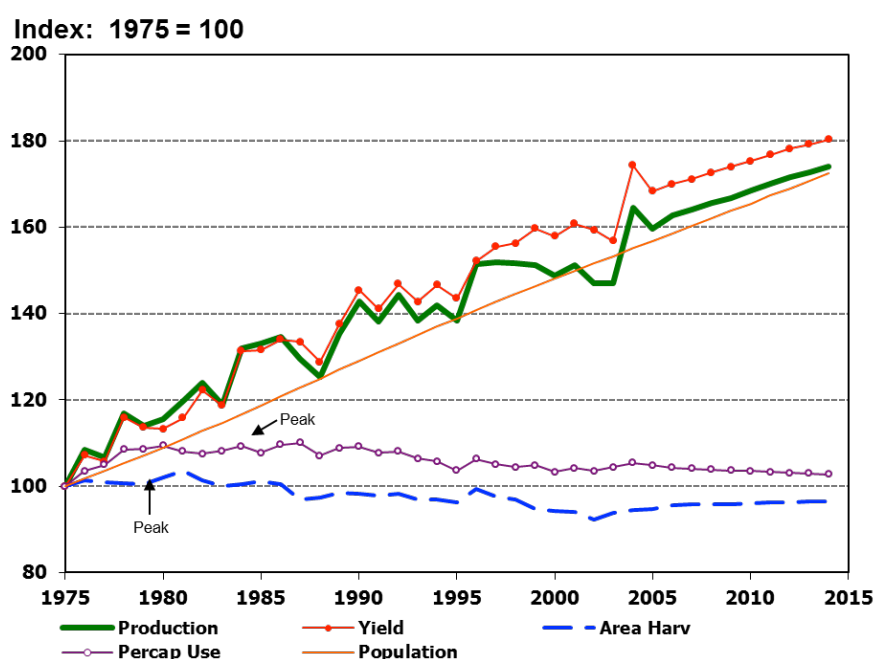
Source: USDA.

Table 6: Global Population

|	Total population (millions)					
	2000	2010	2020	2030	2040	2050
North America	306	337	367	392	413	430
Europe & Russia	752	762	766	761	748	729
Pacific OECD	150	153	152	148	142	135
Africa, sub-Saharan	655	842	1056	1281	1509	1723
Latin America	505	574	638	689	725	744
Middle East & N. Africa	303	370	442	511	575	629
Asia, East	1402	1500	1584	1633	1630	1596
Asia, South/Southeast	1765	2056	2328	2553	2723	2839
Rest of World	210	233	249	262	272	280
Developed	1141	1177	1202	1211	1210	1198
Developing	4696	5417	6132	6758	7257	7627
Rest of World[1]	210	233	249	262	272	280
World	6047	6827	7582	8231	8739	9105

Source: United Nations.

On the supply side, long-term threats to food security are dominated by climate factors, particularly water availability and attendant risks that can be expected from rising average global temperatures. The leading global climate models have somewhat divergent views regarding temperature and precipitation trends (Figures 6 and 7), yet conclusions regarding global agricultural yields are more harmonious

because of the prominence of the so-called CO2 fertilization effect. Generally speaking, temperature and precipitation trends will induce shifting of agricultural capacity, mainly from equatorial to polar latitudes. Increased CO2 concentrations, however, will have a more uniform and positive yield effect, moderating local adverse consequences and amplifying benefits.

Figure 6: Average Annual Temperature Change, 2000-2050 (centigrade)
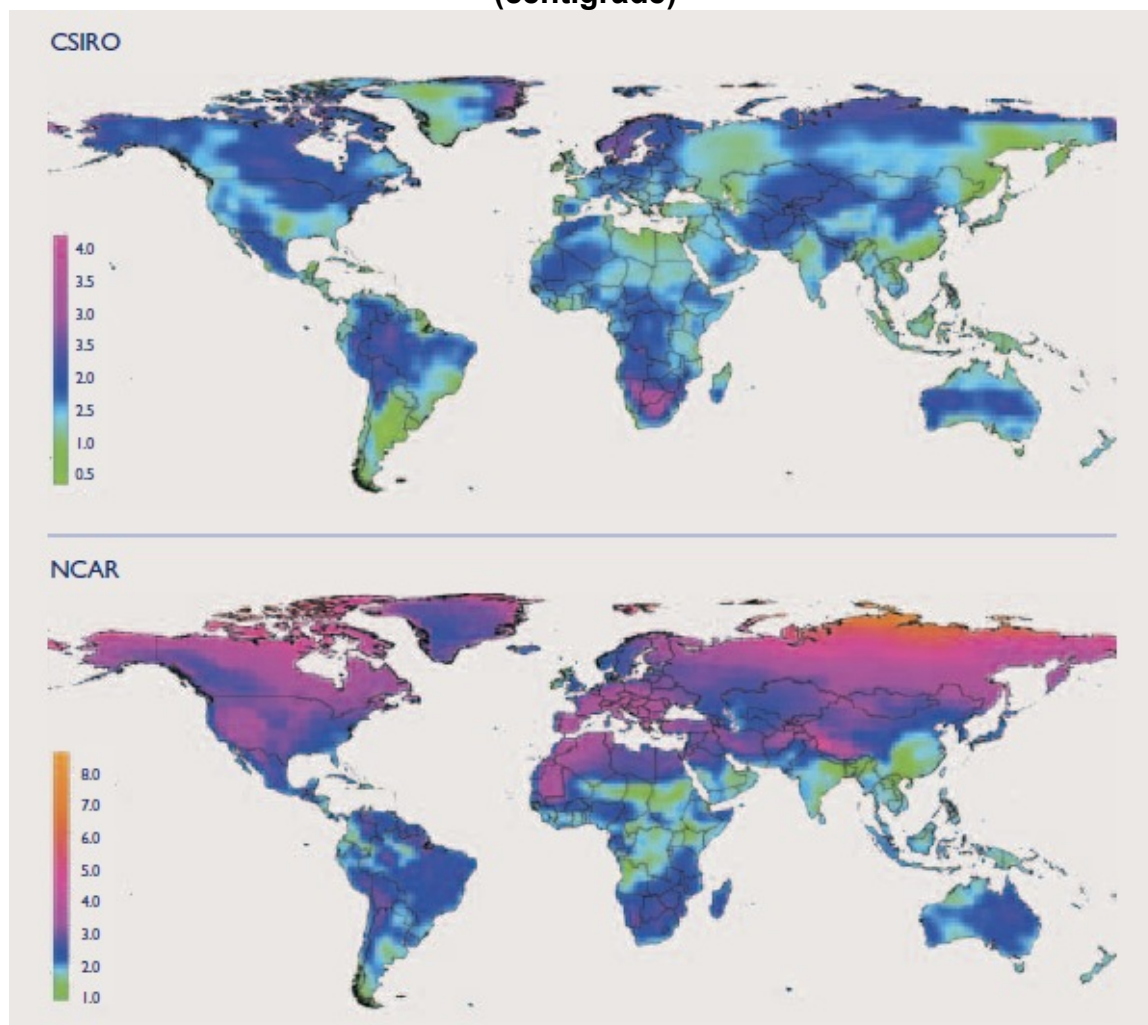
Source: Nelson et al (2009)

