Convergence in Agriculture of Some Asian Countries

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Abstract

An agricultural growth model is proposed to verify the agricultural convergence hypothesis among some Asian countries following the method of Barro and Sala-i-Martin (1992) and Sala-i-Martin (1996). Conditional convergence of agriculture is facilitated by foreign aid intended for agriculture and spatial externalities associated with foreign trade. However, foreign aid for agriculture may not serve the purpose of mobilizing resources for an environment conducive to development, but rather may function as a substitute to public expenditure for the sector.

Keywords: agricultural growth, convergence, trade, foreign aid, public expenditures

JEL Classification: Q17, O13, H50

I. INTRODUCTION

GDP growth in Asia is highly diverse. Some countries have exhibited consistently high growth in recent years while others have shown erratic patterns of expansion and contraction. In 2005 some countries in Central and West Asia posted double digit positive growth while negative growth was experienced in the Kyrgyz Republic. Rapid growth among East Asian countries was observed with the People's Republic of China (PRC) leading at 9.9% in 2005; its growth has consistently hovered around this level since 2000. In Southeast Asia, Myanmar posted 12.2% in 2005, while some countries in the region also experienced rapid growth and others exhibited slow growth. In South Asia, while India led at 8.4% in 2005, other countries were also picking up steam. Some countries, however, posted negative growth in the period 2000–2005. The Pacific Islands exhibited erratic growth patterns from 2000 to 2005.

The post-financial crisis speed in GDP growth is not a result of agricultural growth since in most countries agriculture contributes less than a third of GDP. Except for Myanmar and the Lao People's Democratic Republic (Lao PDR), where the agriculture sector still contributes about half of GDP, many countries in the Asia Pacific region have agriculture contributing less than 10% of GDP. This may be viewed as a potential indicator of rural development, but the dramatic drop in the share of agriculture since 1990 should be examined carefully. Although diversification of economic activities in rural areas is necessary for alleviating the vulnerability of rural households due to excessive dependence on agriculture, agriculture needs to maintain a production level that will meet the food requirements of the growing population. The diminishing share of agriculture may be loosely related to the flow of official development assistance for agriculture in the region. Of the total aid for agriculture among developing countries worldwide in 2004, only 16% went to Asian and Pacific countries; their share has barely exceeded a third of total world development assistance for agriculture since 1994.

Growth of agriculture in Asia has exhibited an entirely different pattern from GDP growth. The countries with rapidly growing GDP are not necessarily the same countries growing as fast in the agriculture sector. While GDP growth is fueled by manufacturing and services benefiting from increasing commodity specialization among countries in the region, the limitations in the size and quality of arable land impose a natural constraint on the growth of the agriculture sector. Given the natural boundaries in the factors of agricultural production, the only possible source of growth for this sector is in more efficient utilization of the limited resources available. In countries where farmers are bound to the limitations of available rural infrastructure, optimal production cannot efficiently be achieved but appropriate intervention is still feasible to target growth. Countries whose production potential may have reached the threshold are only aiming for the loose concept of sustainability of the production level.

Given these patterns in GDP and agriculture growth, is it possible for Asian countries to attain equality in agricultural production? Agricultural production should be within the sustainable level considering that the proportion of world population residing in the region (developing member countries of ADB) has remained around 54% since 1990 (ADB, 2006).

This paper will explore some concepts of spatial-temporal modeling in the verification of a convergence hypothesis of agricultural growth in Asia. Specific dynamics of convergence will be explored, e.g., the role of foreign trade, official development assistance intended for agriculture, and public expenditures. The role of foreign trade will be examined in the context of spatial externalities affecting agricultural growth among "neighboring" countries within the region.

The data used in this paper are obtained from Key Indicators 2006 (ADB, 2006) and International Development Statistics Online (OECD, 2006). Key Indicators 2006 covers only

the Developing Member Countries (DMCs) of ADB and does not include Japan and non-member Asian countries. Pacific countries were also excluded from the analysis because they engaged in minimal trade transactions with other countries in the region and time series data for key indicators is limited. Thus, a total of 27 countries were included in the analysis, forming a panel in the period 1995–2005.

The effect of foreign aid on the economy has been in the center of discourse in the economic literature. The more recent examples have been discussed by Burnside and Dollar (2000) and Easterly (2003). The effect of aid on specific sectors like agriculture has not been given much attention. In contrast to the effect of aid on the economy, which as a whole has not been consistent and has triggered much debate especially on issues of policy implications, the effect on specific sectors needing it most could exhibit a different picture, generating insights on sector-targeted aid. This study will also contribute theoretical and empirical evidence on the dynamics of regional integration/cooperation accomplished through international trade.

II. GROWTH AND REGIONAL COOPERATION

Regional cooperation is a necessary instrument in the international political economy to ensure that inadequacies and needs of one country can be offset by another country. One way in which regional cooperation is implemented is through policies facilitating preferential trading arrangements among cooperating countries.

