ERIA Discussion Paper Series

Market Integration and Energy Trade Efficiency: An Application of Malmqvist Index to Analyse Multi-Product Trade

YU SHENG[1]
Australian National University

YANRUI WU,
University of Western Australia

XUNPENG SHI,
National University of Singapore

DANDAN ZHANG
Peking University

November 2014

Abstract: *As* This paper uses the data envelope analysis method to investigate the Malmquist index-based gravity relationship between bilateral energy trade flows and their determinants throughout the world. Using a balance panel data of 40 countries between 1995 and 2008, this paper shows that market integration will increase energy trade by improving trade efficiency between trade partners, though allowing for a flexible substitution between different energy products tends to weaken these effects. This result highlights cross-product substitution and its implications for the aggregate energy trade pattern, providing insights on the importance of prioritising product-specific trade facilitating policies.

Keywords: energy trade efficiency, energy market integration, Malmquist index

JEL Classification: Q27, Q47, O47

[1] Corresponding author: yusheng@gmail.com, Research Fellow, the Australian National University

1. Introduction

Rapid economic growth in East Asia has substantially affected global energy consumption and its pattern over the past three decades. Between 1980 and 2012, the average gross domestic product (GDP) growth rate of countries in this region is more than 5 percent a year, which is more than double the GDP growth of Organisation for Economic Co-operation and Development (OECD) countries for the same period. The sustained economic growth, mainly due to the rapid expansion of manufacturing industries, led to two consequences. On one hand, it generated a huge increase in energy demand in the region and throughout the world. On the other hand, it created a significant disparity in energy supply and demand across regions. Since the late 1980s, energy consumption growth in this region has accounted for more than two-thirds of the world total, and the cumulative energy demand by this region is still increasing and likely to reach between 7 billion and 8 billion tonnes of oil equivalent (btoe) by 2030 (IEA, 2012).

Scholars and policy makers have reached the consensus that facilitating cross-country energy trade through forming a more integrated regional or global energy market can help stabilize market prices for energy products and secure energy supply (Shi and Kimura, 2010; Wu, *et al.*, 2014). This is because moving toward a more integrated energy market will increase the allocation efficiency of limited energy resources and resolve many economic and political issues related to the imbalance between energy supply and demand. However, limited progress has been made in practice, particularly from developing countries' perspectives. An important reason is that the aggregate benefits that all participants could obtain from involving themselves into regional and global market integration for energy products are hard to justify. In addition, there are also concerns about the fairness of benefit allocation across countries.

To quantify trade creation effects—an important benefit from forming market integration—trade economists have long been using the gravity model to examine the relationship between bilateral trade flow and its determinants (Anderson, 1979; Anderson and Wincoop, 2003; Costinot and Rodriguez-Clare, 2013). In literature, an essential argument is that market integration can increase trade efficiency and thus improve the welfare of all trade partners by providing additional trade creation. For example, Rose (2004) used a gravity model with a large panel data that covered over 50 years and 175 countries, and this showed that joining the Generalised System of Preferences (GSP) raised the bilateral trade by 136 percent, while Subramanian and Wei (2007) showed that membership to the General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) significantly increased imports (around 44% of world trade) for industrial countries though unevenly across countries.Applying this method to analyse the impact of market integration on energy trade creation, many studies (Sheng and Shi, 2013) have also found a substantial positive trade creation effects through joining a more integrated energy market.

Although previous studies contribute to improve general knowledge, the accuracy of their predictions on the trade creation effects of market integration has always been criticized. In particular, the predicted trade creation or trade efficiency obtained from using the data at different aggregation levels are always inconsistent to each other (Subramanian and Wei, 2007). A possible explanation for this phenomenon, among others, is that the standard gravity model usually uses the aggregate trade value (i.e., summed up from commodities) as the dependent variable for the regression analysis. This treatment simplifies the exercise, but neglects the potential role of substitution/complementarity between various trade components in affecting the aggregate bilateral trade flow.

This paper uses the Malmquist index approach—a method initially designed for estimating the multi-output and multi-input production function—to investigate the gravity relationship between bilateral energy trade flows and their determinants. In contrast to previous studies, the approach used in this paper allows for a flexible substitution between different energy products in bilateral trade and thus provide a better measure of trade creation and trade efficiency due to energy market integration (EMI). Using a balance panel data for 40 countries between 1995 and 2008, this paper shows that regional integration will generally increase trade creation and trade efficiency though its effects on different products are different.

Compared to the conventional gravity model with perfect cross-product substitution, results in this paper suggest that the substitution between different energy products is likely to weaken the aggregate trade creation effects (or the trade efficiency gain) due to market integration. Moreover, the implicit shadow price of specific energy products relative to others (derived from the simulation) can change over time, implying that cross-product substitution and market integration process is interacted. A policy implication is that policy makers aiming to promote the bilateral energy trade flow need to prioritise the trade of the most valuable energy products.

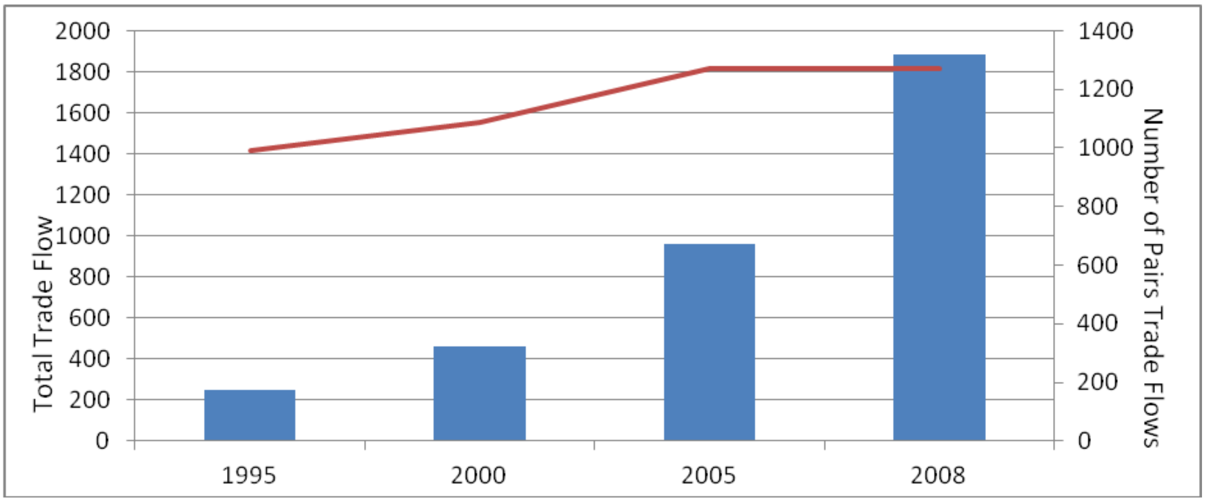
The remainder of the paper is organized as detailed below. Section 2 discusses the changing pattern of global energy trade and its components over the past two decades. A brief summary of the related literature follows. Section 3 provides the methodology and estimation strategy. The Malmquist index approach is employed to examine the gravity relationship between the bilateral energy trade flows and their determinants, and to provide the measure of trade efficiency when allowing for a flexible substitution between different energy products in trade. Section 4 describes the variables to be used and the related data sources, and provides descriptive statistics. Section 5 discusses the empirical results and Section 6 presents the conclusions.