Figure 7: Change in Average Annual Precipitation, 2000-2050 (mm)
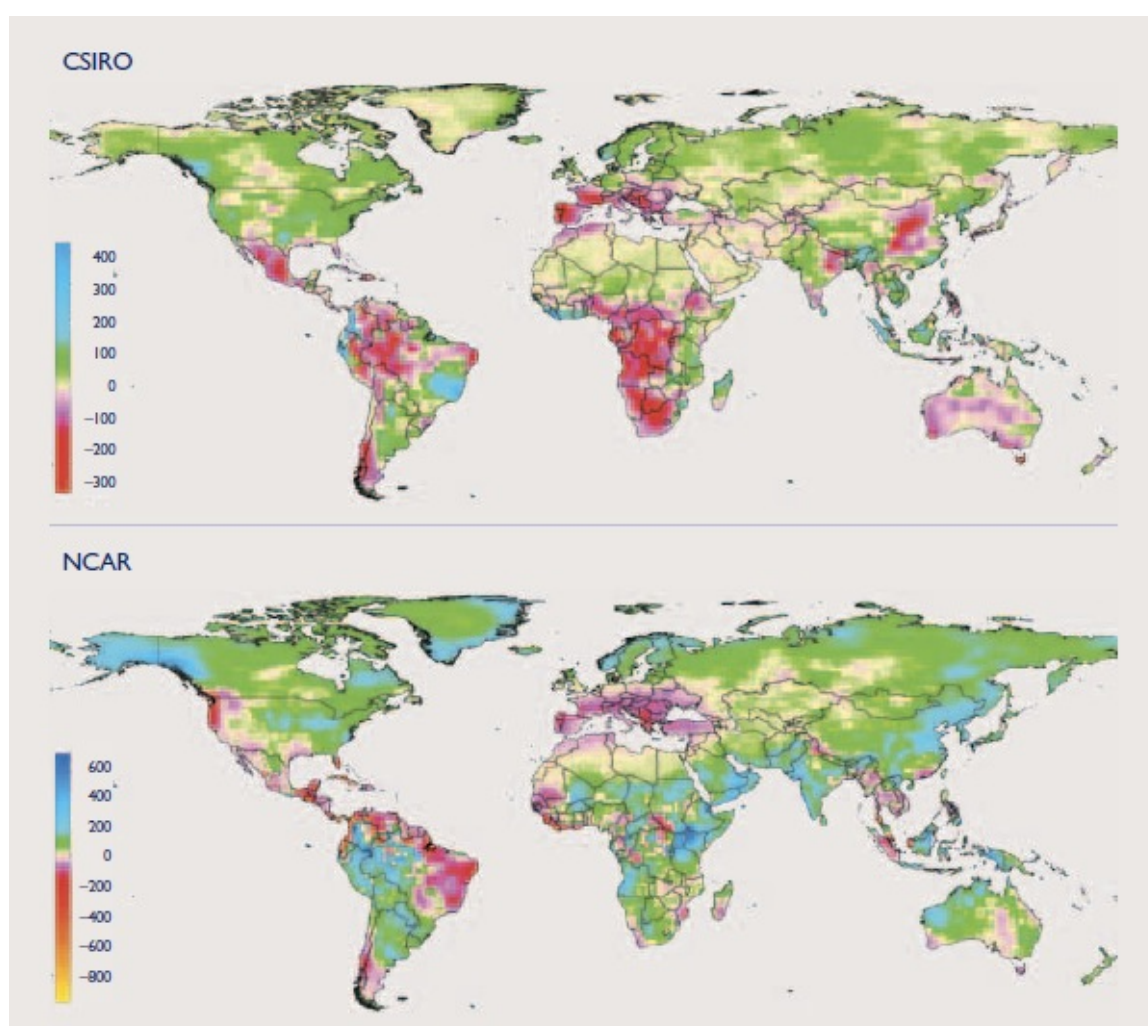
Source: Nelson et al (2009)

As Table 7 shows, despite significant estimated changes in temperature and rainfall patterns, increased CO_2 concentration will spontaneously contribute to agriculture yields in a way that significantly or in some cases fully offsets agricultural resource productivity declines. While these results give comfort to many who are concerned about the impact of climate change on global food security, it must be emphasized that the same research suggests that food prices will rise substantially during the same period, a predictable market response to animate needed resource shifting for adaptation in this sector.

