Is Trade or Trade Risk Good or Bad to Efficiency and Productivity?

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Abstract

The impacts of trade and trade risk on efficiency and productivity of Asia and Sub-Saharan Africa agriculture sector is examined using an extended stochastic frontier analysis econometric model. The extended models links the random and one-sided error term of stochastic frontier analysis to technical efficiency and productivity, respectively. The model estimates primal production function equation, efficiency function equation and productivity function equation, simultaneously. A panel of 17 Asian countries and 32 Sub-Saharan African countries from 1970 to 2010 shows differential impact of trade openness, short-term and long-term trade openness risk on efficiency and productivity.

Keywords: Trade and Trade risk; Stochastic frontier analysis; Efficiency and Productivity; Asian and Sub-Saharan African; 1970-2010

JEL Classification Numbers: C4, O3, O5, Q1.

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1 Introduction

Due to increased globalization and free market economies, the last decade of the twentieth century and the first decade of the twenty-first century brought significant increase in trade within and between countries. Based on Food and Agriculture Organization export and import data, the value of world exports increased from US $32.11 billion to US $1.31 trillion during the period 1961 to 2011, as a result of globalization. Similarly, the export value of Asia (Africa) increased from US $5.02 billion to US $279.15 billion (US $3.75 billion to US $ 45.20 billion) for the same time period. In contrast, the Americas (Europe) exports increased from around US $11.23 ($9.77) billion in 1961 to US $377.80 ($562.41) billion for the same time period. To gauge the relative importance of agricultural trade, the shares of Asian and African exports and imports relative to the world is computed and presented in Figure 1. The export share of Asia relative to world agriculture increased from 17.72 percent in 1961 to 32.50 percent in 2011. Similarly, the export share of Africa relative to world agriculture increased from 15.63 percent in 1961 to 21.25 percent in 2011. In contrast, the export (import) share of Africa relative to world agriculture products declined (increased) from 11.68 percent (4.66 percent) in 1961 to 3.44 percent (6 percent) in 2011. In Asian and African countries, there is an increasing trend in imports, compared to dramatically declining (slightly increasing) trend in exports by African countries.

< Insert Figure 1 >

Trade openness defined as exports plus imports divided by gross domestic product has recently gained popularity; scholars argued that a country that opens its market and trades with other countries would increase its efficiency and productivity by receiving productivity-enhancing tools like technology (Altomonte and Beke, 2010; Chortareas, Desli and Pelagidis 2003; Olajide, 2001; Peluffo, 2012; and Ruttan 2002). The transfer of technology from advanced to developing countries would confer benefits to recipient developing economies efficiency and productivity (Bardhan, 2006; Cline, 2004; and Winters, 2002). The efficiency and productivity-enhancing effects of trade have been widely documented in both macro and micro level studies. However, these researches have mainly focused on the manufacturing industry with very limited work on agriculture (Bigsten et al., 2004; Biesebroeck, 2005) explains that although many scholars recognize the potential for trade to generate agricultural efficiency/productivity gains, they confine their empirical investigations to the link between agriculture, growth, and poverty (Harrison and McMillan, 2007; and Nissanke and Thorbecke, 2006).

It is difficult to make convincing generalizations about how international trade might affect domestic agricultural efficiency and productivity. Increased agriculture production for exports requires the use of input resources more efficiently to spur economic activity down the line in manufacturing, trade, and transportation of these products. International trade has been a hotly debated topic; economists differ on whether there is benefit associated with international trade and how much benefit-trading partners reap from an international trade. Though an increase in exports is argued to be beneficial to trading partners' economic growth (efficiency and productivity), an increase in imports is argued to be a threat to countries' economies, particularly to the least developed countries, and policy makers have a hard time striking the right balance between an open trade and the risks associated with an open trade. While international trade drives economic development (via productivity growth), developing countries are often outperformed by financially stronger developed countries, which put developing countries at a trading disadvantage.

Due to this increased variability associated with trade liberalization, it is important to assess impact of trade and trade risk in the short-run and in the long-run. This helps to understand the importance of trade and its variability on Asian and Sub-Saharan African agricultural efficiency and productivity.

1.1 Need for Evaluating Trade Openness Risk in the Short and Long-term

Risk or variability in trade affects producers' decision to produce goods, how much to produce and how to produce it efficiently leading to productivity growth. It is hard for a producer to initially determine how much to produce and how efficiently to allocate and utilize input resources. An ability to quantify changes in trade risk or variability in the short-term and long-term could help not only producers, but also, policy makers. For example, a producer's decision to invest in a new technology that could increase efficiency and productivity could be affected by how much trade risk is associated with the investment as well as the producer's risk perception. An evaluation of short and long run risk associated with trade openness will help decision makers understand its impact on efficiency and productivity. Not only is risk or variability in trade important for the domestic producer, but its risk is a major concern among trading partners.

< Insert Figures 2 and 3 >

Figure 2 and Figure 3 shows trend in trade openness, short and long run risk from 1961 to 2010 for seventeen Asian and thirty-two Sub-Saharan African countries, respectively to show the importance of variability. Trade openness is used a proxy for trade and measured as the ratio of agriculture exports plus imports divided by total gross domestic product. Trade openness risk in short-run is measured as the window rolling variation of trade openness for the last 5 years, and trade openness risk in long-run is measured as the cumulative rolling variation in trade openness starting with 5 years and accumulating over 40 years. Trade openness in an individual country varies widely over the analyzed period. All countries' short-term and long-term risk or variability is positive suggesting existence of variation in trade openness not only in the short run, but also in the long run. Evaluating this trade variability or risk in the short-term and long-term across Asia and Sub-Saharan Africa over 40 years could help in understanding the constraints and implications of changes in efficiency and productivity measures and how those changes influence domestic agricultural production.