2. Global Energy Trade and Cross-Product Substitution

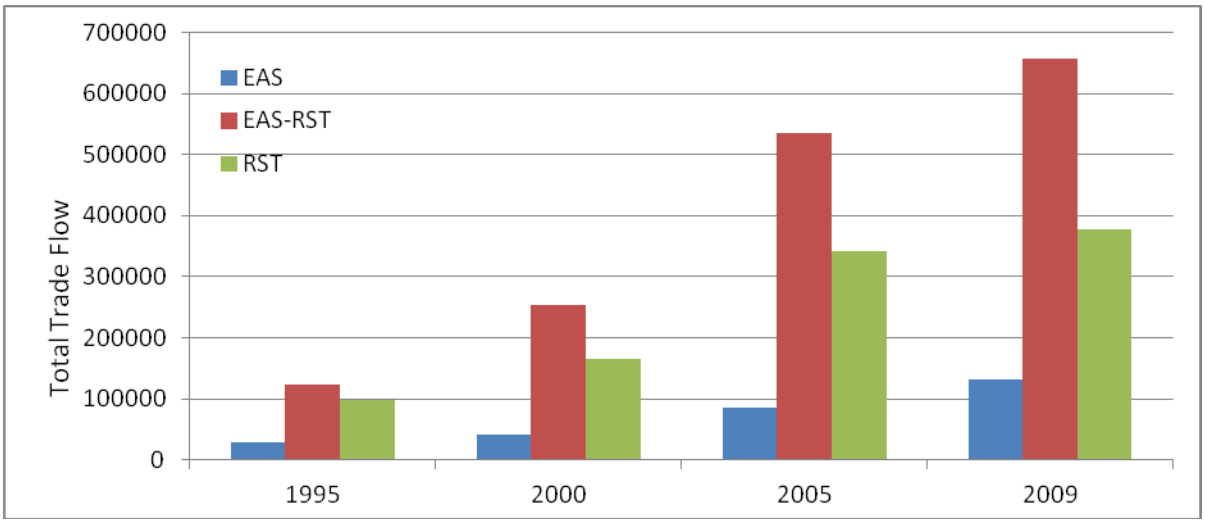
The energy trade has grown rapidly throughout the world over the past two decades, though its growth pattern is unevenly distributed across regions (Figure 1). Between 1995 and 2008, the total value of energy trade throughout the world has increased from US$249.5 million (at constant 2005 prices) to US$1885.4 million with an annual growth rate of 16.8 percent. The growth in energy trade associated with countries in the East Asia Summit (EAS) region is the most important driver. The total value of energy trade among the EAS countries and between the EAS countries and the rest of the world has increased from US$28 million and US$123 million, respectively, in 1980 to US$132 million and US$657 million in 2008. When added together, these account for around 70 percent of total world energy trade. Along with the strong growth in total energy flow, trade pattern has also become more diversified. The number of pairs trade has increased from 991 to 1,271 between 1995 and 2008.

Figure 1: Global energy trade and its components, by region, 1995–2008

A) Total trade flow and the number of pairs trade, 1995–2008 (in US$ billion at 2005 prices)



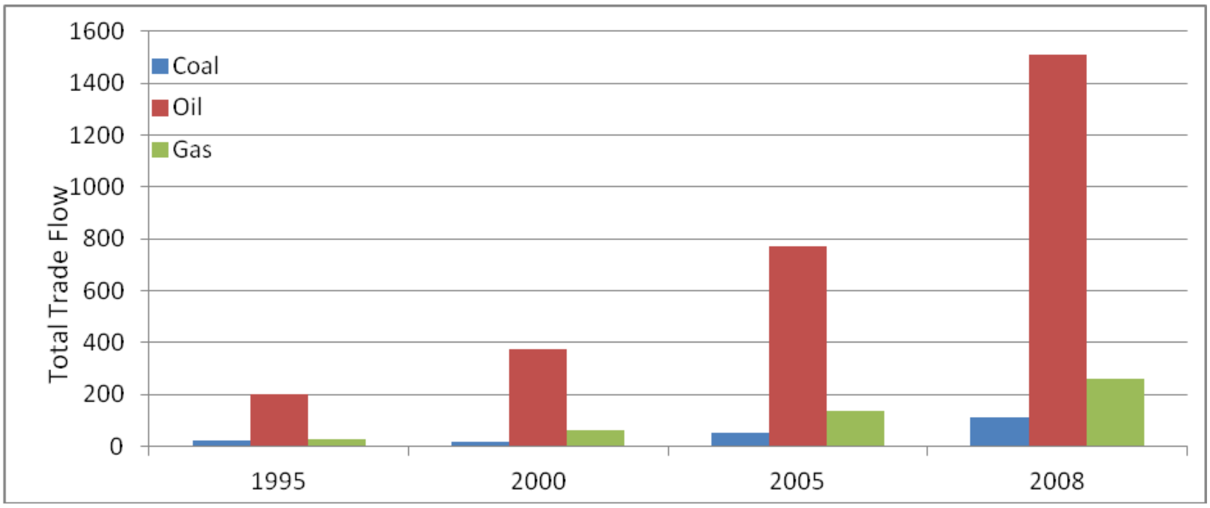
B) Cross-region distribution of energy trade, 1995-2008 (in US$ '000 at 2005 prices)



Source: Global Trade Analysis Project (GTAP) Energy Dataset.

However, the strong growth in total energy trade does not evenly apply to all energy products (Figure 2). Over the period 1995-2008, oil trade has been dominating the total energy trade. The average proportion of oil in total energy trade is around 80 percent, followed by natural gas (11%) and coal (9%). In terms of growth, the growth of trade in natural gas has taken the lead with an average annual growth rate of 19 percent, followed by oil trade (16.8%) and coal trade (13.5%). The uneven proportion (in total trade) and growth of trade in different energy products reflect their relative importance in the bilateral energy trade.

Figure 2: Components of global energy trade, by products, 1995-2008
(in US$ billion at 2005 prices)



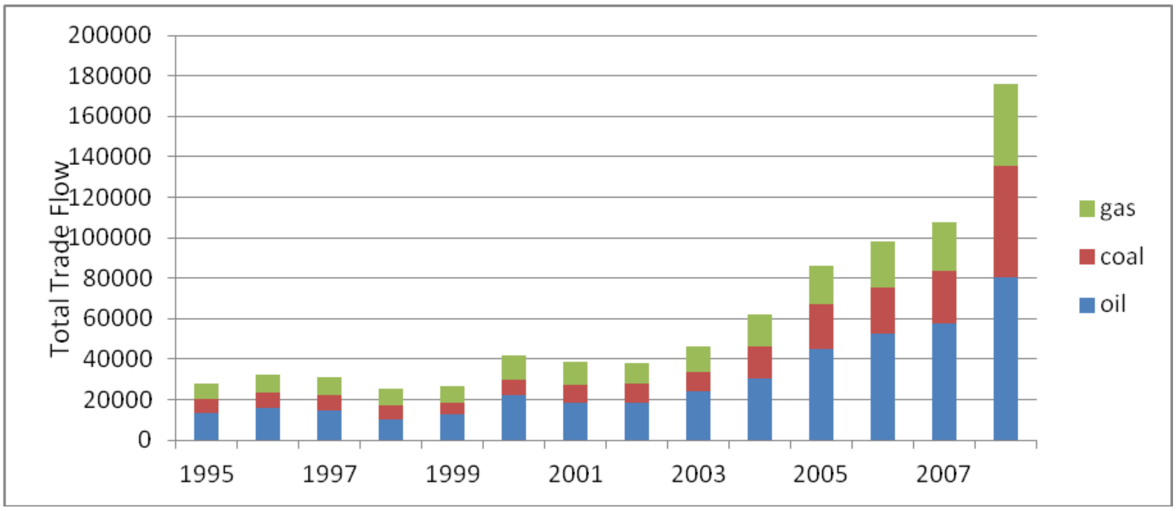
Source: Global Trade Analysis Project (GTAP) Energy Dataset.

The relative importance of different products also varies across different regions (Figure 3). For example, more than one-fourth of energy trade between countries within the EAS region is trade in coal and its share in total regional energy trade has increased from 26 percent in 1995 to 38 percent in 2008. In contrast, trade in coal only accounted for 7 percent of total energy trade between the EAS countries and the rest of world in 1995 and its share has further declined to less than 4 percent in 2008. The disparity in the relative importance of different products across regions is not only determined by the trading partners' characteristics in resource endowments, consumption preference, and production capacities but is also affected by the ease of different trade components' substitutability in consumption and its dynamic changes. Failing to consider this latter point may generate biased estimates on the aggregate trade flow.