The goal of any economic program in a developing country is sustainable development. Liberalization of the trade policies among countries has stimulated an increasing trend of specialization and differentiation of economic activities. For economic security, each country sometimes needs to push production beyond the sustainable level. As an alternative, international trade can help neutralize the possibility of exceeding the sustainable production level. However, this will lead to another possible problem since the welfare benefits of globalization may lead to inequality and deprivation especially within the labor sector, and in developing economies in general. In countries involved in a regional cooperation effort, convergence of growth can provide a clue as to how the negative welfare benefits of globalization can be minimized if not completely eliminated.

This study focuses on agriculture in the context of limitations and the threat towards sustainability. Growth in other sectors can be propelled with investments attracted through market-conducive policy changes, but due to natural constraints in agriculture, growth must be driven by efficiency-inducing public expenditures and development assistance. As Ruttan (2002) pointed out, increases in agricultural production were initially accomplished by increasing the area cultivated, but towards the end of the 20th century, growth began to come instead from increasing productivity. Among developing countries, where agriculture is still dependent on the endowments of natural resources, appropriate strategies can be adopted to drive growth that can contribute to the growth of the economy as a whole. Agriculture can also be the instrument among developing countries to gain access to markets in industrialized countries, thus facilitating convergence.

There is a potential conflict between free trade and sustainability. While environmental concerns and trade are integrating components of economic growth, Weiss (1992) pointed out that often, environmental protection included in free trade agreements is viewed to have an adverse effect on free trade relationships. Although a protectionist argument holds that free trade policies can be a stimulus for industries to migrate to areas with lower environmental standards, there has been no empirical evidence to support this argument. Furthermore, trade theory legalizing imperfect competition (see Krugman, 1993, for details) paved the way for government intervention (policy changes and/or public investment) as an

important element of economic growth in the direction of integrating an economy in a regional cooperation setting.

Regionalism is defined not solely within the confines of geographic proximity, but rather in terms of the relationship between economic flows and policy choice (Mansfield and Milner, 1999). With preferential trading arrangements (PTAs) and instruments, regionalism can facilitate the realization of economies of scale. The formation of the Association of Southeast Asian Nations (ASEAN) and later of the ASEAN Free Trade Area (AFTA) is one initiative aimed towards greater regional integration (Bowles, 1997). The organization was meant to provide a stronger bargaining instrument among member countries, but the proliferation of other regional bodies, bilateral agreements, and multilateral agreements led towards more debates on the individual incentive expected by a member country. Member countries can realize the benefits from economies of scale, but the overlapping PTAs within and outside the region may block the real incentives for regional integration, leading us to return to the question of convergence among the member countries.

Economic integration may also lead to increasing worker insecurity among advanced economies. However, Scheve and Slaughter (2004) emphasized that foreign direct investment (FDI) by multinational enterprises (MNEs) is the part of integration that generates such risk. FDI by MNEs increases the elasticity of demand for labor by the individual firms and this increases the volatility of wages and employment, creating an insecure environment for the workers.

The trends and future direction of international economic integration were analyzed by Rodrick (2000), who noted that this integration is still remarkably limited, possibly because of tariff and non-tariff barriers, linguistic or cultural differences, exchange rate uncertainty, and many other obstacles. A possible alliance of convenience was predicted between the perceived losers (e.g., labor groups) and winners (e.g., exporters) resulting in global federalism that would most likely be a combination of traditional forms of governance with regulatory institutions that would have multiple jurisdictions and be accountable to multiple types of representative bodies.

A positive note by Venables (2003) is that regional cooperation and integration is one key instrument for economic development and poverty reduction. He noted further that integration between low income countries tends towards convergence among member countries, while integration between high income countries tends towards divergence among member countries. The implications and consequences of regional integration, conventions, and other regional agreements need careful study because appropriately chosen agreements between matching countries can contribute to resolving issues of inequality in income distribution. Interventions and policies can be started at the local or regional level, among entities that can potentially converge in some way. This is a more feasible strategy than targeting global convergence all at once.

III. FOREIGN AID AND CONVERGENCE

Assuming homogeneous preferences for technology adoption, the neoclassical growth theory leads towards convergence of growth among economies, where poor countries will grow faster to catch up with the rich countries experiencing a diminishing return to capital. The ultimate by-product of convergence is equality of income. Barro and Sala-i-Martin (1992) explored mathematical approaches to understand convergence, and proposed some empirical strategies for testing the convergence hypothesis. Sala-i-Martin (1996) proposed that the existence of convergence across economies can be used as the main test of the validity of modern theories of economic growth and the speed of convergence provides information on the share of capital in the production function (a parameter in growth theory).

Absolute or β-convergence occurs when poor economies tend to grow faster than rich ones while σ-convergence occurs when the dispersion of their real per capita GDP levels tends to decrease over time. Conditional convergence was also defined to occur when the growth rate of an economy is positively related to the distance that separates it from its own steady state. He further noted that lack of convergence is more interesting as the degree of cross-country income inequality not only fails to disappear, but rather tends to increase over time (σ-divergence). That result of convergence analysis can be used by political economists in devising interregional institutions which may work to overturn the growing income inequality.