1.2 Research Objectives

The primary goal for this research is to empirically evaluate the role of trade openness and short and long run risk or variability associated with trade openness on agricultural production efficiency and productivity of Asian and Sub-Saharan African countries from 1970 to 2010. A double heterogeneity stochastic frontier analysis (SFA) econometric model of the production function equation along with the efficiency and productivity equation is used in the analysis. The production function equation evaluates the importance of input factors apart from estimating technical efficiency and productivity. The technical efficiency and productivity equation evaluates the role of trade openness and short-term and long-term trade openness risk on the Sub-Saharan African region's ability to produce efficiently. These objectives will be achieved using agriculture data from the World Bank, International Monetary Fund (IMF), Penn table, and Food and Agriculture Organization (FAO).

2 Stochastic Frontier Analysis Methodology

Primal production theory assumes a relationship between non-allocable exogenous input vector, $\mathbf{x}$ and production of an endogenous output, y. The primal Cobb-

Douglas production function[1] is represented as

$$y = f(\mathbf{x}; \beta) + \varepsilon \tag{1}$$

where β is a vector of parameter coefficients associated with inputs and ε is the random error.

Stochastic frontier analysis (SFA) introduced in 1977 simultaneoulsy by Aigner, Lovell and Schmidt; Meeusen and van den Broeck; and Battese and Corra. The SFA allows the decomposition of error term, ε into symmetrical random error, v, and one-sided error or inefficiency, u. The SFA model for Cobb-Douglas production function is represented as

$$y = f(\mathbf{x}; \beta) + v - u \tag{2}$$

where $v \sim N(0, \sigma_v^2)$, represents the random error, and $u \sim N(0, \sigma_u^2)$ represents the one-sided efficiency or inefficiency (1-efficeincy).

Last decade saw progress with SFA models used to investigated the influence of a broader set of determinants of technical efficiency, namely geographic variables, market structure conduct, and performance hypothesis, financial risk, policy and size of the firm on inefficiency. In addition, the importance of trade openness on efficiency has been evaluated in the context of developed countries. Here, an extended stochastic frontier analysis model is used to estimate the importance of trade openness, trade openness risk or variation in the short-run and long-run on production technical efficiency.

Productivity or Total factor productivity (TFP) is defined as the ratio of input over output and mathematically the production function y=f(x)+v can be used to represent TFP as TFP(v)=y/f(x). This productivity concept could be extended into the stochastic frontier production function that decomposed error terms,y=f(x)+v-u, where v constitute a conventional error or TFP and u is a one side disturbance that is distributed either as half normal, exponential or gamma and represents efficiency.

Equation 2 can be extended by introducing heterogeneity in the one-sided inefficiency, u and random error, v and represented as

$$\begin{array}{ll} Output & (y_{it}) = f(x_{it}) + v_{it} - u_{it} \\ Efficiency & \left(\sigma^2_{\mathrm{u}_{it}}\right) = g(z_{it}) + \varepsilon_{it} \\ Productivity & \left(\sigma^2_{\mathrm{v}_{it}}\right) = h(z_{it}) + \xi_{it} \end{array} \tag{3}$$

[1] Alternative flexible functional form like Translog production function is also estimated. However, the return to scale was not within the normal range and the likelihood ratio tested rejected in favor of Cobb-Douglas production function for Asian and Sub-Saharan African countries.

where σ_{u}^2 is the variance of inefficiency term, σ_{u}^2 is the variance of productivity term and the inefficiency and productivity is modeled as a function of risk in z variables. Here, the variances as a function of z variables that includes variance of short-term and long-term trade openness risk apart from trade openness.

Next, three alternative specifications of the extended stochastic frontier analysis (SFA) model or equation (3) with the production function equation and the one-sided efficiency equation are presented. This includes country fixed effects in the production function equation and one-sided efficiency equation, and trade openness in the efficiency equation. This is represented as

$$\begin{array}{ll} Output & (y_{it}) = f(\alpha_i, \mathbf{x}_{it}; \beta) + v_{it} - u_{it} \\ Efficiency & \left(\sigma_{\mathrm{u}_{it}}^2\right) = g(\delta' Topen_{it}) + \varepsilon_{it} \\ Productivity & \left(\sigma_{\mathrm{v}_{it}}^2\right) = h(\delta' Topen_{it}) + \xi_{it} \end{array} \tag{4}$$

where α_i represents one-way fixed effects related to country, i.e., $i-1$ country dummies in the production function equation.

The second extended SFA model includes country fixed effects in production function equation and one-sided efficiency equation. In addition, the one-sided efficiency equation includes trade openness and short-term trade openness risk or variation. This is represented as

$$\begin{array}{ll} Output & (y_{it}) = f(\alpha_i, \mathbf{x}_{it}; \beta) + v_{it} - u_{it} \\ Efficiency & \left(\sigma_{\mathrm{u}_{it}}^2\right) = g(\delta'(Topen_{it}, TopenSR_{it})) + \varepsilon_{it} \\ Productivity & \left(\sigma_{\mathrm{v}_{it}}^2\right) = h(\delta'(Topen_{it}, TopenSR_{it})) + \xi_{it} \end{array} \tag{5}$$

Finally, in addition to trade openness and short-term trade openness risk, long-term trade openness risk is also included in the one-sided efficiency equation. This is represented as

$$\begin{array}{ll} Output & (y_{it}) = f(\alpha_i, \mathbf{x}_{it}; \beta) + v_{it} - u_{it} \\ Efficiency & \left(\sigma_{\mathrm{u}_{it}}^2\right) = g(\delta'(Topen_{it}, TopenSR_{it}, TopenLR_{it})) + \varepsilon_{it} \\ Productivity & \left(\sigma_{\mathrm{v}_{it}}^2\right) = h(\delta'(Topen_{it}, TopenSR_{it}, TopenLR_{it})) + \xi_{it} \end{array} \tag{6}$$

3 Asia and Sub-Saharan Africa Agriculture Data, 1970 to 2010

To estimate the extended SFA model data was collected from the Food and Agriculture Organization (FAO), World Bank (WB), International Monetary Fund

(IMF) and Penn table. The data was collected for 17 Asian and 32 Sub-Saharan African countries from 1970 to 2010.