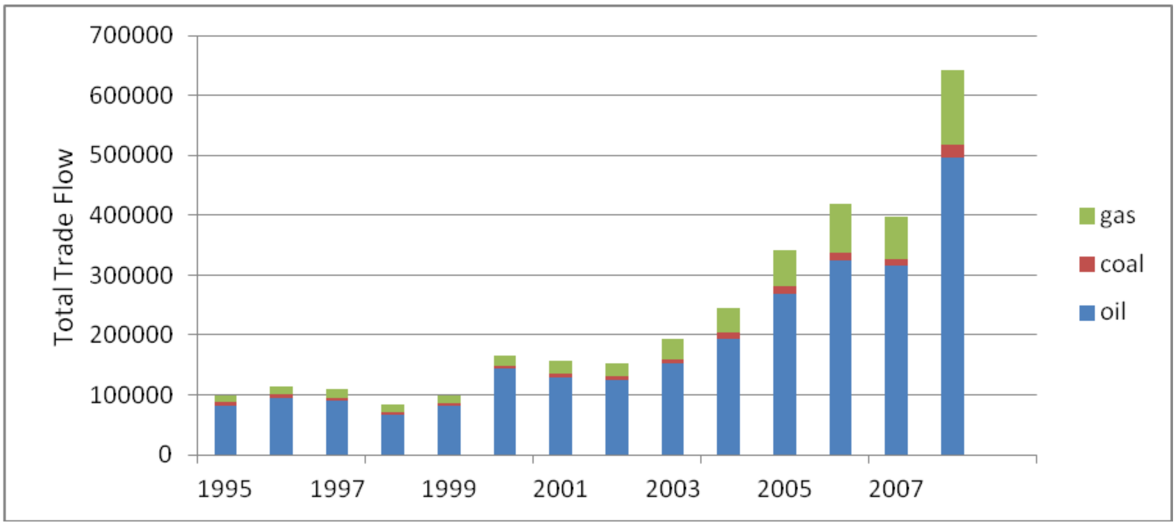
Figure 3: Cross-region comparison of energy trade components, 1995-2008

(in US$ million at 2005 prices)

A) Energy trade between the EAS countries, by products, 1995-2008



B) Energy trade between the EAS countries and the rest of the world, by products, 1995-2008



Source: Global Trade Analysis Project (GTAP) Energy Dataset.

Although there have been a large number of studies exploring the gravity relationship between bilateral energy trade and its determinants, only quite a few attempts have been made to combine the gravity model (for explaining the relationship between bilateral trade flow and its determinants) with the stochastic frontier analysis or the data envelope analysis(originally designed to measure efficiency in production or cost functions (Kuosmanen, *et al.* 2004) to quantify trade efficiency and its potential trade creation effects due to market integration. Trade efficiency is defined as the distance between actual trade flows and the maximum trade possible.

Following earlier studies in this field, several works (Drysdale and Garnaut, 1982; Kalirajan, 1999; Kalirajan and Findlay, 2005; Kang and Fratianni, 2006) applied the stochastic frontier analysis to the standard gravity model and investigated trade efficiency across 10 groups of countries throughout the world between 1975 and 2000 by using the bilateral trade data sets from Ross (2004). They showed that developed countries generally had higher trade efficiency than developing countries, and global and regional market integration contributed to raise cross-country trade efficiency. Among the Asia-Pacific region, the ASEAN has the highest trade efficiency while South Asian countries have the lowest efficiencies.

Kalirajan (1999) and Miankhel, *et al*. (2009) used the same method to examine the trade efficiency between Australia and its 65 trading partners during 2006–2008. They found that China and Japan, as well as ASEAN countries, are the key major trading partners that could provide substantial potential for Australia’s trade in mineral products (including energy products). Kalirajan and Singh (2008), following Drysdale, et al. (2000), examined the trade efficiency between China and its 56 trading partners and found that China’s efficiency was higher for trade with other Asia-Pacific region economies (especially, Chile, Hong Kong, Indonesia, Malaysia, Singapore, and Thailand) than with the European Union (EU) and the United States (US). Roperto (2013) and Roperto and Edgardo (2014) examined the trade efficiency between the Philippines and its trade partners and found that global and regional integration tend to increase trade efficiency among ASEAN countries.

The existing literature, though providing some useful information, suffers in general with two shortcomings. *First*, most of these studies focused on total trade with little implication for bilateral energy trade and the related market integration policies. *Second*, like conventional gravity studies, most of these researches use aggregate trade value as dependent variable to measure trade efficiency, which neglected the effects of cross-product non-substitution. In this paper, the Malmquist index is used to measure efficiency of multi-product energy trade when flexible substitution between trade components is considered.

3. The Malmqvist Index Approach and Trade Efficiency Measure

When investigating the gravity relationship between bilateral trade flow and its determinants, one can start by using a standard empirical specification, initially derived by Anderson (1979) and Anderson and Van Wincoop (2003), such that

$$lnX_{ij}^{k}(\tau,E)=A_{i}^{k}(\tau,E)+B_{i}^{k}(\tau,E)+\varepsilon^{k}ln\tau_{ij}^{k}+\mu_{it} \quad (1)$$

where

i — is the exporting country,

j — is the importing country, and

k — is the industry (or commodity/commodity group).

The terms $A_{i}^{k}(\tau,E)$ and $B_{i}^{k}(\tau,E)$ are income levels, which vary only at the ik and jk levels. τ_{ij}^{k} captures the 'partial equilibrium' effects of bilateral trade barrier or trade policies. μ_{it} is the residual that is used to capture the randomly distributed unobserved white noises. Equation (1) can be estimated by using different methodologies for specific purposes, including the identification of bilateral trade determination, the assessment of negative effects of regional integration, and so on.

In the literature for measuring trade efficiency, the stochastic frontier analysis or the data envelopment analysis are usually employed for the regression. Specifically, one can retrieve the best performing trade flow given trading partners' income level, trade barriers, and other controlled factors, and compare it with other trade flows to quantify their relative differences as a measure of trade efficiency. Normally, Equation (1) is specified to take the constant elasticity of substitution (CES) or the trans-log forms, and μ_{it} is assumed to contain an inefficient component (u_{it}<0) and a white noise (v_{it}), such that $\mu_{it}=u_{it}+v_{it}$. These methods work well for analysing trade flow (X_{ij}^{k}) at the commodity level, but it could not provide useful information on how trade flow may evolve and whether they are efficient at the aggregate level. This is because the substitution/complementary relationship between different components can usually change their aggregation and thus affect the measure of trade pattern at the aggregate level and its corresponding trade efficiency. In particular, when there are no perfect substitution between trade components, the model may tend to overestimate potential trade flow and trade efficiency.

To deal with the multi-outcome case, productivity economists designed the distance function method to retrieve the real substitutive/complementary relationship between different outputs (i.e., in production function), namely the Malmquist index. The method, initially used for estimating the production function, can now be used to investigate the gravity relationship between multi-product bilateral energy trade and its determinants. Since it assumes a relatively more flexible conversion function between different energy trade components, changes of trade in each energy product between any pair of trading partners can be identified through the calculation of the relative ratio of the distance of each data point relative to a commonly shared potential frontier.

With the standard assumption of imperfect substitution between multi-product energy trades ($y^{\cdot}$) and between trade determinants ($x^{\dagger}\cdot$) , the Malmquist index between period t and $t+1$ is given by:

$$M_0 = [M_0^t * M_0^{t+1}]^{1/2} = [\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} * \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}]^{1/2} \quad (2)$$

This index is estimated as the geometric mean of two distance functions: one used as a reference the potential trade frontier at period *t* and the other used as a reference at period t+1 (Fare, *et al.*, 1994). Since the reference point can be defined as the potential maximum trade flow that could be achieved once the related trade determinants are constant, the Malmquist index can be treated as a measure of trade efficiency relative to the reference and its change over time could provide information on how the trade efficiency changed over time.