Table 7: Impacts of Climate Change on Cereal Production, with and without CO2 Fertilization

	Change in cereal production compared to the Reference scenario (percent)											
	Hadley A2				CSIRO A2				Hadley A2, without CO2 fertilization			
	2020	2030	2050	2080	2020	2030	2050	2080	2020	2030	2050	2080
North America	1.9	-2.9	-2.9	-0.8	2.8	0.1	5.8	7.1	0.9	-3.9	-4.6	-4.8
Europe & Russia	0.8	2.0	1.8	1.5	0.5	1.7	1.0	3.1	0.1	1.0	0.1	-1.1
Pacific OECD	-2.2	2.4	9.5	14.0	2.5	6.9	7.0	18.2	-1.8	2.8	9.3	13.6
Africa, sub-Saharan	-1.3	0.3	-2.0	-2.5	-0.6	0.4	-2.9	-7.2	-0.9	0.6	-2.0	-2.2
Latin America	0.9	4.7	5.5	6.0	1.3	3.5	-0.7	0.9	1.3	5.0	6.4	8.0
Mid. East & N. Africa	-0.5	0.7	1.1	-1.0	5.2	7.7	7.4	-1.0	-0.7	0.3	0.3	-2.2
Asia, East	0.1	0.7	2.0	-2.8	-2.2	-2.8	-3.4	-7.2	-0.6	-0.4	0.2	-5.3
Asia, South/Southeast	-1.3	-1.3	-3.7	-12.2	-4.8	-5.9	-8.9	-12.8	-1.6	-1.9	-4.6	-13.2
Rest of World	-1.6	-1.7	-3.1	-4.6	-2.4	-2.8	-3.4	-4.6	-2.6	-3.4	-6.1	-9.0
Developed	1.2	-0.7	-0.3	0.5	1.7	1.1	4.2	5.9	0.3	-1.7	-2.0	-2.8
Developing	-0.3	0.7	0.2	-3.9	-1.8	-1.8	-4.2	-7.3	-0.6	0.2	-0.6	-4.9
World	0.3	0.1	-0.2	-2.2	-0.4	-0.6	-0.8	-2.1	-0.3	-0.7	-1.4	-4.3

Source: Fischer, 2009.

4. LONG TERM SCENARIOS FOR ASIAN REGIONAL FOOD SECURITY

For trade facilitation, we recognize the important regional initiatives of multilateras and GMS national governments to establish large transit corridors. These will significantly lower medium and long-distance market access costs, and can be expected to foster complementary infrastructure for feeder road and rail access that achieves more extensive participation. For the present scenario, we chose a central case that reduces trade, transport, and transit (TTT) margins for the low income GMS by 50%.

Finally, SCI has been a dramatic agent of growth elsewhere in the Asian region, and is likely to exert significant growth leverage on the low-income GMS as new opportunities arise for agro-food development and market access increases the average profitability of regional investments by reducing costs. As our reference case, we assume that SCI in each low-income GMS country rises linearly to 4% of GDP by 2020. For reference, this would place them in the world's top quartile by this metric, including both high (Singapore = 12%) and low income countries (Mongolia = 11%).

A. Scenarios

The dynamic CGE model was calibrated to a baseline time series reflecting a business-as-usual (Baseline) scenario over 2006–2020.[1] This Baseline comprises consensus forecasts for real GDP obtained from independent sources (e.g. International Monetary Fund, Data Resources International, and Cambridge Econometrics). The model is then run forward to meet these targets, making average capital productivity growth for each country and/or region endogenous. This calibration yields productivity growth that would be needed to attain the macro trajectories, and these are then held fixed in the model under other policy scenarios. Other exogenous macro forecasts could have been used and compared, but this is the standard way to calibrate these models.

As outlined in the introduction, the main objective of the present forecasting exercise is to assess the prospects for improving food security in Asia. To do this, we consider a combination of external risks and opportunities, comprising six scenarios explicated in Table 9 below. The risks are generic – rising energy prices and supply shocks to global agrifood markets. On the opportunity side, we consider four sources of greater efficiency and productivity for the region.

1.1.1 Facilitation of Trade and Market Access

Most agricultural households in rural Asia live behind high walls of market access barriers, including high transactions and transport costs with respect to remote markets, and these are often compounded by infrastructure and information constraints within and between country economies. As long as distribution margins remain high, low income agro-food enterprises with relatively low value products will be prevented from accessing markets. By converse reasoning, lowering market access costs and related margins enlarges the horizon of profitable trade for all, increasing commerce, capturing value added, and promoting self-directed poverty reduction.

1.1.2 Productivity Growth in Agriculture and Related Food Industries

Because of Asia's geographic diversity and substantial differences in stages of development, agricultural yields and productivity in livestock production vary

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[1] The forecasting tool used for these projections is a global CGE model, calibrated to the GTAP Version 7 database. Technical documentation is available from the authors.

tremendously across the region. In many country economies especially, agrifood production is far below its ultimate potential. Because of relatively small-scale land tenure patterns, it is unlikely that rural households in these countries can achieve significant livelihood improvements unless output per hectare improves substantially, and migration trends suggest that higher output per household member will also be essential.

Table 8: Average Annual Growth of Agricultural Output

	1970–1979	1980–1989	1990–1999	2000–2006
Sub-Saharan Africa	1.31	2.6	3.1	2.2
LatinAmerica and Caribbean	3.07	2.37	2.87	3.13
Brazil	3.83	3.73	3.29	4.41
Middle East and North Africa	2.94	3.37	2.73	2.34
NE Asia, High	2.15	1.03	-0.01	-0.01
NE Asia, Low	3.11	4.55	5.06	3.85
PRC	3.09	4.6	5.17	3.87
SE Asia	3.68	3.59	3.13	3.54
South Asia	2.56	3.39	3	2.19
India	2.69	3.52	2.94	2
North America	2.17	0.73	2.03	1.1
Oceania	1.79	1.25	2.93	-0.04
Western Europe	1.54	0.94	0.46	-0.35
Eastern Europe	1.8	0.25	-2.18	-0.19
Russian Federation	1.32	0.98	-4.62	2.7
Developing countries	2.82	3.46	3.64	3.09
Developed countries	1.88	0.86	1.21	0.39
Russian Fed. & Eastern Europe	1.47	0.77	-3.88	1.81
World	2.23	2.13	2.04	2.22

NE = northeast, SE = southeast

Sources: United States Department of Agriculture, World Bank

1.1.3 Supply Chain Integration

One of the defining characteristics of low-income economies everywhere is limited reserves of domestic saving, which in turn limits the progress of development by restricting investment in productive assets and enterprise expansion. The era of globalization has changed the nature of this constraint, however, with the advent of transboundary or Supply Chain Integration (SCI) that permits low-income countries to leverage foreign savings for domestic investment, technological change, and growth. To help low-income Asian economies achieve their economic potential in the most timely fashion, SCI can be an essential catalyst.