The seventeen Asian countries include - Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand and Vietnam. The list of 32 Sub-Saharan African countries include - Angola, Benin, Burkina Faso, Burundi, Cameroon, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Sudan (former), Togo, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

< Insert Figures 4 and 5>

Four categories of inputs and one category of output are used to estimate the primal production function. The four inputs used include a) land variable (area harvested), excluding the area from which, although sown or planted, there was no harvest due to damage or failure, b) labor variable including farm population, a measure of hired and self-employed, and unpaid family labor, c) capital variable including capital stock, machinery and machinery archives used in agriculture production, and d) fertilizer variable which is a sum of nitrogen (N), phosphorous (P) and Potassium (K) expressed in thousands of metric tons. The output used in this analysis is the gross agriculture production index published by the Food and Agriculture Organization (FAO) which is the output from the agriculture sector. Detail on the construction of output and inputs variable is available on the Food and Agriculture Organization (FAO) webpage, $www.fao.org$

The annual time-series data for the Sub-Saharan African countries was used to estimate the stochastic frontier analysis model. The other variables used in the efficiency equation included: exports, imports and gross domestic product (GDP). These variables were used in the computation of trade openness (Topen), trade openness risk in the short-run (TopenSR) and trade openness risk in the long-run (TopenLR). Trade openness was computed as a ratio of exports plus imports (EXIM) divided by GDP. Each of the variables is defined in Table 1 below.

< Insert Table 1 >

Table 2 summarizes the minimal, median, mean, and maximal values for the output, four inputs, GDP, EXIM, trade openness, trade openness short-run risk

and trade openness long-run risk used in this analysis. In addition, the normalized output and input data by individual country for Asia and Sub-Saharan Africa is presented in Figure 4 and Figure 5, respectively.

< Insert Table 2, Figures 4 and 5 >

The trends presented in Figure 4 and 5 for Asia and Sub-Saharan Africa countries are normal data.

4 Empirical Application and Results

The theoretical methodology presented in section 3 estimates the impact of trade openness and the short-run as well as long-run trade openness risk efficiency and productivity for 17 Asian and 32 Sub-Saharan African countries from 1970 to 2010. Even though four extended double heterogeneity SFA models are estimated only the final model is presented and compared between Asia and Sub-Saharan Africa. The specific double heterogeneity stochastic frontier analysis with the production function equation includes output as endogenous variable; and four inputs, technology (trend) and individual country dummies as exogenous variables. The efficiency and productivity equations includes inefficiency as endogenous variable; and trade openness (Topen), short-term trade openness risk (TopenSR), long-term trade openness risk (TopenLR), technology (trend) and individual country dummies as exogenous variables.

The stochastic frontier model with short- and long-term trade openness is defined as:

$$\begin{aligned}
Output_{it} &= \beta_0 + \beta_1 land_{it} + \beta_2 labor_{it} + \beta_3 capital_{it} \\
&\quad + \beta_4 fertilizer_{it} + \beta_t trend \\
&\quad + \alpha_{i-1} Cdum_{i-1} + v_{it} - u_{it} \\
Inefficiency\left(\sigma^2_{u_{it}}\right) &= \delta_0 + \delta_1 Topen_{it} + \delta_2 TopenSR_{it} + \delta_3 TopenLR_{it} \\
&\quad + \delta_t trend + \varepsilon_{it} \\
Productivity\left(\sigma^2_{v_{it}}\right) &= \delta_0 + \delta_1 Topen_{it} + \delta_2 TopenSR_{it} + \delta_3 TopenLR_{it} \\
&\quad + \delta_t trend + \xi_{it}
\end{aligned} \tag{7}$$

where $Cdum$ represent individual country dummy, $Topen$ represents trade openness, $TopenSR$ represents the short-term trade openness risk, $TopenLR$ represent the long-term trade openness risk.

The input and output variables are estimated in logarithmic form and hence the parameter coefficient of production function represents input elasticities. The regression results for Asia and Sub-Saharan Africa agriculture sector are presented in Tables 3 and 4, respectively. Regression results in each table include parameter coefficient, standard error, Z-value and probability value [2].

4.1 Asia Trade Openness Results

Based on the table 3, all four inputs (land, labor, capital and fertilizer) and technology (trend) showed positive and highly significant effect on the Sub-Saharan African agriculture output production. Land had the highest influence on agriculture output production, followed by labor, capital, fertilizer and technology in that order. This means, a one percent increase in land, holding the other four variables' effects constant, would increase Asia's agriculture output production by 0.49 percent. Similarly, a one percent increase in labor, would increase Asia's agriculture output production by 0.419. Finally, a one percent increase in capital, fertilizer or technology would increase Asia's agriculture output production by 0.085, 0.067 and 0.0217 percent, respectively.

< Insert Table 3 >

The impacts of trade openness on Asia's agriculture production technical efficiency measure was positive and statistically significant at 10 percent level of significance. This suggest a one percent increase in trade openness would reduce Asia's agriculture production technical efficiency by 0.024 percent. The short-run trade openness risk was positive but not statistically significant suggesting short-run variations due to domestic policies, regime changes and unknown changes would not have an effect of efficiency. However, long-run trade openness risk or variability would have a long lasting effect as reflected by the positive and significant sign. A one percent increase in long-run trade openness variability would lead to 0.214 percent increase in domestic productivity efficiency.