Moreover, Fare, *et al.* (1994) also showed that the Malmquist index could be decomposed into an efficiency change component and a technical change component, and that these results could be applied to the different period-based Malmquist indexes.

$$M_{t,t+1} = \frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^t(x^t,y^t)} * [\frac{D_0^t(x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})} * \frac{D_0^t(x^t,y^t)}{D_0^{t+1}(x^t,y^t)}]^{1/2} \quad (3)$$

The efficiency change component of the Malmquist indexes measures the change in how far the observed trade is from the maximum potential trade between period *t* and t+1, and the technical change component reflects the shift of natural created trade (due to demand and preferences) between the two periods. To define the trade determinants-based Malmquist index, it is necessary to characterise the trade determination mechanism (namely, the gravity model) and estimate its efficiency in trade generation.

Using Equations (2) and (3), the trade creation mechanism describes the possibilities for the transformation of trade determinants (x_t->R+) such as GDP, bilateral distances, and trade policies into energy trade flows (y_t->R+). Yet, the method looks like a black box and could not directly provide the relative importance of the different energy products as components in the total bilateral energy trade. To deal with this problem, this paper followed Coelli and Rao (2001) by using the simulation method and deriving the implicit share (or marginal contribution of various trade components and trade determinants) in the Malmquist index following the neoclassical assumption.

All efficient possibilities of bilateral energy trade in the time period *t* is characterised by the set (or the frontier of the set) of

$$D_0^t(x^t,y^t) = \max_{(x^t,y^t)\in L^t} \frac{\rho y^t}{\omega x^t} : \frac{\rho y^t}{\omega x^t} \leq 1 \quad (4)$$

The technology satisfies the usual set of axioms: closeness, non-emptiness, scarcity, and no free lunch. The frontier of the set for a given output vector is defined as the input vector that cannot be decreased by a uniform factor without leaving the set. Such a frontier can be estimated by using a minimisation process

$$\text{mix}_{\theta,\lambda}\, \theta_0 \quad (5)$$

s.t.

$\sum_{i=1}^{r} y_{ik}\lambda_i - y_{0k} \geq 0$ k=1,…,m

$x_{0k}\theta - \sum_{i=1}^{r} x_{ij}\,\lambda_i \geq 0$ j=1,…,n

$\lambda \geq 0$

where

i— represents the *r* different TUs that defined the trade frontier,

k—are *m* trade flows, and

j—are *n* trade determinants.

The efficiency score obtained (θ) will take values between 0 and 1, with r indicating that the bilateral trade is located at the frontier.

Equation (5) is known as the data envelop form of the approach. An equivalent dual approach can be derived from its primal form (Kuosmanen, *et al.*, 2004). The envelope approach is preferred to the distance function way for estimating trade efficiency since it requires fewer constraints. Also, the current form has the advantage of a more intuitive specification, offering a better economic interpretation of the problem.

Using the above method, the impact of EMI policies on trade creation of multi-products can be estimated at the same time. In particular, the marginal contribution of each product to various determinants to trade can be isolated from the others through the dual method. This provides some useful knowledge to inform the relevant policies, since the marginal contribution of various trade determinants can be converted into corresponding cost-benefit ratios.

4. Data Collection and Variables Definition

Data used in this study come from four major sources including (i) the global trade analysis project (GTAP) energy product database, (ii) the UN Comtrade Database and data used by Subramanian and Wei (Subramanian and Wei, 2007), (iii) the World Development Indicator Database, (iv) and the energy statistics from the BP Statistical Review of World Energy. Initially, the database cover the bilateral trade in three types of energy products, including coal, petrol, and gas across 172 countries (including 26 EAS countries) over the period 1995–2008. Yet, the real number of trade flows is much smaller than the initial dataset and many trade flows are zeros.

This is because energy trade across countries heavily depends on exporting countries' initial natural endowments. Since the gravity model is more reliable in providing long-term projection, this paper uses the five-year average to smooth the year-to-year fluctuation in energy trade. Finally, the estimation of Malmquist index requires the balanced panel data, which impose the additional constraints.

With all three constraints considered, the sample size is cut down to 1,164 pairs of bilateral trade, covering 40 countries over four time periods—1995, 2000, 2005, and 2008. The sample is representative since they are added up to account for 44 percent of total energy trade of the whole world in 2008, which include 60 percent of coal trade, 43 percent of oil trade, and 45 percent of natural gas trade.

The dependent variable—the bilateral trade in coal, petrol, and gas between each pair of countries—is defined as real import value of each commodity. To make it comparable across countries and over time, nominal import values are deflated by using the corresponding commodity price at 2005 prices (provided by the GTAP datasets). It is to be noted that the import value rather than the total trade value was deliberately used to represent the bilateral trade since energy trade is usually a one-way trade. With such a treatment, the bilateral energy trade can be better captured by the characteristics of importers and exporters.

Independent variables first include the GDP per capita of both importers and exporters in US dollars at constant 2000 price and the geographical distances between the corresponding trade partners. Data for the period 1995–2000 are coming directly from Subramanian and Wei (2007) while data for the period after 2000 are coming from the World Development Indicator Database. Some adjustments have been made to make them consistent over time. In addition to the standard variables used in gravity models, the natural endowment of energy products in exporting countries are also used as control variables. This is important since it is impossible for countries holding no natural reserve in energy products to export. Data on natural endowment of natural reserves of each type of energy products in exporting and importing countries are obtained from various issues of the BP Statistical Review of World Energy.

Table 1 provides the summary statistics of the dependent variables (the bilateral trade in three energy products) and the major independent variables (i.e., GDP per capita, distance, and natural reserve in individual energy products).

Table 1: Logarithm of major variables in the regression

Variable Names	No. of Obs.	Mean	Std. Dev.	Min.	Max.
ln_agg._energy_trade	1164	5.16	2.18	0.00	11.46
ln_coal_trade	1164	1.81	2.19	0.00	9.83
ln_oil_trade	1164	3.67	3.17	0.00	11.06
ln_gas_trade	1164	0.81	2.07	0.00	10.33
ln_GDP_capita_importer	1164	8.73	1.49	5.43	10.64
ln_GDP_capita_exporter	1164	9.41	1.19	5.74	10.64
ln_distance	1164	7.73	0.97	5.09	9.34
ln_land_area	1164	26.84	2.59	17.81	32.20
dummy for common language	1164	0.17	0.37	0.00	1.00
dummy for FTA	1164	0.21	0.41	0.00	1.00
share of manufacturing industry	1164	29.01	11.40	4.00	94.40
ratio of energy to non-energy trade	1164	0.00	0.01	0.00	0.42
coal_ reserve_importer	1164	214.31	472.87	0.00	2802.00
oil_reserve_importer	1164	41.50	74.18	0.00	264.21
gas_reserve_importer	1164	3.29	5.32	0.00	29.61
coal_ reserve_exporter	1164	155.90	399.84	0.00	2802.00
oil_reserve_exporter	1164	8.97	28.48	0.00	181.50
gas_reserve_exporter	1164	0.97	2.13	0.00	29.61

Note: FTA = Free Trade Agreement, GDP = gross domestic product, No. of Obs. = Number of observations., Std. Dev. = standard deviation, max. = maximum, min. = minimum.
Source: Global Trade Analysis Project (GTAP) Energy Dataset.

5. Empirical Results: Multi-Product Energy Trade Determinants and Its Efficiency

5.1. Bilateral Trade Determination and Substitution between Trade Components

Applying the Malmquist index method to the data of bilateral energy trade, the gravity relationship is estimated between bilateral energy trade flows and their determinants, including the trading partners' economic growth, trade barriers (i.e., distance) and other controlled variables such as country-specific industrial trade and structure, Free Trade Agreement (FTA) participation, and initial endowment in natural resources. For robustness check, results obtained from two models are compared. The first model only uses the trading partners' GDP per capita and the geographical distance as the determinants of bilateral energy trade while the second model also incorporates other controlled variables. The results are shown in Table 2.