One relevant question is, supposing that for some reasons economies in a region will converge, what could drive their growth to achieve this convergence? The diminishing return to capital argument may work well on the assumption of homogeneous technology adoption. This also imposes an implicit assumption that economies are efficient enough in utilizing the factors of production available to them. Foreign aid is postulated as one possible source of capital that will fuel faster growth among the low-income economies and enable high-income economies to achieve sustainability.

Durlauf (1996) examined studies that provide evidence of convergence and observed that they were consistent with the growth pattern described in the neoclassical growth of Solow, but contradicted the endogenous growth models. Among these studies, there are alternative perspectives that may be explained by a combination of the definition used, class of theoretical growth models, and econometric method used. Bernard and Durlauf (1996) noted that the empirical growth literature has produced diverse definitions and testing procedures as well as conflicting conclusions with respect to the convergence hypothesis. Neither a cross-section nor a time series testing framework is likely to yield unambiguous conclusions relative to different growth models. The authors noted that the bulk of cross-section evidence on convergence that has thus far appeared can be construed as consistent with some versions of the new growth theory (endogenous growth) and the time series results accepting the no convergence null may be due to transitional dynamics in the data. They proposed further that a step ahead for both approaches would be in the theme of integration of the transition information in the cross-section approach with the steady state information in the time series approach to create a more general empirical approach.

Among the middle- and lower-income countries, fiscal policy is influenced by official development assistance (ODA) through the generation of incentives and opportunities for the expansion of public expenditure (Remmer, 2004). However, aid has failed to mobilize resources towards development. Furthermore, dependence on aid is caused by reduced revenue generation. The careful scrutiny of aid policies is thus imperative: inappropriate policies in which aid is used interchangeably with public expenditure and thus becomes a disincentive for revenue generation seem to motivate further aid dependence. Policy reforms that truly mobilize resources are needed to trigger development.

The observation of Remmer (2004) affirms the earlier empirical work of Burnside and Dollar (2000) on the strong positive correlation between bilateral aid and public expenditure. According to Burnside and Dollar (2000), this correlation can be the reason that aid has a minimal impact on growth in general. However, conditional on a good policy environment, aid can yield a bigger positive impact on growth. This has serious repercussions for the allocation of aid among developing countries. It is important to target the original goal of aid in influencing policy reforms that will mobilize development-driving resources. There is also empirical evidence that aid managed multilaterally is decided conditional upon good policy while aid related to bilateral agreements is impartial to the quality of the policy environment of the receiving government.

Some cautions on the results of Burnside and Dollar (2000) are provided by Easterly (2003): since econometric analysis is dependent on so many factors, each set can generate different

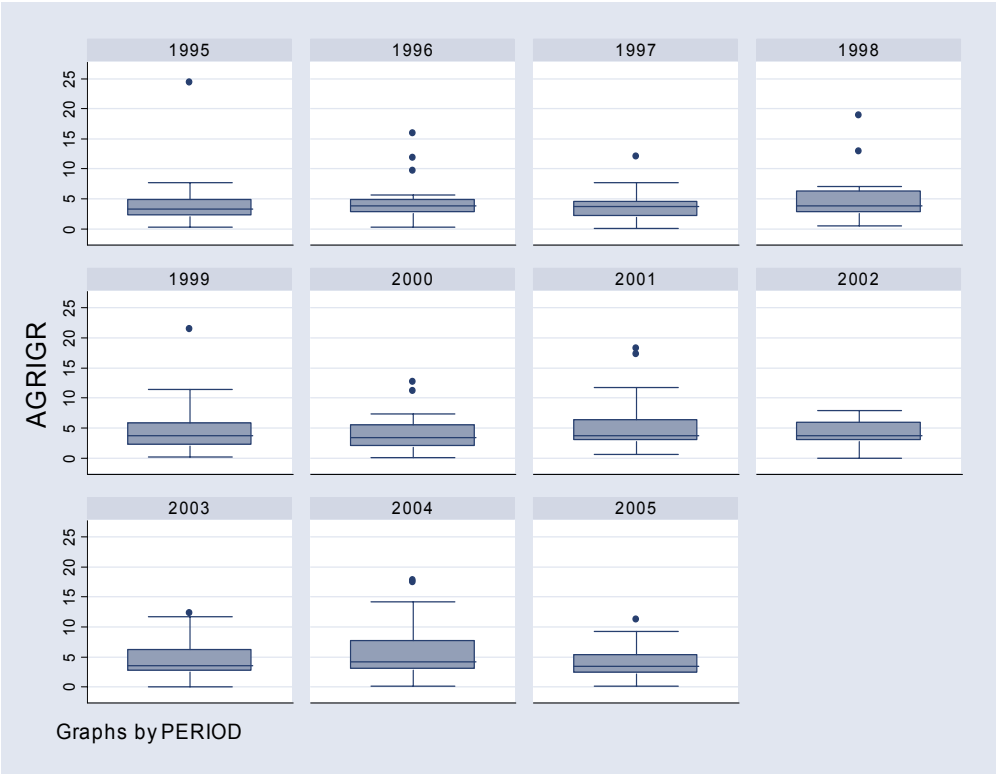
results. Easterly emphasized that the basic goal of aid is simply benefiting the poor. Aid does not aim to transfer as much money as politically feasible from the wealthy to the poor nations nor foster society-wide transformation from poverty to wealth. The last is a noble aim despite the disappointing results in the past.