The impacts of trade openness on Asia's agriculture productivity was positive and statistically significant. This suggest a one percent increase in trade openness would increase Asia's agriculture productivity by 0.161 percent. The short-run and long-run trade openness risk was negative and statistically significant. This

[2]Detailed regression results including the country fixed effects of the production function and technical efficiency equation are available from the authors. Also, available from the authors is the LIMDEP, STATA or the R code used in the analysis

suggest, a one percent increase in short-run and long-run trade openness risk or variability would lead to 0.364 percent and 0.416 percent, respectively decrease in domestic productivity.

This suggest differential effects of trade openness and short or long-run trade openness risk on Asia's agriculture efficiency and productivity.

4.2 Sub-Saharan Africa Trade Openness Results

Table 4 shows three equations - production function, efficiency and productivity results. Four inputs (land, labor, capital and fertilizer) and technology (trend) used for the production equation and three variables; trade openness, trade openness risk in short run and trade openness risk in long run used for efficiency and productivity equation.

< Insert Table 4 >

For the production function, all variable coefficients showed positive effect on the Sub-Saharan African production and all five variables are positive and highly significant. Capital had the highest effects on production, followed by land, labor, trend and fertilizer. The results showed, a one unit change in capital, land, labor, fertilizer, or technology, holding other variables' effects constant, would lead to 0.574, 0.36, 0.017, 0.011 or 0.015 percentage changes in the Sub-Saharan African region's agricultural production, respectively.

For the efficiency equation, the Sub-Saharan African are similar to Asia results. A one unit change in trade openness would lead to negative (-0.023) change on inefficiency measure. While a one unit change in trade openness in short-run risk and a one unit change in trade openness in short-run risk show positive (0.053 and 0.201) change on inefficiency measure, respectively. In other word, trade openness decrease Sub-Saharan African domestic agriculture production inefficiency level, while variability or risk associated with trade openness in short run and long-run increase Sub-Saharan African agricultural production inefficiency level. However, only trade openness and trade openness risk in long run are significant.

Finally, under the productivity equation, the effect of trade openness, trade openness risk in short and long-run on Sub-Saharan African agriculture productivity is evaluated. Trade openness showed negative impact on productivity while trade openness risk in short and long run showed negative effects on productivity variation. The results showed that a one unit change in trade openness would decrease productivity by 0.038 percent, while a one unit change in trade openness

risk in short and long run would decrease productivity variation by 0.028 and 0.156 percent, respectively.

5 Conclusions and Discussions

The extended stochastic frontier analysis model with three equations - a one-way fixed effects primal production function equation, an efficiency equation and productivity equation were used to measure the impact of trade and trade variability on efficiency for Asian and Sub-Saharan African region from 1970 to 2010.

Unlike previous studies that assume technical efficient production function, stochastic frontier analysis accounts for technical efficiency and estimates the relationship between input factors and output. In additional the extended stochastic frontier analysis evaluates the importance of trade openness, trade openness risk in the short-run and trade openness risk in the long-run. Quantifying trade openness and trade openness risk on efficiency and productivity measures is important; it helps producers decide how much to produce and how to produce it efficiently using their limited resources.

Based on the empirical findings, all the four inputs (land, labor, capital and fertilizer) plus technology (trend) showed positive and statistically significant effect on Asia's and Sub-Saharan Africa's agricultural production section. However, the importance of the input variables to agriculture production is different across Asia's and Sub-Saharan Africa's agriculture.

To evaluate the role of trade openness and trade openness risk on efficiency measures for Sub-Saharan African region over the 40 year period, trade openness was used to model trade openness. Trade openness risk in the short-run and trade openness risk in the long-run were used to model trade risk or trade variability over time. Each of the three variables was regressed with technology (trend) to examine its effect on efficiency level. Empirical evidence showed that trade openness had a positive effect on efficiency while trade openness risk in the short-run and in the long-run had a negative effect on efficiency measures. These results mean trade openness would reduce Asia's and Sub-Saharan Africa's agricultural inefficiency level, while trade openness risks both in short-run and in the long-run would increase the Asia's and Sub-Saharan Africa's agricultural inefficiency level.

In conclusion, an examination of the effects of trade openness and trade openness risk on Asia's and Sub-Saharan Africa's agricultural efficiency levels revealed that, the region's openness to a free trade would reduce its inefficiency measures while its trade openness risk or trade variability in the short-run and in the long-

run would increase its inefficiency measures. However, according to results in Tables 3 and 4, only trade openness and trade openness risk in the long run were significant, while trade openness risk in the short run were insignificant.

The effect of trade openness risk in the short run was insignificant, which means producers do not respond to the short-run changes in trade variability, but a persistent trade openness variability or trade openness risk beyond five years would impacts region's efficiency levels and cause producers to respond; this is shown by a high significance in trade openness risk in the long run.

With respect to productivity, an examination of the effects of trade openness and trade openness risk on Asia's and Sub-Saharan Africa's agricultural productivity revealed that, the region's openness to a free trade would reduce its productivity while its trade openness risk or trade variability in the short-run and in the long-run would reduce variation in productivity measures.

References

[1] Altomonte, C., and Bekes, G. 2010. Trade Complexity and Productivity. *Centre for Firms in the Global Economy*, working papers No. 12: 1-36.

[2] Aigner, D., Lovell, K., and Schmidt, P. 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*, 6: 21-37.

[3] Bardhan, P. 2006. Globalization and rural poverty. *World Development* 34: 1393-1404.

[4] Battees, G., and Corra, G. 1977. Estimation of a Production Frontier Model, with application to the pastoral zone off Eastern Australia. *Australian Journal of Agricultural Economics*, 21: 169-179.

[5] Biesebroeck, J. 2005. Exporting raises productivity in Sub-Saharan African manufacturing firms. *Journal of International Economics*, 67: 373-391.