When allowing for more flexible substation/complementarities between different energy products, the marginal contribution of various trade determinants to bilateral trade flows are measured and reported in Table 2. These results are further compared with those obtained from the model, which uses the aggregate energy trade flow as the dependent variable.

Table 2: Marginal Contribution of Trade Determinants to the Aggregate Energy Trade

	Model I		**Model II**	
	Single-Product Energy Trade	Multi-Product Energy Trade	Single-Product Energy Trade	Multi-Product Energy Trade
ln_GDP_per_capita_importer	0.035***	0.009**	0.040***	0.011**
	(0.005)	(0.004)	(0.005)	(0.004)
ln_GDP_per_capita_exporter	0.025***	0.019***	0.037***	0.027***
	(0.006)	(0.005)	(0.006)	(0.005)
ln_distance	-0.007	-0.004	-0.038***	-0.018**
	(0.008)	(0.006)	(0.009)	(0.007)
Ratio of energy to non-energy trade	-	-	0.950*	0.964**
	-	-	(0.512)	(0.412)
Share of secondary industry in GDP	-	-	0.191***	0.724***
	-	-	(0.015)	(0.103)
Dummy_for_FTA	-	-	0.044**	0.017
	-	-	(0.022)	(0.017)
coal_reserve_cty1	-	-	-0.000***	-0.000***
	-	-	(0.000)	(0.000)
oil_reserve_cty1	-	-	0.001***	0.001***
	-	-	(0.000)	(0.000)
gas_reserve_cty1	-	-	0.008***	0.007***
	-	-	(0.002)	(0.001)
coal_reserve_cty2	-	-	0.000***	0.000***
	-	-	(0.000)	(0.000)
oil_reserve_cty2	-	-	0.001***	0.000*
	-	-	(0.000)	(0.000)
gas_reserve_cty2	-	-	0.006	0.000
	-	-	(0.004)	(0.003)
Constant	0.559***	0.443***	0.664***	0.496***
	(0.105)	(0.084)	(0.114)	(0.089)

Note: FTA = Free Trade Agreement, GDP = gross domestic product.
*** p<0.01, ** p<0.05, * p<0.1
Source: Global Trade Analysis Project (GTAP) Energy Dataset.

Consistent with the prediction of conventional gravity models, trading partners' economic growth positively contributed to bilateral energy trade while geographical distance negatively contributed to bilateral energy trade (Table 2). However, the magnitude of these coefficients of trade determinants is much smaller than that obtained from the traditional models (which assume that different energy products are perfectly substituted). This implies that using the aggregate energy trade flow as dependent variable may tend to overestimate the potential trade driven by conventional gravity drivers and thus cause the overestimation of trade efficiency, which is defined as the gap of real trade flow relative to potential trade flow.

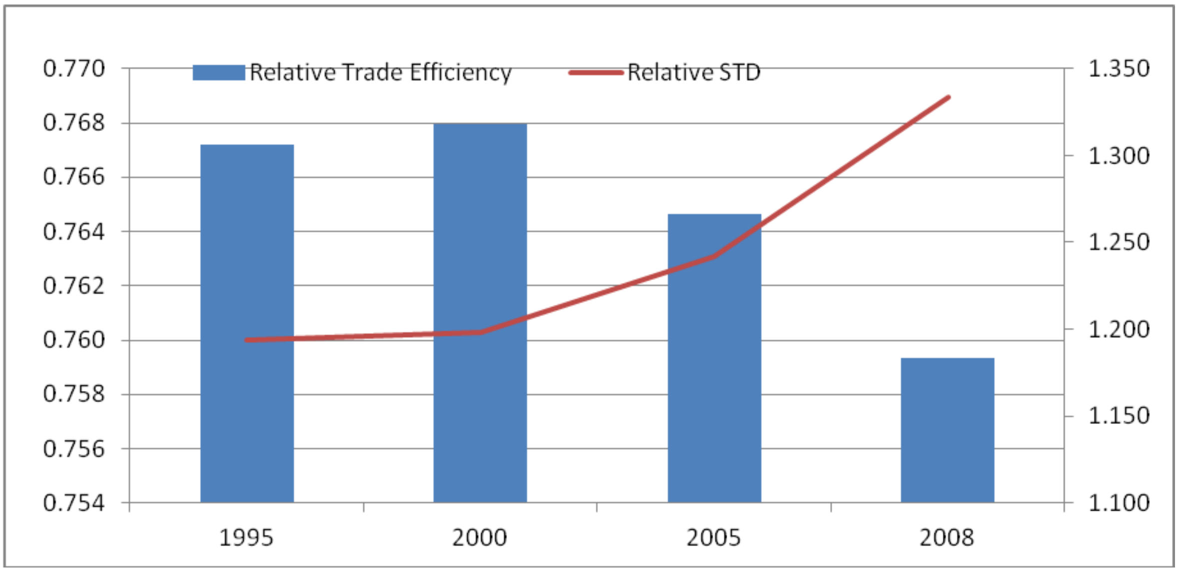
As an example, Table 3 compares the average growth in efficiency of bilateral energy trade between using the sum of energy trade (or the single-product trade model) and using the individual energy trade flow (or the multi-product trade model). Between 1995 and 2008, the average bilateral energy trade efficiency measured either by using the Malmquist index method for multi-product trade or by using the Malmquist index method for single-product trade has been increasing but their trends are different. In particular, the relative trade efficiency of the multi-product energy trade to that of the single-product energy trade declines while the standard deviation of estimated trade efficiency increases (Figure .4). This implies that bilateral trade efficiency, when flexible substitution between different energy products is allowed, is more likely to be diversified along with the increased mean.

Table 3: Comparison of Energy Trade Efficiency, 1995-2008

Year	No. of Obs.	Single-Product Trade Mean	Single-Product Trade Std.	Multi-Product Trade Mean	Multi-Product Trade Std.
1995	291	0.344	0.153	0.264	0.183
2000	291	0.380	0.166	0.292	0.199
2005	291	0.417	0.172	0.319	0.214
2008	291	0.460	0.173	0.349	0.231

Note : No. of Obs. = Number of Observations, Std. = standard deviation.
Source: Authors' own estimation.

Figure 4: Relative Trade Efficiency by Different Assumptions–Mean and Standard Deviation



Note : Relative STD = relative standard deviation.
Source: Authors' own estimation.

In addition, the finding also shows that the exporters' initial endowment in energy resources (among other controlled factors) also affects the possibility of bilateral trade creation in energy products.

5.2. Efficiency of Energy Trade and Market Integration

Based on the assumption of a multi-product trade and the imperfect substitution between different energy products, empirical results show that the average efficiency in bilateral energy trade across countries has been improving over time. Between 1995 and 2010, there are on average more than 14 percent growth in cross-country energy trade for every five years with constant income growth and natural (i.e., geographical or endowment) trade barriers, though the trend tends to decline over time. This finding reflects the globalisation and regionalisation throughout the world and their potential impact on EMI and in promoting bilateral/multilateral energy trade.