Focusing on panel data from developing and emerging economies in the 1990s, Harms and Lutz (2006) controlled for countries' institutional environment and concluded that on average, the effect of aid on private foreign investment is close to zero. When private agents are faced with a substantial regulatory burden, the authors observed that the effect of aid becomes positive. They further noted that these results are robust to a wide range of specifications, samples, and estimation methods.

IV. MODELING AGRICULTURAL GROWTH

Agricultural growth is facing a serious threat of becoming unsustainable soon. As discussed above, growth in crop and animal production was initially fueled by increasing the cultivated area. As arable land is becoming exhausted, growth is now driven by increasing productivity as a result of scientific/technological advancement. Figure 1 characterizes the distribution of agricultural growth among 27 Asian countries. While neither increasing nor declining trends are visible from the figure, the growth numbers generally become dense near zero over the 11-year period.

Figure 1: Agricultural Growth Across Asian Countries



Source of basic data: Key Indicators 2006, ADB

What will push agricultural growth in the coming years then? Ruttan (2002) suggested that for those countries in which land and labor productivity levels are furthest from frontier levels, there is still no problem of how to trigger growth since opportunities still exist to enhance agricultural productivity substantially while developments in biological technology can benefit those that are land-constrained. The growing realization of resource and environmental

constraints in agricultural productivity is now threatening group of poor countries. Substantial support for agricultural research capacity is needed to preempt the possible threat to world food security. Agricultural growth can be achieved only through an integrated strategy of institutional innovation and technical change.

One recent model of agricultural growth explored its linkages with industrial development. Consistent with the development literature, Gollin et al. (2002) argued that structural transformation provides a useful theory of both why industrialization occurs at different dates and why it proceeds slowly, implying that growth in agricultural productivity is a central theme to development. Thus, understanding of the determinants of agricultural productivity facilitates the understanding of the development process for the currently poor nations as well. The authors proposed that agricultural production be done by choosing one of the two (traditional or modern) agricultural technologies discriminated basically by the exogenous technological change (motivated by research). Technology innovation accumulates over time and as labor flows out of agriculture, producers will shift from traditional to modern technologies, completing and initiating anew the cycle of transformation.

The role of the government was explored by Remmer (2004) through an error correction model (ECM), $\Delta Y_{i,t} = \alpha + \Delta X_{i,t}\beta + \phi\left(Y_{i,t-1} - X_{i,t-1}\gamma\right) + \varepsilon_{i,t}$, where Y is government spending, X is a vector of independent variables including annual change in government spending as a percentage of GDP, lagged level of government expenditure, annual rate of change in each of the independent variables, and lagged values of the independent variables.

In the context of facilitating regional integration, we examine the agriculture sector among selected Asian countries. It is fair to consider economic convergence as one goal in multilateral agreement among countries. Convergence implies equality of production potential among countries involved in an integrating region. As the integrating region approaches steady-state production potential, food security can be evaluated among the ultimate goals.

An econometric framework is formulated to analyze agricultural growth in the region. Let us assume that homogeneous technology is available and producers only need to gain access to it for the efficient optimization of production. Agricultural growth will be explained by the current size of the sector, public expenditure, foreign aid, and the relation of the countries to their trading partners.

The current output of the agriculture sector is a combined result of the mix of natural and technological factors of production. For some countries, area cultivated (capacity for livestock, pond size for aquaculture) has been maximized, while opportunities for expansion may still be available for others. Among those countries where cultivated area has been maximized, growth in production will be driven only by use of production technology that can be enhanced further through agricultural research. Given that room is still available for expansion of cultivated area, several options like irrigation development, liming in acidic soil, building of new animal housing for livestock, pond construction for aquaculture, and other approaches can be taken. Regardless of the technology used, expansion in production area is expected to contribute to speeding up growth of the sector. While cultivated area is expanding, technology improvement can occur and can simultaneously contribute to the growth of the sector. Given homogenous technology, as all countries maximize cultivated area expansion and technology adoption, sectoral growth will converge to the same steady-state rate among all countries. The current size of production is a combined measure of residual area that can still be converted into productive use and the discrepancy between the current technology in use and frontier technology (homogeneous across countries). While the current size of production is still far from the frontier level, growth is expected to accelerate.