[6] Bigsten et al. 2004. Do African manufacturing firms learn from exporting? The *Journal of Development Studies*, 40: 115- 141

[7] Chortareas, G., Desli, E., and Pelagidis, T. 2003. Trade Openness and Aggregate Productivity Efficiency. *European Research Studies*, VI 1-2: 188-200.

[8] Cline, W. 2004. Trade Policy and Global Poverty. Washington, DC: Institute of International Economics, *Center for Global Development.*

[9] Harrison, A., and McMillan, M. 2007. On the links between globalization and poverty. *The Journal of Economic Inequality*, 5: 123-134.

[10] Meeusen, W., and Brubeck, J. 1977. Efficiency Estimation from Cobb-Douglas Production Functions with composed errors. *International Economic Review*, 18: 435-444.

[11] Nissanke, M., and Thorbecke, E. 2006. Channels and policy debate in the globalization- inequality-poverty nexus. *World Development*, 34: 1338-1360

[12] Olajide, O. 2010. Does Trade Liberalization Cause Long Run Economic Growth in Mexico? An Empirical Investigation, *International Journal of Economics and Finance*, 2(3): 63-74.

[13] Peluffo, A. 2012. The Effects of Exports and Imported Intermediates on Productivity and the Demand for Skilled Labor: A Firm Level Analysis for Uruguay. *Institute of economics*: 1-24.

[14] Ruttan, V. 2002. Productivity Growth in World Agriculture: Sources and Constraints. *The Journal of Economic Perspective*, 16(4): 161-184

[15] Winters, A. 2002. Trade Liberalization and poverty: what are the links? T*he World Economy*, 25: 1339-1367.

Figure 1: Trends in export share and import share of Asia and Africa countries relative to the World, 1961 to 2010.

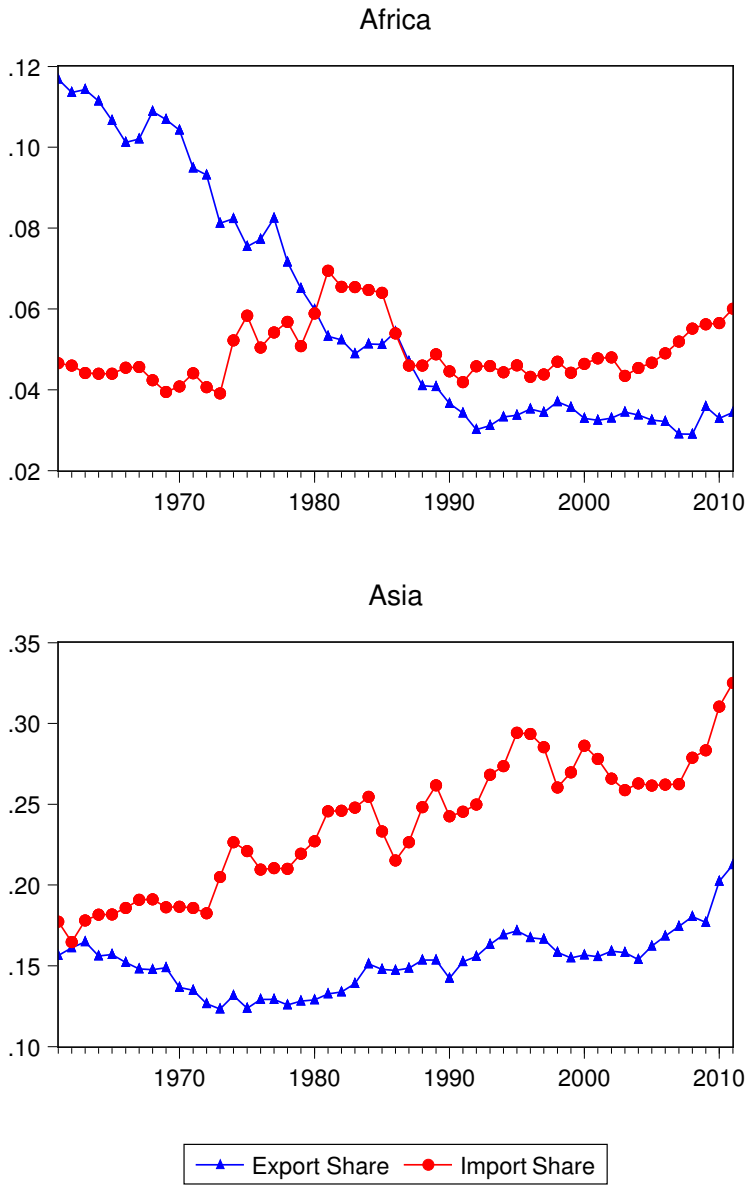

Figure 2: Trends in trade openness, short-term and long-term risk in trade openness of Asian countries