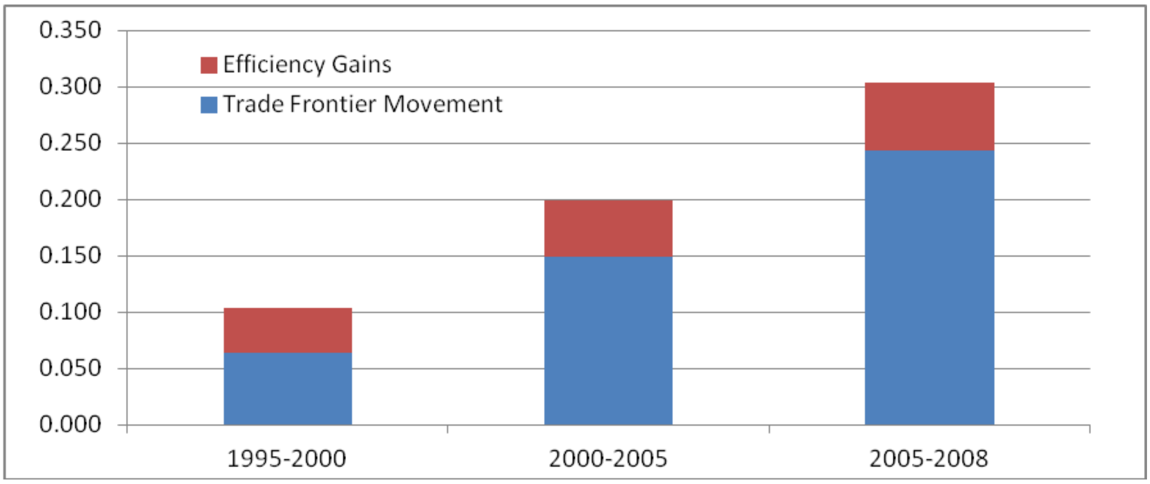
Table 4: Changes in Average Energy Trade Efficiency and its Components, 1995-2008

Year	Total trade	Frontier movement	Efficiency improvement
1995	1.000	1.000	1.000
2000	1.106	1.064	1.040
2005	1.207	1.149	1.050
2008	1.319	1.243	1.060

Source: Authors' own estimation.

A decomposition analysis shows that the rapid increase in the bilateral trade potential of energy products is driven by two forces: the contribution of advanced countries' efforts in further improving the trade efficiency, and the contribution of lagged countries' efforts in catching up with advanced countries. On average, the advanced countries' improving the trade efficiency accounted for around 70 percent of total efficiency gain in energy trade while lagged countries' catching up with advanced countries accounted for around 30 percent of total efficiency gain.

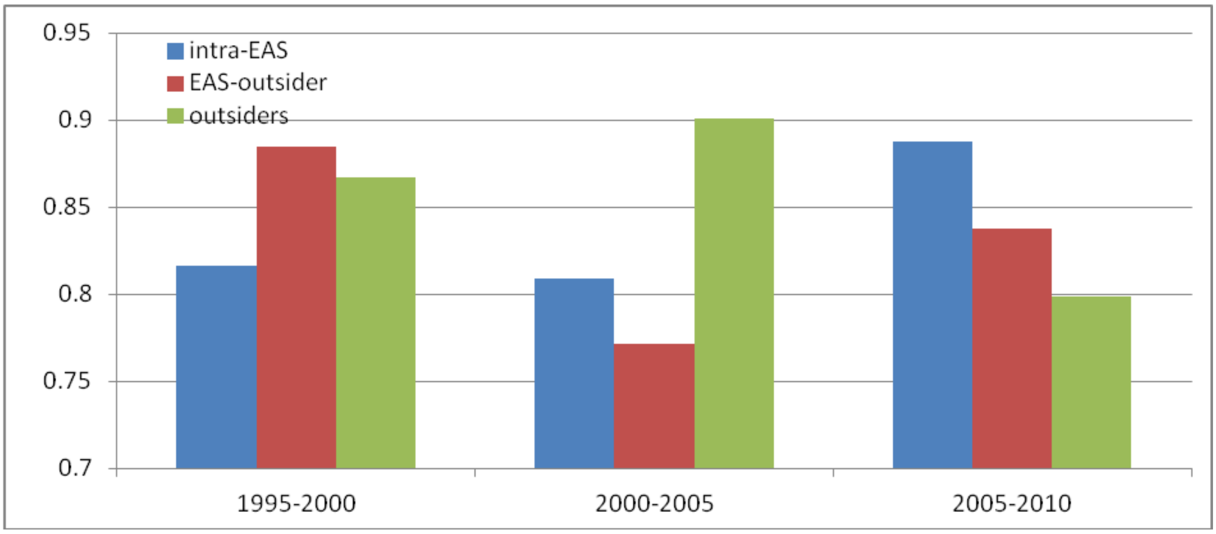
Figure 5: Trade Frontier Movement vs. Efficiency Gain, 1995-2008



Source: Authors' own estimation.

How does the trade efficiency of energy products change across different regions, in particular, within the EAS region? To answer this question, the bilateral trade flows were categorised into three groups: (i) the energy trade between EAS countries (intra-regional trade), (ii) the energy trade between EAS countries and the countries outside of the region, and (iii) the energy trade between countries outside of the region. The average efficiency of energy trade for each group of country pairs were estimated and presented in Figure 6.

Figure 6: Comparison of Average Energy Trade Efficiency, by Country Groups, 1995-2008



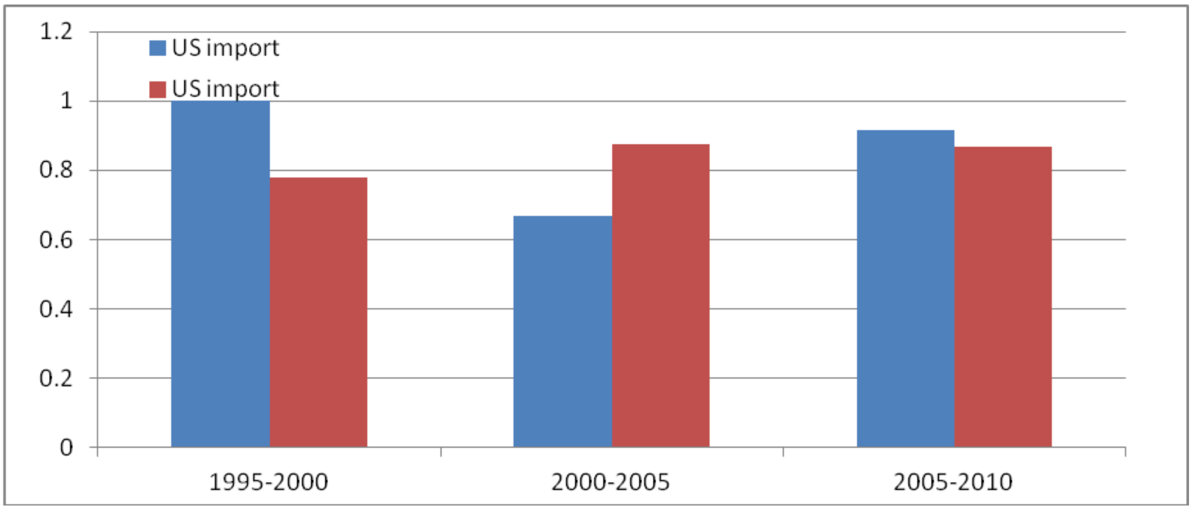
Source: Authors' own estimation.

Comparing across the three groups of countries, the average energy trade efficiency between EAS countries has been low relative to that of countries in other groups, but it increased quickly over time. The average energy trade efficiency between EAS countries has increased from 0.82 in 1995 to 0.89 in 2008. Over the same period, energy trade efficiencies between EAS countries and countries outside of the regions and that between countries outside of the region have declined from 0.88 and 0.87 down to 0.86 and 0.84, respectively. This implies that public policies aimed at improving EMI, among other factors, have played an active role in facilitating cross-country energy trade.