As production approaches the frontier level, growth will stabilize to the steady-state rate, similar to the constant return to scale assumption in neoclassical economics.

The relationship between the current size of the sector and growth can be used to verify the convergence hypothesis. Conceptually, agricultural convergence occurs when producers yield outputs growing at the same steady-state rate. Thus, a negative slope on the current production axis by agricultural growth curve implies that "small" producers are catching up with the "large" producers in producing towards frontier levels. Narrowing of the growth differential occurs when those lagged-behind producers maximize production area and use optimal technology. Both area maximization and optimal technology adoption can be facilitated by three main (non-exclusive) determinants: public expenditures, foreign aid, and relation with trading partners.

The economic structure of a country can be viewed as a stimulus for production on one side and subsequent international trade on another. Government support in the agriculture sector for instance can be used as a gauge of how much output can be expected that will either be consumed locally or will enter into the international trading market. Public expenditure intended for economic activities of the agriculture sector is used as a proxy indicator of economic structure. The effect of public expenditures intended for agriculture will directly affect growth as well as facilitate the movement of production along frontier levels. Public expenditures are usually focused on policy formulation and implementation that will enhance the environment for agricultural production. In many countries, a portion of these expenses is allocated for conducting agricultural research and disseminating the results. Some countries may allocate resources to facilitate access to infrastructure and other capacity building services, while other countries may engage in direct provision of such. In some cases a portion of such expenditure is allotted for credit needed by producers in the production process.

Foreign aid can either be in the form of a grant or a loan. Although foreign aid in the early 1990s was usually designed for very specialized purposes, it has now adopted an integrated, complementing package of menus that will facilitate, say, agricultural development. Whether as grants or as loans, aid can be used in infrastructure development or in capacity building activities that will also directly affect growth in agriculture or will assist producers in moving towards the frontier production level. Foreign aid for countries that have already reached the production frontier level will facilitate sustainability of production growth at the steady-state rate. The bureaucratic process and the delivery of services as well as the conversion into production growth will take time—perhaps beyond a few production cycles. Thus, a lagged rather than immediate effect of foreign aid is expected.

As the economy opens to international trade as a result of bilateral or multilateral agreements, the effect on growth of the sector cannot be ignored. The relation with trading partners can benefit an economy through private investments that can enhance infrastructure, access to production inputs, marketing, and other amenities. Relations with a trading partner can be viewed as a spatial externality. Because of the more viable land, water, and air transport, the spatial neighborhood will no longer be limited to contiguous countries. In the context of regional cooperation, the spatial neighborhood can be defined in terms of trade relations a country would have with other countries.

There are several ways to define a spatial neighborhood and subsequently the spatial distance measures. As an example, consider two countries A and B within the region. If A's exports to B are as much as its imports from B, then B is a neighbor of A. Similarity in import and export levels is defined based on whether import/export transactions are among the top ten trading partners of country A. The spatial distance of A is measured as an average of agricultural growth rate among countries in the neighborhood where A is located. B can be in the neighborhood of A, but A need not be in the neighborhood of B.

Growth in the neighborhood of A is expected to contribute to the growth of A. Thus, if it is in a fast-growing neighborhood, fast growth for A can also be expected. On the other hand, being in the slow-growing neighborhood will also mean a slow growth for the country. Thus, the slope of agricultural growth along the axis of spatial distance should be positive. The logic underlying this relationship is that mutual benefits between trading countries can be expected only when they are engaged in the same amount of trade going in and out of the country, i.e., when they belong to the same neighborhood.

Based on the Key Indicators (ADB, 2006), the spatial neighbors of some Asian countries are given in Table 1. Armenia has a different set of countries for its export partners from its import partners. Thus, following the concepts above, Armenia does not belong to any neighborhood, and the spatial distance is the same as the growth rate of the country. On the other hand, while the PRC belongs to the neighborhood of many countries, only the Republic of Korea and Singapore belong to the neighborhood of the PRC. The spatial distance then is the average of the growth rates in the PRC, the Republic of Korea, and Singapore.

Table 1: Spatial Neighborhood System

Country	Neighbors*
Armenia	None
Azerbaijan	None
Kazakhstan	PRC
Kyrgyz Republic	PRC, Kazakhstan, Uzbekistan
Pakistan	PRC
Tajikistan	Uzbekistan
Turkmenistan	None
Uzbekistan	PRC, Kazakhstan, Tajikistan
Rep. of Korea	PRC, Indonesia, Malaysia, Singapore
Mongolia	PRC, Rep. of Korea, Singapore
PRC	Rep. of Korea, Singapore
Taipei,China	Rep. of Korea, Malaysia, Singapore
Bangladesh	None
Bhutan	India, Philippines
India	PRC, Singapore
Maldives	Singapore, Sri Lanka, Thailand
Nepal	PRC, India
Sri Lanka	India
Brunei Darussalam	PRC, Singapore, Thailand
Cambodia	PRC, Singapore, Viet Nam
Indonesia	PRC, Rep. of Korea, Singapore, Thailand
Lao PDR	PRC, Thailand, Vietnam
Malaysia	PRC, Rep. of Korea, Singapore, Thailand
Myanmar	PRC, India, Malaysia, Singapore, Thailand
Philippines	PRC, Rep. of Korea, Malaysia, Singapore, Thailand
Singapore	PRC, Rep. of Korea, Malaysia, Thailand
Thailand	PRC, Indonesia, Malaysia, Singapore
Viet Nam	PRC, Rep. of Korea, Singapore