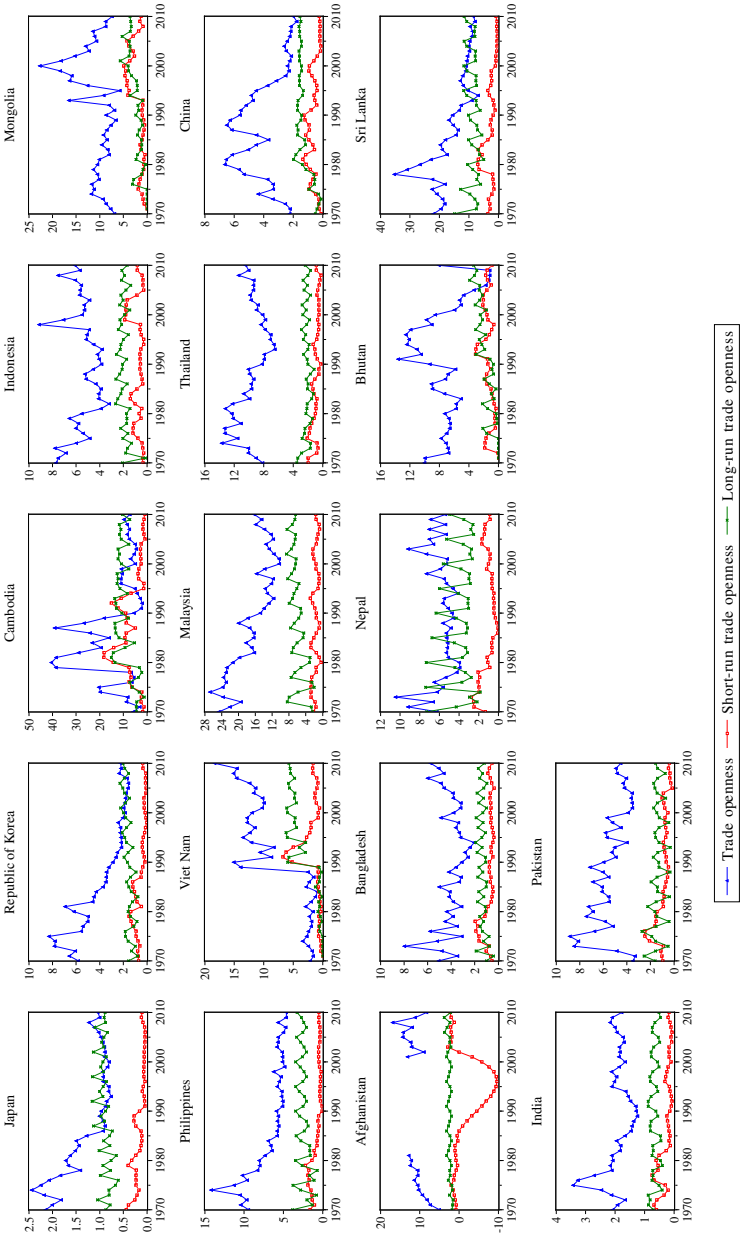

Figure 3: Trends in trade openness, short-term and long-term risk in trade openness of Sub-Saharan African countries

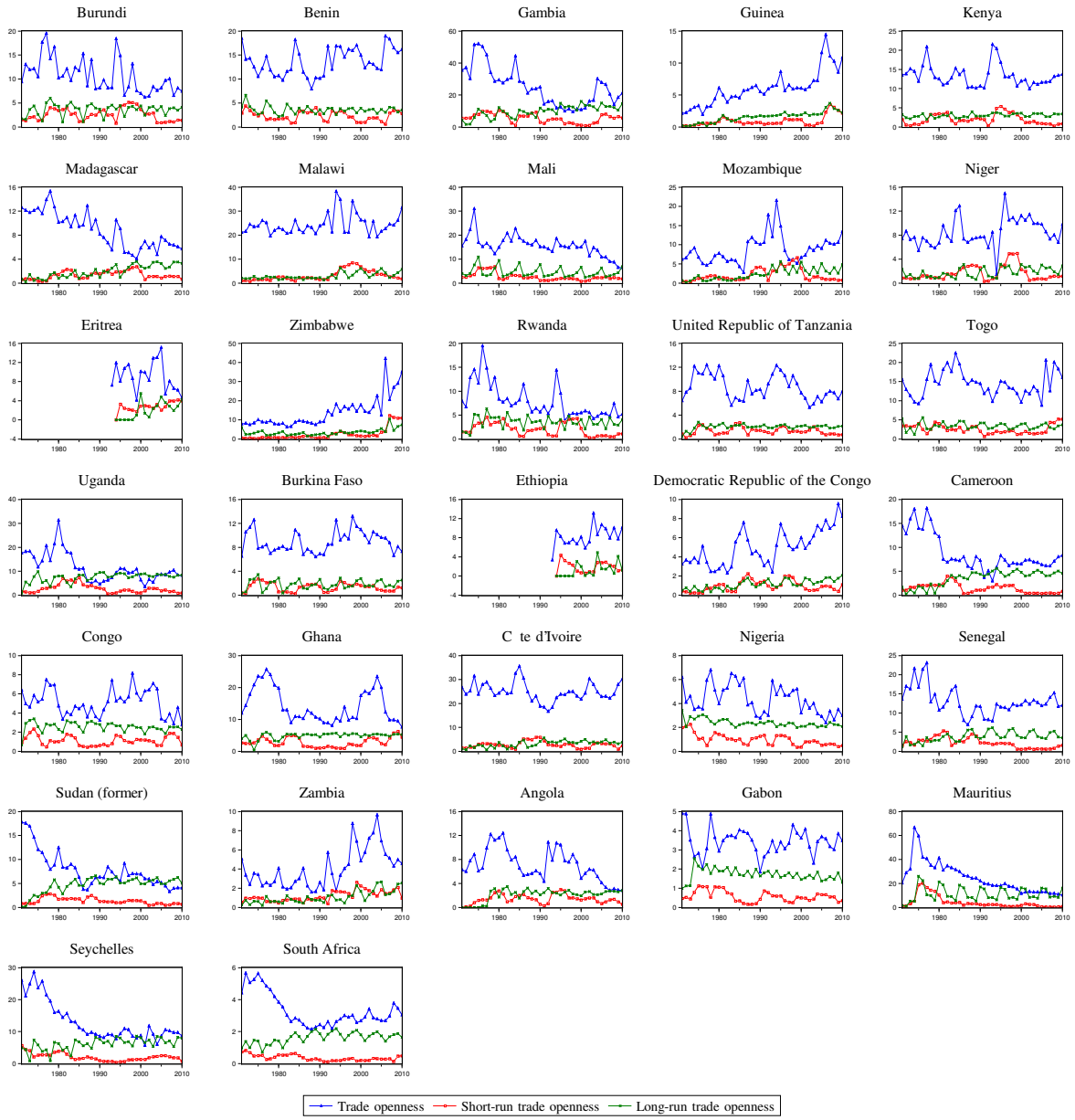

Figure 4: Trends in output and input variables of Asian countries.