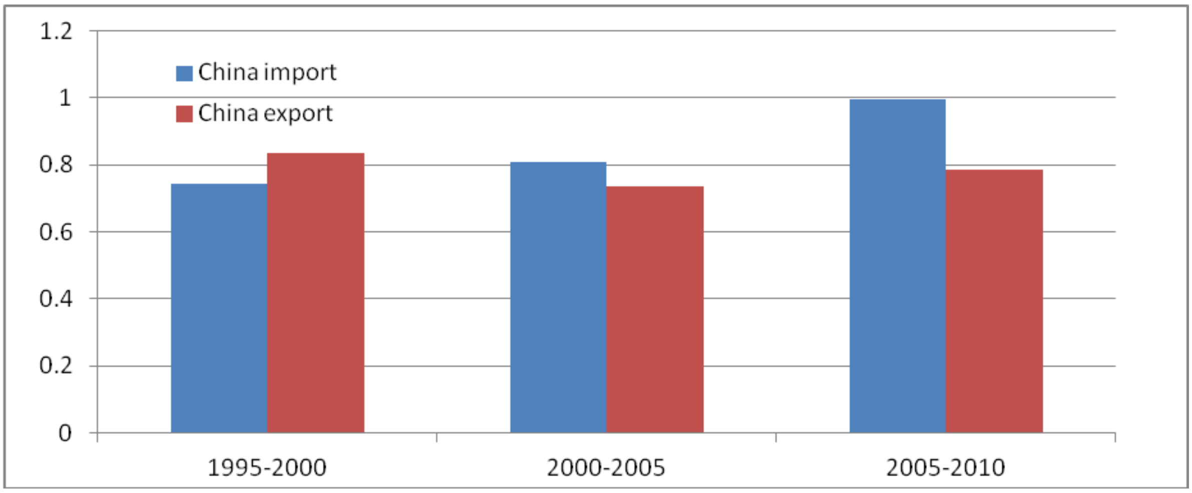
Although the average energy trade efficiency between EAS countries has been increasing, there are still significant differences across countries. Figure 7 shows the average energy trade efficiency of three countries (the US, China, and Indonesia) in exports and imports. Over the period 1995–2008, energy trade efficiency of imports and exports between the US and its trading partners in the EAS region has been declining while that between China and its trading partners in the region has been increasing. This, in general, represents the changes in energy trade pattern between developed and developing countries due to their different performance in economic development and the related energy demand. As for Indonesia, energy trade efficiency of imports has been declining while that of exports has been increasing between 1995 and 2010. This finding is more likely to reflect the country's specific endowment in energy resources and its booming petrol and gas production.

Figure 7: Average Energy Trade Efficiency of Imports and Exports: United States, China, and Indonesia

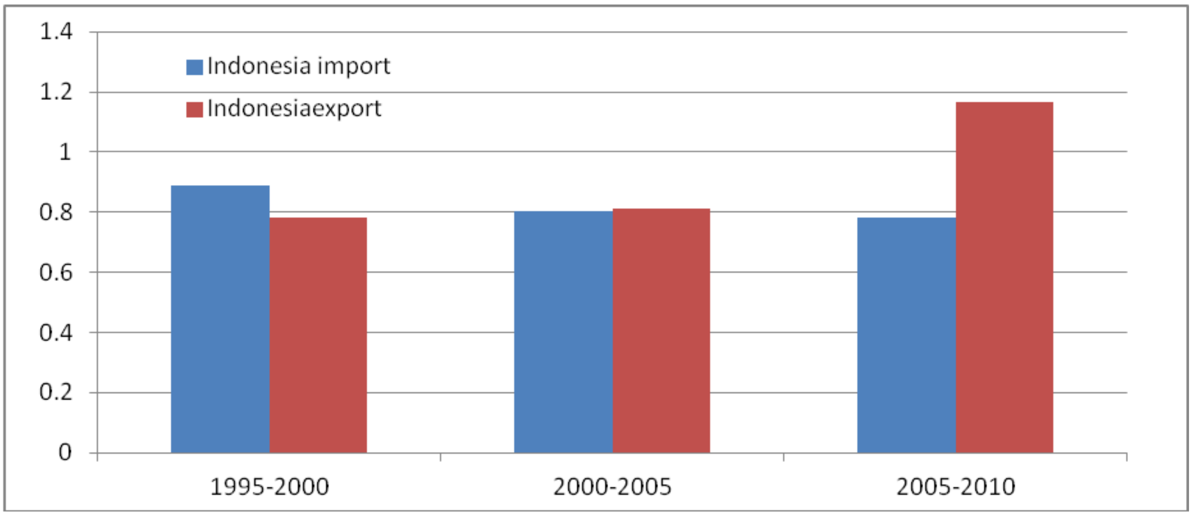
A) Average energy trade efficiency in the United States



B) Average energy trade efficiency in China



C) Average energy trade efficiency in Indonesia



Source: Authors' own estimation

5.3. Implicit Share: Importance of Trade Components in Bilateral Energy Trade

Using the Malmquist index to examine the gravity relationship between multi-product trade and its determinants, one can obtain additional results on the implicit prices for different trade components through the related simulation. Usually, these implicit prices may reflect the relative importance of each energy products in the aggregate energy trade. Based on Coelli and Rao (2001), the simulation is used to derive the implicit prices of all three energy products specified in the model—coal, petrol, and gas—and the results are shown in Table 5.

Table 5: Implicit Price of Coal, Petrol and Gas in Bilateral Trade Model

Year	ln_coal	ln_petrol	ln_gas
1995	0.414	0.237	0.000
2000	0.318	0.313	0.003
2005	0.203	0.371	0.008
2008	0.185	0.386	0.013

Source: Authors' own estimation.

Between 1995 and 2008, implicit prices of petrol and gas have been increasing faster relative to the price of coal. The implicit prices of petrol and gas increased from 0.24 and 0.00 in 1995 to 0.39 and 0.01 in 2008 while that of coal declined from 0.41

in 1995 to 0.19 in 2008. This result partly reflects the increasing importance of trade in petrol and gas in total energy trade possibly due to changing preference. An important implication is to further improve the aggregate energy trade efficiency across countries, with more emphasis given to petrol and gas since their performance continues to increase over time.

6. Policy Implication, Expected Result, and Future Development Study

The development level of East Asia is vastly different from that of Cambodia, Lao PDR, Myanmar, and Viet Nam (also called CLMV countries). The 2008 gross national income (GNI) per capita in current value is US$630 for Cambodia, US$750 for Lao PDR, and US$910 for Viet Nam, while that in developed EAS countries, Australia has a GNI per capita of US$41,890, Japan has US$37,930, South Korea has US$21,570, and New Zealand has US$26,830, all in current values. The difference between the richest and the poorest countries is more than 60 times. Since narrowing development gaps is a prerequisite for the process of regional integration, it is therefore very important to study the impact of EMI on growth convergence.

It is widely believed that EMI will help participants to be more closely related through improving the bilateral trade efficiencies. Yet, how the trade creation process is achieved is not yet well understood. To address this issue, this study provides policy makers with some useful information on what kind of impact EMI can have on potential energy trade and the dynamic path of energy trade in different products, particularly on its impact on country-specific products. As the analysis is narrowing the focus from the aggregate energy trade down to products, it improves the possibility of applying EMI-oriented policies for the region and in trade-related countries.

A few policy implications are expected. At the regional level, the productivity analysis will make it possible for stakeholders to understand the trade potential. This will help the regional policy makers to gauge their efforts. The estimated benefits will also reassure policy makers in their determination to move EMI forward. At the national level, *first*, information on the impact of EMI on product trade will help policy makers assess whether the consequence of EMI is acceptable since different kinds of energy products may have different strategic roles in each national economy. *Second*, this knowledge will make it possible for national policy makers to understand the impact by sector and, thus, they are able to formulate appropriate policies that will offset or enhance a particular impact.

7. Conclusions

This paper employs the Malmquist index approach to estimate the gravity relationship between bilateral energy trade and its determinants. Using a balance panel data of 40 countries covering the period between 1995 and 2010, a measure of energy trade efficiency at the aggregate level is provided and its change over time when considering the flexible substitution between different energy products, including coal, oil, and natural gas. Results show that along with the rapid growth in total energy trade, the trade efficiency in all energy products across countries have been increasing over the past two decades, particularly within the EAS region (though there are some cross-country disparities). Both the advanced countries' trade efficiency improvement and the lagged countries' catch-up efforts played important roles in driving such a change.

Results also show that different energy products contribute differently to the aggregate energy trade creation and to the corresponding trade efficiency gain. Generally, trade in coal accounts for the highest implicit prices but it has been declining over time relative to trade in petrol and gas, which suggests that trade in coal is losing its advantage over trade in petrol and gas. Thus, public policies that aim to improve regional EMI could benefit more by focusing on trade in petrol and gas.