**Based on whether a "neighbor " country is among the top ten export destinations or top ten import sources.*

Lao PDR = Lao People's Democratic Republic; PRC = People's Republic of China

An approach to the verification of the convergence hypothesis was discussed by Barro and Sala-i-Martin (1992) and Sala-i-Martin (1996). Given the annual growth rate of GDP $\gamma_{i,t,t+T}$ of country i between period t and t+T, $\log(y_{i,t})$, the logarithm of economy GDP per capita at time t, Sala-i-Martin (1996) proposed to verify the convergence hypothesis from the model $\gamma_{i,t,t+T} = \alpha - \beta \log(y_{i,t}) + \varepsilon_{i,t}$, where $\beta>0$ means that there is β-convergence (absolute). Small economies will grow faster while large economies will stabilize, until the small economies catch up with the large ones towards the steady-state level. Other definitions of convergence were also given. If σ_t is the dispersion of per capita GDP of economies at time t, $\sigma_{t+T} < \sigma_t$ implies σ-convergence, where convergence is viewed in terms of more predictable differentiation of economies. Conditional convergence is defined by fitting $\gamma_{i,t,t+T} = a - b \log(y_{i,t}) + \psi X_{i,t} + \varepsilon_{i,t}$, where $X_{i,t}$ is a vector of variables that hold constant the steady state of economy i, $b = \frac{(1 - e^{-\beta T})}{T}$, if the estimate of β is positive once $X_{i,t}$ is held constant, then there is conditional convergence and the value of β estimates the rate of convergence, say per year if data is annual.

Following the framework above and using the basic definition of conditional convergence, consider the equation $\gamma_{it} = \alpha_0 + \alpha_1 \log(y_{it}) + \alpha_2 A_{it-d} + \alpha_3 E_{it} + \alpha_4 W_{it} + u_i + \varepsilon_{it}$, where $\varepsilon_{it} = \rho \varepsilon_{it-1} + a_{it}$, α_0, α_1, α_2, α_3, α_4, and ρ are parameters, $u_i \sim N(0, \sigma_u^2)$ independent of ε_{it} and $a_{it} \sim N(0, \sigma_a^2)$. The subscript i refers to the country and t is the time point. γ_{it} is the growth in GDP from agriculture, y_{it} is the GDP from agriculture, A_{it-d} is foreign aid (loan or grant) intended for agriculture lagged by d years (five years is "optimal" in this study), E_{it} is government expenditure for the agriculture sector, W_{it} is the measure of spatial distance in the neighborhood where country i is located, u_i is the random effect specific to country i (may account for country-specific externalities), and ε_{it} is the autocorrelated error or order 1. The magnitude of GDP from agriculture is considered instead of per capita to account for both the accumulation of technology adoption and the expansion of production area. The level also serves as a proxy indicator of the discrepancy between the current production level and the frontier level that varies across countries. Any country specificities that the level might introduce will be compensated by the random component u_i.

V. ECONOMIC AND AGRICULTURAL GROWTH

Absolute convergence of GDP is verified using the approach of Sala-i-Martin (1996). Results are summarized in Table 2. While the model fit well with the data, there is no empirical evidence that GDP among the selected Asian countries will converge absolutely. Even if convergence is verified conditioning on the GDP of the agriculture sector, there is still no evidence of convergence in GDP. Growth in GDP among Asian countries is explained prominently by the spatial externalities associated with trading among their neighbors, country specific endowments (random components), and temporal accumulation of growth-inducing endowments.

Table 2: Random Effect Model for GDP Convergence

Classical Model for the Verification of Convergence Hypothesis (Random Effect Model)				
Overall R^2	57.84	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	-1.3082	0.273
ρ	0.2372	Log(GDP)	0.0740	0.507
σ_u	1.1003	WGDPGrowth	0.9788	0.000
σ_ε	1.6792			
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.3004			
Classical Model for the Verification of Convergence Hypothesis (Random Effect Model) Adjusted for GDP of Agriculture				
Overall R^2	58.15	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	-1.4403	0.230
ρ	0.2375	Log(GDP)	-0.0731	0.711
σ_u	1.0884	WGDPGrowth	0.1969	0.000
σ_ε	1.6777	Log(GDPAgri)	0.9803	0.371
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.2962			

Using the same approach to verify the absolute convergence of agricultural growth, Table 3 indicates that without accounting for the spatial effect of the neighborhood defined by international trade, the model will not fit the data well. Conditioning on the spatial externalities defined by trade, a weak ($p<0.095$) evidence of convergence in agricultural growth is achieved. Country-specific endowments and temporal accumulation also contribute to explaining agricultural growth behavior. While weak evidence of conditional convergence of agricultural growth is obtained, a steady-state growth rate of the general economy cannot be reached because the contribution of agriculture to total GDP was declining among Asian countries during the estimation period (1995–2005).