Table 9 summarizes the six core scenarios. After detailed examination of baseline regional growth characteristics, these are thought to best represent the salient policy issues addressed in the present study.

Table 9: Core Scenarios

Scenario	Name	Description
1	Energy Price Escalation	Assume prices of global fossil fuels rise 100% above baseline trends by 2030
2	Agrifood Supply Shock	Assume non-Asian nations experience declining agrifood exports, falling 20% below baseline trends by 2030
3	Infrastructure Investment for Trade Facilitation	Assume that investments and institutional changes effect a 50% reduction in trade, transport, and transit (TTT) margins for Asian countries
4	Trade Liberalization	Assume Asia achieves abolition of nominal trade distortions (import taxes and subsidies) across the region
5	Agro-Food Productivity	Assume that total factor productivity grows at 4% annually in agriculture and food processing sectors
6	Supply Chain Integration	In addition to Scenario 2, assume that, for country's, the stock of SCI rises to at least 15% of GDP by 2030.

GDP = gross domestic product, SCI = Supply Chain Integration

B. Macroeconomic Results

The macroeconomic results for the six scenarios, stated in terms of real GDP growth, are summarized in Table 10. Generally speaking, these results are consistent with intuition and a large body of related work on regional trade, agrifood productivity, and investment. The most salient findings are summarized as follows:

Energy price increases (EPrice) - If they emerge as part of a steady trend, higher oil prices can be accommodated without significant adverse impacts on the regional economies. In particular, a 100% increase in global fossil fuel prices would trigger the expected structural adjustments needed to reduce conventional energy intensity of GDP and keep the Asian economies on their expected growth trajectories. Noteworthy in this case is intensification of comparative advantage in less energy-intensive production, which benefits countries like Viet Nam and Philippines, while being adverse to conventional energy exporters like Malaysia and Kazakhstan. Overall, however, aggregate impacts are quite moderate.

Supply Shock (SShock) – Declines in food exports from non-Asian countries generally induces higher output in the region, which is to be expected from the significant underutilized agrifood capacity in the region. This impact is moderate overall, however, because the region is relatively self-sufficient in food.

Reduction in trade, transport, and tariff margins (TMarg and TrLib) – As many studies of regional and global trade liberalization have already demonstrated, removing hard and soft institutional and price barriers to trade would realize substantial efficiency gains and increase regional incomes. The benefits depend on two factors: prior protection/margin levels, and export competitiveness. The region as a whole would only increase GDP by 1%, but many lower income countries would see much greater gains because they face higher margins and trade barriers and they have significant export cost advantages. These results strongly support the argument that Asian regional trade facilitate is Pareto improving and promotes regional livelihoods convergence – good for every country, small in overall impact, but more positive for poorer countries (Figure 9).

Figure 9: Real GDP by country, Cumulative Percent Change 2010-2030
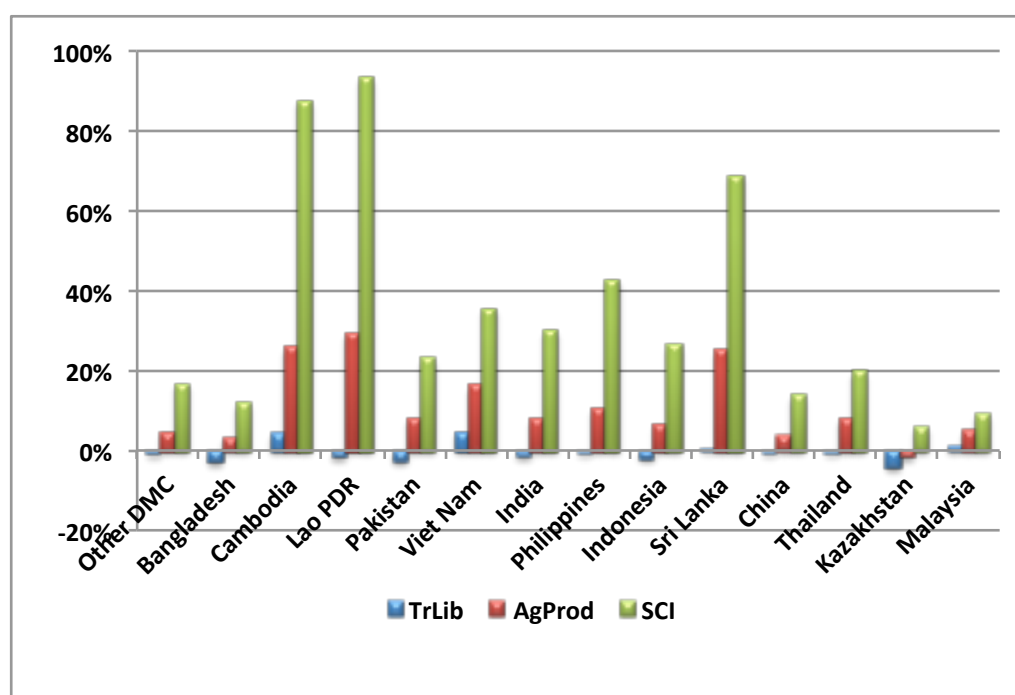
Source: Author estimates.