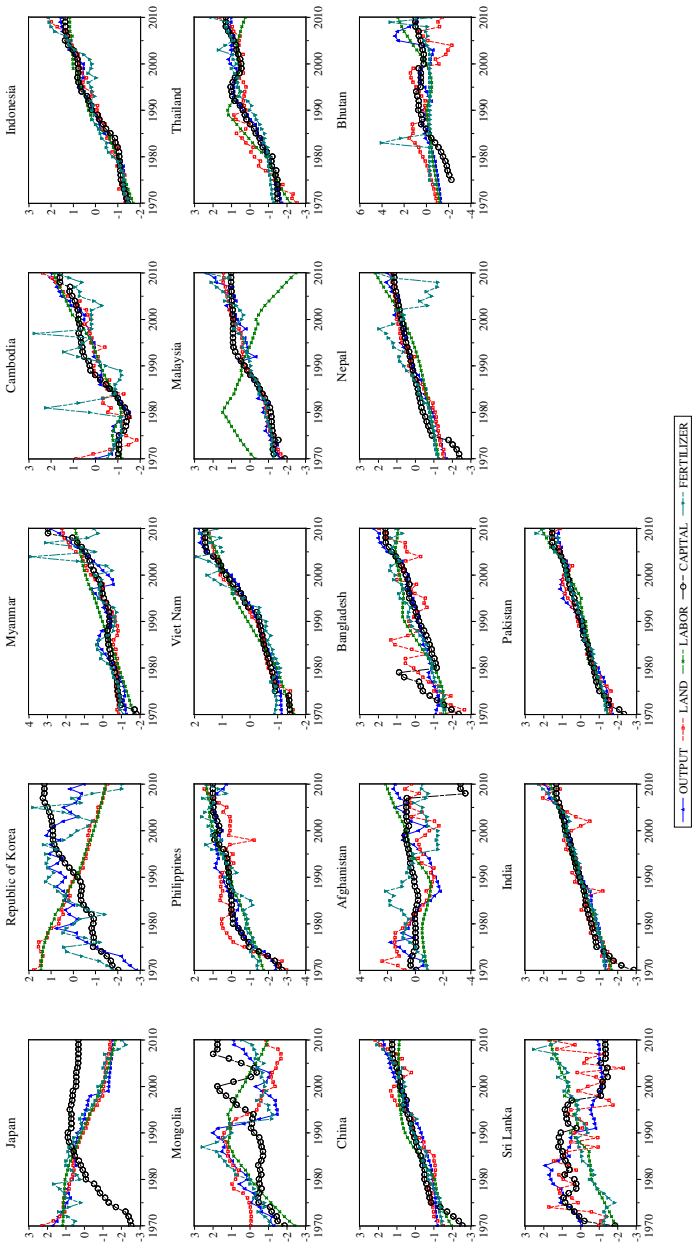

Figure 5: Trends in trade openness, short-term and long-term risk in trade openness of Sub-Saharan African countries