Table 3: Spatial-Temporal Model for GDP (Agriculture) Convergence

Classical Model for the Verification of Convergence Hypothesis (Random Effect Model)				
Overall R^2	2.70	Determinant	Coefficient	p-value
Overall Fit p-value	0.2055	Constant	6.96901	0.000
ρ		Log(GDP Agri)	-0.29104	0.075
σ_u				
σ_ε				
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$				
Classical Model for the Verification of Convergence Hypothesis (Random Effect Model) Adjusted for Trade Neighborhood Distance				
Overall R^2	53.29	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.14825	0.214
ρ	-0.10835	Log(GDP Agri)	-0.17098	0.095
σ_u	0.44728	WGDPGrowth	1.09286	0.000
σ_ε	2.55171			
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.02981			

VI. CONDITIONAL AGRICULTURAL CONVERGENCE

The postulated agricultural growth model is estimated and the results are summarized in Table 4. Significant evidence of conditional convergence ($p<0.047$) in agricultural growth among some Asian countries is found. The effect of spatial externalities defined by participation of a country in international trade, country-specific random endowments, and temporal accumulation also contributes significantly to agricultural growth. While public expenditures directed specifically to agriculture and foreign aid (grants and loans) five years ago do not have direct effects on agricultural growth, they facilitate countries' movement towards the steady-state production rate, leading further towards convergence. This supports our postulate on the possible dynamics of the roles of public expenditures, foreign aid, and international trade for Asian countries to attain convergence in agricultural growth. Conditioning on the current trade, foreign aid (intended for agriculture), and public expenditures (for agriculture), Asian economies will converge in agricultural growth at the rate of approximately 15% per year. This relatively fast speed of convergence is explained by the massive movement of foreign aid after the financial crisis and at the time of the emergence of new economies. The foreign aid levels (for agriculture), however, have been declining continuously in recent years. Should this pattern among the conditioning variables prevail in the coming years, the 15% annual rate of convergence will not be possible. One important insight, though, is that conditional convergence of agricultural growth among Asian countries is feasible.

Table 4: Spatial-Temporal Model for GDP (Agriculture) Convergence

Random Effect Spatial Model (All Indicators)				
Overall R^2	53.43	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.802336	0.126
ρ	-0.1083	Log(GDP Agri)	-0.288968	0.047
σ_u	0.4094	Agri Services	0.000060	0.501
σ_ε	2.5828	Grant5	0.000005	0.534
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0245	Loan5	0.000002	0.366
		WAgriGrowth	1.107947	0.000

VII. FOREIGN AID AND AGRICULTURAL GROWTH

Conditioning on public expenditures on agricultural services and spatial distance measure, the sensitivity of agricultural convergence is examined by dropping or including foreign aid among the conditioning variables. Results are summarized in Table 5. As pointed out in the previous section, aid individually does not have a significant direct effect on growth, but it is instrumental in facilitating convergence. This implies that the effect is more in the direction of helping producers move closer to production frontiers, a sustainability-leading path. Conditional agricultural convergence is also more sensitive to loans than grants. If loans are ignored, evidence of agricultural convergence weakens. On the other hand, if grants are ignored, the evidence of agricultural convergence barely changes. Although the implementation policies for grants are usually prescribed by the donors, the receiving country has bigger participation in the drafting of a loan package. In negotiations on loans intended for agricultural use, receiving countries should carefully examine provisions that should provide incentives for efficient agricultural production, taking into consideration country-specific endowments.

Table 5: Spatial-Temporal Model for Effect of Foreign Aid

Random Effect Spatial Model (All Indicators)				
Overall R^2	53.43	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.802336	0.126
ρ	-0.1083	Log(GDP Agri)	-0.288968	0.047
σ_u	0.4094	Agri Services	0.000060	0.501
σ_ε	2.5828	Grant5	0.000005	0.534
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0245	Loan5	0.000002	0.366
		WAgriGrowth	1.107947	0.000
Random Effect Spatial Model (Without Loan for Agriculture)				
Overall R^2	52.57	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.647899	0.144
ρ	-0.1335	Log(GDP Agri)	-0.260088	0.057
σ_u	0.2942	Agri Services	0.000058	0.513
σ_ε	2.6526	Grant5	0.000008	0.265
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0122	WAgriGrowth	1.106040	0.000
Random Effect Spatial Model (Without Grant for Agriculture)				
Overall R^2	53.33	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.7806340	0.120
ρ	-0.1017	Log(GDP Agri)	-0.2741230	0.049
σ_u	0.4016	Agri Services	0.0000559	0.520
σ_ε	2.5811	Loan5	0.0000021	0.204
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0236	WAgriGrowth	1.1016530	0.000
Random Effect Spatial Model (Without Foreign Aid)				
Overall R^2	52.17	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.415290	0.194
ρ	-0.1232	Log(GDP Agri)	-0.202530	0.103
σ_u	0.3231	Agri Services	0.000050	0.598
σ_ε	2.6496	WAgriGrowth	1.091480	0.000
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0147			