Agrifood Productivity Growth (AgProd) - Given the importance of agrifood to incomes most of Asia's poor, where rural dwellers still constitute a significant majority of total population, it is hardly surprising that rising productivity for agrifood has a dramatic effect on regional real GDP.[2] Because higher income countries are more diversified and less impacted on the income side, the aggregate impact is modest, but again we see much larger benefits for lower income economies. Even moderate productivity growth like that specified in Scenario 5 would increase cumulative GDP by double digit percentages in most Countries.[3] Again we see a Pareto impact, improving real incomes across the entire region, but most so among lower income economies.

Table 10: Real GDP by country, Cumulative Percent Change 2010-2030

	EPrice	SShock	TMarg	TrLib	AgProd	SCI
Other	1.5%	1.7%	2.5%	2.9%	8.9%	18.7%
Bangladesh	0.2%	0.5%	1.2%	1.2%	6.9%	11.4%
Cambodia	-0.4%	0.0%	4.9%	13.1%	40.9%	61.0%
Lao PDR	0.1%	0.8%	1.8%	4.4%	49.0%	55.1%
Pakistan	0.0%	0.2%	0.6%	0.9%	13.4%	17.9%
Viet Nam	2.1%	2.8%	6.2%	12.3%	27.4%	33.3%
India	0.1%	0.2%	0.8%	2.4%	14.8%	22.5%
Philippines	1.1%	1.7%	3.2%	2.5%	15.7%	32.7%
Indonesia	0.2%	0.7%	1.4%	1.6%	12.7%	20.0%
Sri Lanka	0.2%	0.9%	1.6%	1.9%	28.9%	30.1%
China	0.2%	0.3%	1.1%	1.4%	5.5%	13.6%
Thailand	-0.2%	0.4%	1.7%	3.3%	13.6%	15.1%
Kazakhstan	-0.7%	-0.7%	-0.1%	0.0%	2.3%	10.1%
Malaysia	-0.2%	0.0%	0.8%	3.8%	8.0%	9.5%
HiInc Asia	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%
All Asia	0.1%	0.2%	0.6%	1.0%	4.8%	8.8%

Note: In this and subsequent tables, countries/regions are listed in order of increasing per capita income.

Source: Author estimates.

Greater Asian Regional Supply Chain Integration (SCI) - More intensive use of SCI within Asia would significantly increase long term growth in the region. For this experiment, about USD1.8 trillion of additional external investment was brought into the Asian region (about half today's Asian dollar reserves) over a 20 year period.[4]

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[2] See Jha et al (2010) for more on this aspect of growth, particularly its historical context.
[3] China's agrifood productivity was not increased in these scenarios because it is already at high growth rates in the baseline.
[4] China, Thailand, and Malaysia remained on Baseline SCI trends because of high initial stocks.

These monies significantly increased real growth rates, particularly in lower income Countries, some cases doubling the benefit of agrifood productivity growth. Overall, they contributed to USD3.5 trillion in additional real GDP, nearly double the investment (Table 11). Clearly, regional allocation of investment resources can be a potent catalysis for growth, particularly in lower income countries where domestic savings are a serious constraint.

Table 11: Real GDP by country, Cumulative 2010 USD Billions, 2010-2030

	EPrice	SShock	TMarg	TrLib	AgProd	SCI
Other	11	13	19	22	68	142
Bangladesh	1	3	7	8	42	69
Cambodia	0	0	4	9	29	44
Lao PDR	0	0	1	1	15	17
Pakistan	0	2	6	10	143	191
Viet Nam	11	15	33	65	145	177
India	6	17	69	201	1,252	1,903
Philippines	10	15	28	22	139	290
Indonesia	6	18	38	43	332	521
China	44	87	296	374	1,447	3,567
Thailand	-2	6	24	48	195	217
Kazakhstan	-4	-4	-1	0	13	58
Malaysia	-3	0	9	44	93	110
Sri Lanka	0	2	3	4	61	63
HiInc Asia	-20	-19	-5	2	150	162
All Asia	61	155	532	853	4,125	7,532

Source: Author estimates.

The next three tables give more detailed macroeconomic results for three generic scenarios, 4, 5, and 6. Scenario 4 can be thought to represent the composite of external risks (energy and food prices), combined with a first set of policy responses (regional trade facilitation). We see from the results in Table 12 that such regional integration is a credible "first line of defense" in the sense that it benefits every member country and some significantly so. Indeed, real GDP benefits understate the gains to Asian households, more accurately reflected in the Equivalent Variation (EV) income effects of the last column. Although consumption prices (CPI) increase because of the adverse shocks, trade facilitation expands income opportunities to

more than offset this. Significantly if not surprisingly, trade volumes increase sharply for member countries, further acceleration regional integration.

Table 12: Trade Liberalization and Margin Reduction (TLMR), Macroeconomic Impacts

(cumulative percent change, 2010-2030)

	GDP	Output	Exports	Imports	Cons	CPI	EV Inc
Other	3%	5%	46%	57%	11%	3%	11%
Bangladesh	1%	0%	14%	12%	2%	0%	2%
Cambodia	15%	5%	29%	67%	40%	3%	39%
Lao PDR	2%	0%	32%	36%	10%	4%	10%
Pakistan	1%	0%	10%	6%	2%	1%	2%
Viet Nam	5%	10%	52%	75%	26%	6%	26%
India	0%	1%	60%	68%	3%	0%	2%
Philippines	2%	2%	9%	16%	7%	5%	7%
Indonesia	3%	1%	26%	42%	6%	5%	6%
Sri Lanka	2%	0%	12%	14%	6%	2%	6%
China	1%	1%	25%	29%	2%	3%	2%
Thailand	0%	3%	23%	29%	9%	1%	9%
Kazakhstan	0%	0%	6%	13%	4%	2%	4%
Malaysia	1%	5%	13%	16%	6%	-1%	5%

Source: Author estimates.

The second line of policy initiative, promoting agrifood productivity growth, dramatically increases the benefits of a more liberal regional trading environment. Indeed, trade volume increases in many cases are multiplies of those under simple trade facilitation (TLMR). This clearly underlines the need for complementary policy's to reap the full benefits of regional integration, particularly in a sector like agrifood which has strong pro-poor multiplier effects. In terms of income, we see very strong stimulus to both GDP and EV income in lower income economies, logically as these are still comprise of agrarian majorities.