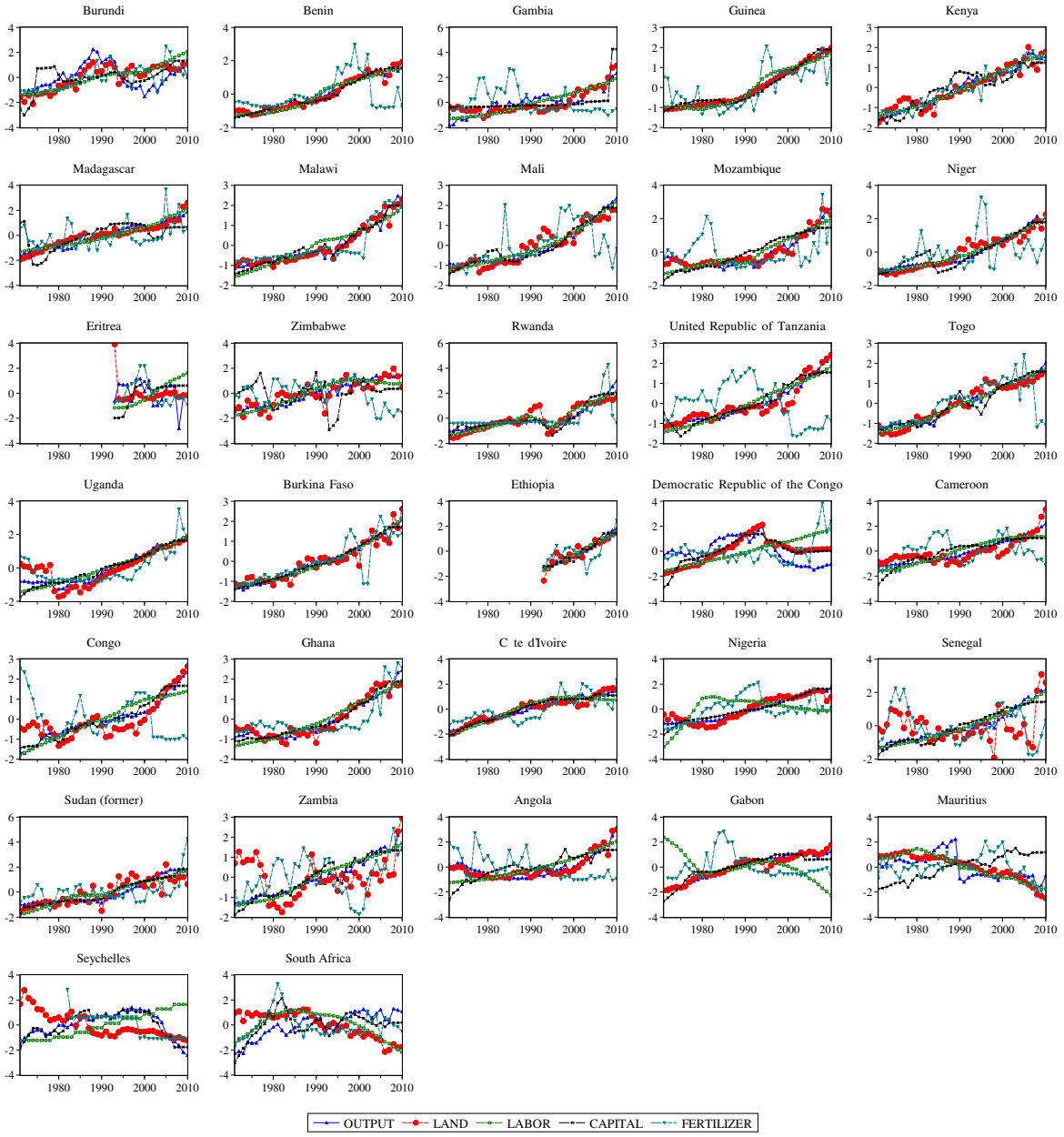

Table 1: Description of the Variables Used in the Analysis

Variables	Definitions
Output	Output (agriculture production in gross production index)
Land	The area in thousands hectares from which a crop is gathered excluding the area from which, although sown or planted, there was no harvest due to damage, failure
Labor	All those employed (thousands), including people above a specified age who, during the reference period, were in paid employment, at work, self-employed or with a job but not at work, and unemployed, including people above a specified age who, during the reference period, were without work, currently available for work and seeking work
Capital	Number of machinery and machinery archives and value of capital stock used in agriculture production in thousands
Fertilizer	Amount of fertilizer (metric tons) used in production and defined as sum of three fertilizers (N, P and K)
Export plus Imports	Export and Import values in thousands (total agricultural exports and imports in current value of the US dollars)
GDP	Gross Domestic Product (GDP) in current value of the US dollar values)
Trade openness	Ratio of exports and imports divided by total GDP
Trade openness risk in Short-term	Trade openness risk in short-term (TopenSR) is defined as window rolling variation in trade openness in the last 5 years
Trade openness risk in long-run	Trade openness risk in short-run (TopenSR) is defined as cumulative rolling variation in trade openness since last 5 years

Table 2: Summary Statistics of the Variables, 1970 to 2010

	South East Asia		**Sub-Saharan Africa**	
	Mean	Std. Deviations	Mean	Std. Deviations
Output	272	179	283	171
Land	24,400,000	47,500,000	4,037,704	5,723,797
Labor	46,454	109,240	3,903	4,257
Capital	76,420	121,426	9,207	12,303
Fertilizer	2,927,856	8,125,913	65,337	137,439
Trade Openness	7.54	5.93	11.21	7.80
Trade Risk Short-run	1.20	2.28	2.01	1.91
Trade Risk Long-run	3.01	2.94	3.51	2.87

Table 3: Stochastic Frontier Regression Results for Asia Countries, 1970 to 2010

	Coef.	Std. Err.	z	P>z
	Production Function Equation			
Intercept	-7.6599	0.3260	-23.5	< 0.0005
Land	0.4916	0.0261	18.83	< 0.0005
Labor	0.4191	0.0248	16.92	< 0.0005
Capital	0.0853	0.0287	2.97	0.003
Fertilizer	0.0667	0.0088	7.59	< 0.0005
Trend	0.0217	0.0013	16.57	< 0.0005
	Efficiency Equation			
Intercept	-5.4865	0.4294	-12.78	< 0.0005
Trade Openness	-0.0240	0.0141	-1.7	0.09
Trade Risk Short-run	0.0247	0.0359	0.69	0.493
Trade Risk Long-run	0.2144	0.0253	8.49	< 0.0005
Trend	0.0864	0.0100	8.67	< 0.0005
	Productivity Equation			
Intercept	1.0323	0.3146	3.28	0.001
Trade Openness	-0.1612	0.0198	-8.12	< 0.0005
Trade Risk Short-run	-0.3643	0.1742	-2.09	0.037
Trade Risk Long-run	-0.4164	0.1457	-2.86	0.004
Trend	-0.2221	0.0215	-10.33	< 0.0005

Table 4: Stochastic Frontier Regression Results for Sub-Saharan Africa Countries, 1970 to 2010

	Coef.	Std. Err.	z	P>z
		Production Function Equation		
Intercept	-7.2272	0.4146	-17.43	< 0.0005
Land	0.3600	0.0238	15.15	< 0.0005
Labor	0.1701	0.0373	4.56	< 0.0005
Capital	0.5739	0.0416	13.8	< 0.0005
Fertilizer	0.0110	0.0053	2.08	0.037
Trend	0.0152	0.0010	14.97	< 0.0005
		Efficiency Equation		
Intercept	-7.9045	0.6271	-12.61	< 0.0005
Trade Openness	-0.0232	0.0129	-1.8	0.073
Trade Risk Short-run	0.0525	0.0398	1.32	0.187
Trade Risk Long-run	0.2014	0.0238	8.46	< 0.0005
Trend	0.1017	0.0121	8.39	< 0.0005
		Productivity Equation		
Intercept	-0.9725	0.2649	-3.67	< 0.0005
Trade Openness	-0.0380	0.0101	-3.75	< 0.0005
Trade Risk Short-run	-0.0287	0.0620	-0.46	0.644
Trade Risk Long-run	-0.1561	0.0468	-3.34	0.001
Trend	-0.0991	0.0119	-8.35	< 0.0005