VIII. PUBLIC EXPENDITURE AND AGRICULTURAL GROWTH

The level of public expenditure on agricultural services among Asian countries may not be large enough to influence convergence of agricultural growth. From Table 6, whether or not public expenditure is included among the conditioning variables, the evidence of conditional convergence of agriculture barely changes. It seems that exchangeability of loan and public expenditure allocations for agriculture is prevalent in Asia, consistent with the observation of Remmer (2004).

Table 6: Spatial-Temporal Model for Effect of Public Expenditure

Random Effect Spatial Model (All Indicators)				
Overall R^2	53.43	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.802336	0.126
ρ	-0.1083	Log(GDP Agri)	-0.288968	0.047
σ_u	0.4094	Agri Services	0.000060	0.501
σ_ε	2.5828	Grant5	0.000005	0.534
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0245	Loan5	0.000002	0.366
		WAgriGrowth	1.107947	0.000
Random Effect Spatial Model (Without Expenditure on Agriculture)				
Overall R^2	54.39	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.450542	0.142
ρ	-0.0997	Log(GDP Agri)	-0.240751	0.044
σ_u	0.5032	Grant5	0.000005	0.510
σ_ε	2.4934	Loan5	0.000001	0.418
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0391	WAgriGrowth	1.105170	0.000

International Trade and Agricultural Growth

The role of international trade in economic convergence and regional integration cannot be ignored. In Table 7, removal of spatial distance yields insignificant evidence of convergence, emphasizing the spatial dependence/peculiarity of convergence in agricultural growth among Asian countries. The importance of spatial distance is also associated with country-specific random effects. This can be taken to mean that the random effect component in the model is still part of the spatial externality accounted for by the spatial distance. The implication is that to effectively achieve the goals of regional integration, careful matching among countries engaged in the bilateral or multilateral agreements should be done to facilitate convergence in agricultural growth.

Table 7: Spatial-Temporal Model for Effect of International Trade

Random Effect Spatial Model (All Indicators)				
Overall R^2	53.43	Determinant	Coefficient	p-value
Overall Fit p-value	0.0000	Constant	1.802336	0.126
ρ	-0.1083	Log(GDP Agri)	-0.288968	0.047
σ_u	0.4094	Agri Services	0.000060	0.501
σ_ε	2.5828	Grant5	0.000005	0.534
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0245	Loan5	0.000002	0.366
		WAgriGrowth	1.107947	0.000
Random Effect Spatial Model (Without the Spatial Indicator)				
Overall R^2	4.24	Determinant	Coefficient	p-value
Overall Fit p-value	0.4480	Constant	7.1719220	0.000
ρ	-0.0333	Log(GDP Agri)	-0.2944709	0.178
σ_u	1.0360	Agri Services	0.0000400	0.760
σ_ε	3.5909	Grant5	-0.0000111	0.306
$\sigma_u/(\sigma_u+\sigma_\varepsilon)$	0.0771	Loan5	0.0000006	0.810

IX. CONCLUSION

There is significant evidence of conditional convergence ($p<0.047$) in agricultural growth among some Asian countries. The effect of spatial externalities defined by participation of a country in international trade, country-specific random endowments, and temporal accumulation also contributes significantly to agricultural growth. While public expenditures intended specifically for agriculture and foreign aid (grants and loans) do not have direct effects on agricultural growth, they facilitate countries' movement towards the steady-state production rate leading towards convergence. Conditioning on current trade, foreign aid (intended for agriculture), and public expenditures (for agriculture), Asian economies will converge in agricultural growth at the rate of approximately 15% per year. The foreign aid levels (for agriculture), however, have been declining continuously in recent years. Should this pattern prevail in the coming years, a 15% annual rate of convergence will be impossible to realize.

The level of public expenditure on agricultural services among Asian countries may not be large enough to influence convergence of agricultural growth. Whether or not public expenditure is included among the conditioning variables, the evidence of conditional convergence of agriculture barely changes. It seems that exchangeability of loan and public expenditure allocations for agriculture is prevalent in Asia, consistent with the observation of Remmer (2004).

The role of international trade in economic convergence and regional integration cannot be ignored. The importance of spatial distance is also associated with country-specific random effects. The implication is that to effectively achieve the goals of regional integration, careful matching among countries engaged in bilateral or multilateral agreements should be done to facilitate convergence in agricultural growth.

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