On the demand side, this scenario is particularly significant because it shows the reversal of consumer price effects in many low income countries. This finding reminds us that, while important, energy expenditures are a much smaller share of household income than food products. Livelihoods protection and promotion, it is clear from these results, begins at the foundation of basic needs for the poor, food.

Policy complementarity is also plainly evident in the SCI results, where we see strong growth across the entire region and most so among lower income, more saving-constrained economies. SCI is of course not merely an income transfer, but an agent for investment, technology transfer, and access to export opportunities. All three of these features act in synergy with domestic resources, especially those that are relatively abundant and low cost. For this reason, reallocation of Asian financial reserves from lower growth, high income OECD economies can be expected to yield higher absolute returns, returns that can benefit both the investors and those in the destination countries. It remains an ironic fact that some of the destination countries of the last great race for emerging market investment (1990-2010) are now in a position to join the other side of this process, yet they have left large financial reserves at the starting gate.

Table 13: TLMR and Agrifood Productivity Growth (APG), Macroeconomic Impacts

(cumulative percent change, 2010-2030)

	GDP		Output	Exports	Imports	Cons	CPI	EV Inc
Other		10%	14%	70%	73%	19%	1%	19%
Bangladesh		8%	7%	39%	24%	9%	-3%	9%
Cambodia		44%	33%	56%	66%	65%	-3%	62%
Lao PDR		47%	33%	124%	50%	48%	0%	45%
Pakistan		15%	12%	51%	13%	12%	-4%	10%
Viet Nam		24%	23%	74%	84%	42%	3%	41%
India		16%	12%	110%	82%	15%	-4%	14%
Philippines		16%	13%	30%	18%	17%	3%	16%
Indonesia		15%	11%	56%	49%	15%	4%	15%
Sri Lanka		34%	21%	86%	32%	25%	3%	23%
China		6%	4%	25%	29%	11%	0%	11%
Thailand		9%	12%	42%	35%	16%	1%	16%
Kazakhstan		3%	3%	9%	17%	7%	0%	7%
Malaysia		6%	8%	16%	19%	15%	-5%	11%

Source: Author estimates.

In any case, increasing the depth and scope of Asian SCI should be a high priority for regional policy makers, particularly in an era of global growth uncertainty. Taken together, Asian economies are no longer small relative to their historical destination markets, and it is not realistic to expect high growth rates via rapid expansion of domestic market share in slow growing OECD economies. For this reason, Asia

represents a logical source of investment diversification for itself, not only for the usual portfolio risk reduction benefits, but because the region represents most of the world's superior national growth rates already.[5]

Table 14: TLMR, APG, and SCI, Macroeconomic Impacts

(cumulative percent change, 2010-2030)

	GDP	Output	Exports	Imports	Cons	CPI	EV Inc
Other	25%	21%	60%	97%	30%	3%	30%
Bangladesh	15%	7%	-9%	43%	17%	3%	16%
Cambodia	71%	49%	47%	97%	88%	-3%	85%
Lao PDR	53%	42%	64%	84%	64%	3%	60%
Pakistan	19%	16%	18%	39%	22%	1%	20%
Viet Nam	31%	25%	68%	96%	50%	5%	49%
India	29%	18%	53%	134%	27%	0%	25%
Philippines	35%	30%	26%	52%	38%	5%	37%
Indonesia	31%	16%	36%	84%	26%	7%	26%
Sri Lanka	38%	22%	69%	48%	31%	7%	28%
China	23%	10%	6%	52%	21%	3%	21%
Thailand	10%	13%	44%	37%	19%	3%	19%
Kazakhstan	14%	10%	-3%	39%	15%	2%	15%
Malaysia	7%	10%	20%	23%	18%	-4%	13%

Source: Author estimates.

C. Food Security

National policies in all countries are strongly influenced by the most basic forms of economic security, i.e. personal health, safety, and nutrition. In lower income countries, the risks associated with these basic needs are higher because a larger proportion of the population is vulnerable, not meeting basic needs, or worse. In countries with large poor urban populations, food vulnerability relates mainly to consumption goods, while for rural poor it affects income as well as consumption. We have seen in above that the Asian region faces many uncertainties regarding food output and availability, and that there are many ways to measure the attendant risks. In this section we examine the long term forecasts from this perspective.

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[5] See Roland-Holst and Weiss (2004), Roland-Holst et al (2005), and Roland-Holst and Brooks (2007) for extensions of these arguments.

We saw that trade facilitation, agrifood productivity growth, and greater inbound SCI all have the potential to contribute substantially to Asian livelihoods. What they can do for food security is suggested first by the results of Table 15, which presents national changes in total agrifood output for each scenario and country/region analyzed. As above, we focus attention on the last three scenarios.

Table 15: Agrifood Output by country, Cumulative Percent Change 2010-2030

	EPrice	SShock	TMarg	TrLib	AgProd	SCI
Other	-1.4%	-0.3%	-2.7%	-2.3%	31.3%	33.0%
Bangladesh	0.6%	1.7%	-0.6%	-0.3%	14.3%	15.4%
Cambodia	-2.3%	-1.2%	-3.9%	-35.2%	49.9%	63.9%
Lao PDR	0.4%	0.5%	-0.9%	-9.0%	27.9%	51.7%
Pakistan	0.0%	0.8%	0.3%	0.1%	24.0%	30.7%
Viet Nam	-1.0%	-0.3%	2.4%	-24.5%	14.5%	15.4%
India	-0.2%	0.4%	0.3%	-11.3%	13.9%	16.7%
Philippines	-0.2%	0.9%	-1.6%	-1.1%	22.8%	42.2%
Indonesia	-0.1%	1.2%	0.4%	1.2%	25.6%	27.9%
Sri Lanka	-0.6%	-0.8%	-5.1%	-4.1%	21.0%	28.4%
China	-0.4%	1.2%	0.6%	-1.1%	27.0%	30.6%
Thailand	0.2%	2.1%	-2.0%	-12.5%	6.9%	6.0%
Kazakhstan	0.0%	1.6%	2.5%	2.5%	7.1%	18.2%
Malaysia	2.1%	7.8%	13.2%	18.2%	31.1%	44.4%
All Asia	-0.3%	1.0%	0.4%	-4.0%	22.0%	26.0%

Source: Author estimates.

The impact of trade facilitation on national agrifood output is ambiguous, as would be expected from the logic of basic Ricardian trade theory. Although trade regional facilitation increases efficiency and thus induces higher aggregate income in all member countries, simply removing trade distortions has the effect of intensifying pre-existing patterns of comparative advantage. Thus countries with established and emerging competitiveness, and low resource cost in rural areas, will see resources pulled from agriculture toward light and heavy manufacturing. Even countries like Thailand, with high levels of agrifood industrialization, are more constrained by trade margins and tariffs against other industries. When these come down, the latter expand at the expense of agrifood. This threat to agrifood competitiveness has been a persistent controversy in trade agreements, particularly between (heavy agro-subsidy) North and South partners, for decades.

Agrifood's loss of competitiveness is by no means inevitable, however, and the most constructive approach to realizing the aggregate gains from greater regional trade efficiency is to promote agrifood productivity growth as a complementary policy. When this is done (AgProd scenario), our results indicate that the benefits are uniformly positive across the region (Figure 10). In particular, even moderate productivity growth (4%/annum) is enough to reverse large adverse effects and achieve over 30% higher cumulative agrifood output in some countries by 2030.

The intuition behind this process is simple. Higher farm productivity not only keeps domestic agrifood production competitive, but it enables the release of labor resources to other sectors stimulated by trade facilitation, creating a win-win growth setting for both rural and urban sectors. Finally, higher levels of SCI consolidate these gains in both sectors, improving national efficiency, further raising labor productivity and real wages.

Figure 10: Agrifood Output Changes, cumulative percentage, 2010-2030
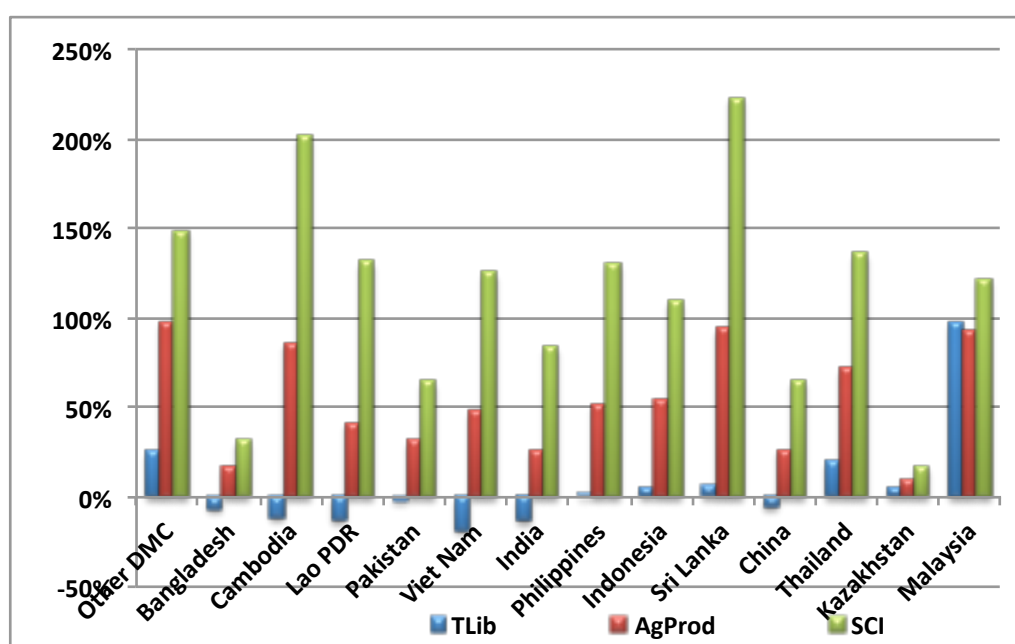
Source: Author estimates.

**Figure 11: Changes in Agrifood Output Resulting from
Productivity Growth (Blue) and Supply Chain Integration (Green)**

(Cumulative percent, 2010-2030)
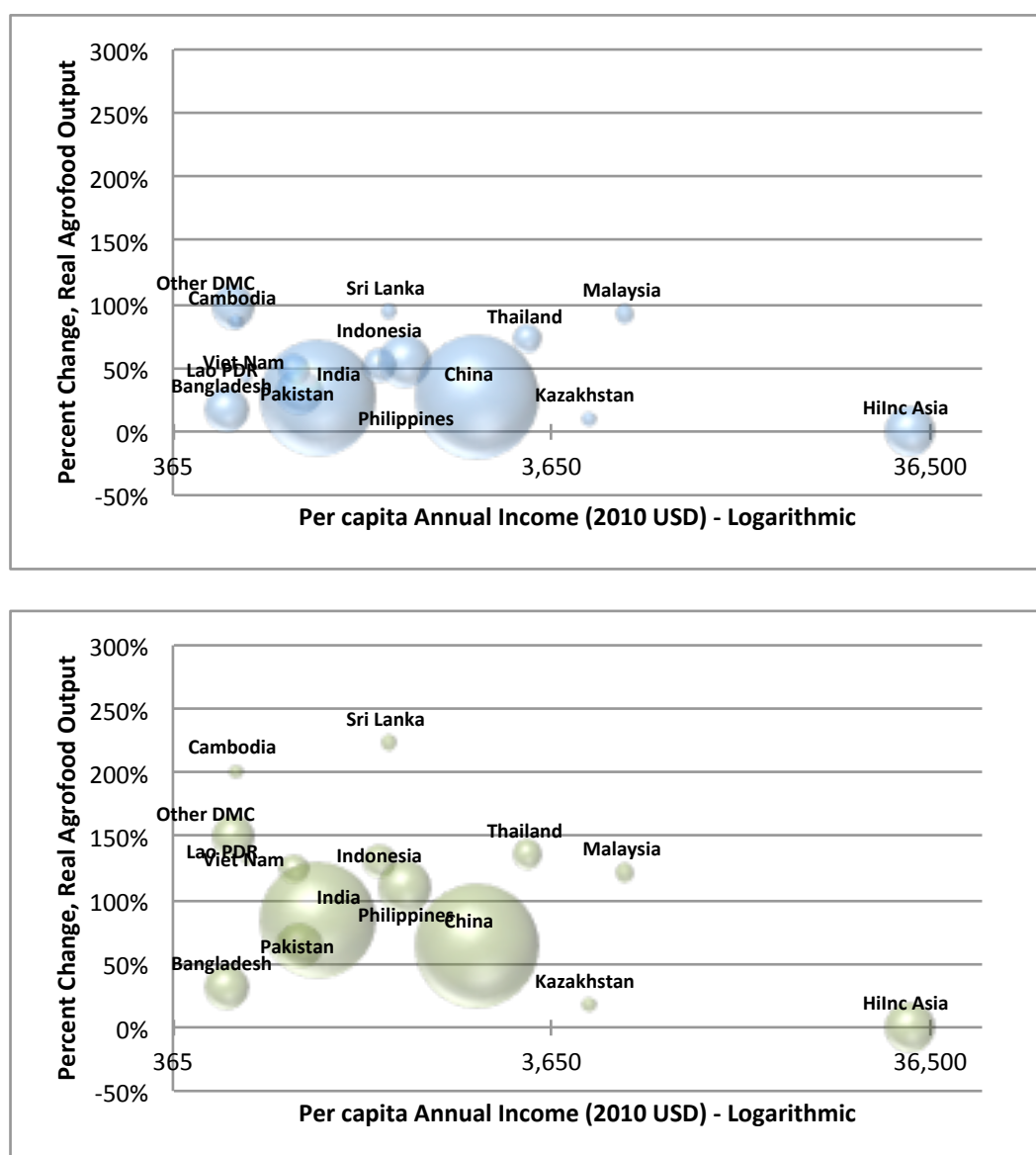
Source: Author estimates.

As discussion of the adjustment mechanisms suggests, the primary agrifood benefits in these scenarios relate to more efficient recruitment of relatively low wage and low price resources in the rural sectors of low income countries. This logic has a corollary that the policies should be pro-poor across Asian countries. The concept of regional economic convergence is of particular importance to Asia, which comprises countries with very diverse livelihoods conditions. As Figure 11 makes clear, the policies considered will make important contributions to this convergence, enhancing relative growth in low income countries more than in high income countries. Although

outcomes vary for reasons other than average income levels, there is a clear downward trend in these national results, particularly when weighted by population. Of particular importance is the SCI scenario, where regional capital mobility and expanded contractual networks helps lower income countries overcome local capital consraints and more fully realize their agrifood potential.

5. CONCLUSIONS

With greater regional integration in Asia, agrifood exporting countries may benefit from increased foreign investment and technological transfer in agricultural supply chains while achieving greater market access in high-demand rising income economies, most notably China. Attaining food security in a world with high food prices will remain a challenge but proper policy, appropriately targeted investment and improvements in agricultural supply chains hold the potential for improved livelihoods and food security across the region.

Using a global dynamic forecasting model, we examined the long term nature of Asian food security in the context of energy and food price risk, as well as policy responses including regional integration, agrifood productivity growth, and greater regional supply chain integratio (SCI). Our results strongly support these three types of policies as essential to sustained regional growth, greater food security, and economic convergence or pro-poor Asian growth. These results have many detailed lessons at the national and sector level, but a few salient conclusions emerge:

Energy price increases, if they emerge as part of a steady trend, higher oil prices can be accommodated without significant adverse impacts on Asian developing economies.

Declining food exports from non-Asian countries generally induces higher output within the region, which is to be expected from the significant underutilized agrifood capacity in the region.

Reduction in trade, transport, and tariff margins would realize substantial efficiency gains and increase regional incomes. The benefits depend on two factors: prior

protection/margin levels, and export competitiveness. These results strongly support the argument that Asian integration is Pareto improving and promotes regional livelihoods.

Given the importance of agrifood to incomes most of Asia's poor, where rural dwellers still constitute a significant majority of total population, it is hardly surprising that rising productivity for agrifood has a dramatic positive effect on regional real GDP. Even moderate productivity growth like that specified in our scenaios would increase cumulative GDP by double digit percentages in most countries. Again we see a Pareto impact, improving real incomes across the entire region, but most so among lower income economies.

More intensive and extensive use of SCI within Asia would significantly increase long term growth in the region. For this experiment, about USD1.8 trillion of additional external investment was brought into the Asian region (about half today's Asian dollar reserves) over a 20 year period. These monies significantly increased real growth rates, particularly in lower income countries, some cases doubling the benefit of agrifood productivity growth. The results show clearly that regional supply chain expansion, with its attendant benefits of technology transfer and enhanced market acces, can be a potent catalysis for growth, particularly in lower income countries where domestic savings are a serious constraint. These policies not only significantly increase the regions food output and availability, they are good for growth, good for every country, and better for the poor.

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PPLPI Research Reports have not been subject to independent peer review and constitute views of the authors only. For comments and / or additional information, please contact:

David Roland-Holst
Department of Agricultural and Resource Economics
207Giannini Hall
University of California Berkeley
CA 94720 - 3310 USA
E-mail: dwrh@berkeley.edu

Songsak Sriboonchitta
Faculty of Economics
Chiang Mai University
239 Huay Kaew Rd
Chiang Mai 50200 THAILAND
Email: sriboonchitta@yahoo.com

Or visit the PPLPI website at: www.fao.org/ag/pplpi.html