References

Anderson, J. (1979), 'A Theoretical Foundation for the Gravity Equation', *American Economic Review*, 69(1), pp. 106-16.

Anderson, J. and E. van Wincoop (2003), 'Gravity with Gravitas: A solution to the Border Puzzle', *American Economic Review*, 93(1), pp. 170-92.

Coelli, T.J. and P. R. Rao (2001), 'Implicit Value Shares in Malmquist TFP Index Numbers', *Centre for Efficiency and Productivity Analysis (CEPA) Working Papers No.* 4/2001, Armidale: School of Economic Studies, University of New England.

Costinot, A. and A. Rodriguez-Clare (2013), 'Trade Theory with Numbers: Quantifying the Consequences of Globalization', in A. Gopinah, E. Helpman, and R. Rogoff (eds.) *Handbook of International Economics*, Vol. 4, New York.

Drysdale, P. and R. Garnaut (1982), 'Trade Intensities and the Analysis of Bilateral Trade Flows in a Many-Country World: A Survey', *Hitotsubashi Journal of Economics*, 22(2), pp. 62-84.

Drysdale, P., Y. Huang, and K.P. Kalirajan (2000), 'Measuring and Explaining Trade Efficiency', a paper presented at the Asia Pacific Economies Program Seminar, Asia Pacific School of Economics and Management, The Australian National University, Canberra, August 2000.

Fare, R. S. Grosskopf, M. Norris, and Z. Zhang (1994), Productivity Growth, Technical Progress and Efficiency Change in Industrialized Countries', *American Economic Review*, 84, pp.66-83.

International Energy Agency (IEA) (2008), *World Energy Outlook*, Paris: IEA.

International Energy Agency (IEA) (2012), *World Energy Outlook*, Jakarta: IEA.

Kang, H. and M. Fratianni (2006), 'International Trade Efficiency, the Gravity Equation, and the Stochastic Frontier', *Working Papers 2006-08*, Indiana: Kelley School of Business, Department of Business Economics and Public Policy, Indiana University.

Kalirajan, K. (1999), 'Stochastic Varying Coefficients Gravity Model: An Application in Trade Analysis', *Journal of Applied Statistics*, 26(2), pp.185-94.

Kalirajan, K. and Findlay, C. (2005), Estimating Potential Trade Using Gravity Models: A Suggested Methodology, Tokyo: Foundation for Advanced Studies on International Development.

Kalirajan, K. and K. Singh (2008), 'A Comparative Analysis of China's and India's Recent Export Performances', *Asian Economic Papers*, vol. 7(1), pp. 1-28, Cambridge: MIT Press.

Kuosmanen, T., T. Post, and T. Sipilainen (2004), 'Shadow Price Approach to Total Factor Productivity Measurement: With an Application to Finnish Grass-Silage Production', *Journal of Productivity Analysis*, 22, pp. 95-121.

Miankhel, A.K., S.M. Thangavelu, and K. Kalirajan (2009), 'Foreign Direct Investment, Export and Economic Growth in Selected Emerging Countries: Multivariate VAR Analysis', *MPRA Paper* No. 22763, Munich, Germany: University Library of Munich.

Rose, A. (2004) 'Do We Really Know that the WTO Increases Trade?', *American Economic Review*, 94(1), pp.98-114.

Roperto, D. Jr. (2013), 'Trade Performance and Potential of the Philippines: An Application of Stochastic Frontier Gravity Model', *MPRA Paper* No. 51677, Munich, Germany: University Library of Munich.

Roperto, D. Jr. and C. Edgardo (2014), 'Philippine Export Efficiency and Potential: An Application of Stochastic Frontier Gravity Model', *MPRA Paper* No. 53580, Munich, Germany: University Library of Munich.

Sheng, Y. and X. Shi (2013), 'Energy Market Integration and Equitable Growth Across Countries', Applied Energy 104, pp.319-325.

Shi, X and F. Kimura (2010), 'Energy Market Integration in the East Asia Summit Region: Review of Initiatives and Estimation of Benefits', Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA).

Subramanian, A. and S.J. Wei (2007), 'The WTO Promotes Trade, Strongly but Unevenly', *Journal of International Economics*, 72(2007), pp.151-75.

Wu, Y., X. Shi, and F. Kimura (2012), *Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies*, Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA).

Wu, Y., F. Kimura, and X. Shi, (2014), E*nergy Market Integration in East Asia: Deepen Understanding and Move Forward*. Rutledge, Oxon, New York.

Thanh, N. N. and K. Kalirajan (2006), 'Can Devaluation be Effective in Improving the Balance of Payments in Vietnam?', *Journal of Policy Modeling*, 28(4), pp. 467-76.

ERIA Discussion Paper Series

No.	Author(s)	Title	Year
2014-20	Yu SHENG, Yanrui WU, Xunpeng SHI, Dandan ZHANG	Market Integration and Energy Trade Efficiency: An Application of Malmqviat Index to Analyse Multi-Product Trade	Nov 2014
2014-19	Andindya BHATTACHARYA and Tania BHATTACHARYA	ASEAN-India Gas Cooperation: Redifining India's "Look East" Policy with Myanmar	Nov 2014
2014-18	Olivier CADOT, Lili Yan ING	How Restrictive Are ASEAN's RoO?	Sep 2014
2014-17	Sadayuki TAKII	Import Penetration, Export Orientation, and Plant Size in Indonesian Manufacturing	July 2014
2014-16	Tomoko INUI, Keiko ITO, and Daisuke MIYAKAWA	Japanese Small and Medium-Sized Enterprises' Export Decisions: The Role of Overseas Market Information	July 2014
2014-15	Han PHOUMIN and Fukunari KIMURA	Trade-off Relationship between Energy Intensity-thus energy demand- and Income Level: Empirical Evidence and Policy Implications for ASEAN and East Asia Countries	June 2014
2014-14	Cassey LEE	The Exporting and Productivity Nexus: Does Firm Size Matter?	May 2014
2014-13	Yifan ZHANG	Productivity Evolution of Chinese large and Small Firms in the Era of Globalisation	May 2014
2014-12	Valéria SMEETS, Sharon TRAIBERMAN, Frederic WARZYNSKI	Offshoring and the Shortening of the Quality Ladder:Evidence from Danish Apparel	May 2014
2014-11	Inkyo CHEONG	Korea's Policy Package for Enhancing its FTA Utilization and Implications for Korea's Policy	May 2014
2014-10	Sothea OUM, Dionisius NARJOKO, and Charles HARVIE	Constraints, Determinants of SME Innovation, and the Role of Government Support	May 2014
2014-09	Christopher PARSONS and Pierre-Louis Vézina	Migrant Networks and Trade: The Vietnamese Boat People as a Natural Experiment	May 2014

No.	Author(s)	Title	Year
2014-08	Kazunobu HAYAKAWA and Toshiyuki MATSUURA	Dynamic Tow-way Relationship between Exporting and Importing: Evidence from Japan	May 2014
2014-07	DOAN Thi Thanh Ha and Kozo KIYOTA	Firm-level Evidence on Productivity Differentials and Turnover in Vietnamese Manufacturing	Apr 2014
2014-06	Larry QIU and Miaojie YU	Multiproduct Firms, Export Product Scope, and Trade Liberalization: The Role of Managerial Efficiency	Apr 2014
2014-05	Han PHOUMIN and Shigeru KIMURA	Analysis on Price Elasticity of Energy Demand in East Asia: Empirical Evidence and Policy Implications for ASEAN and East Asia	Apr 2014
2014-04	Youngho CHANG and Yanfei LI	Non-renewable Resources in Asian Economies: Perspectives of Availability, Applicability, Acceptability, and Affordability	Feb 2014
2014-03	Yasuyuki SAWADA and Fauziah ZEN	Disaster Management in ASEAN	Jan 2014
2014-02	Cassey LEE	Competition Law Enforcement in Malaysia	Jan 2014
2014-01	Rizal SUKMA	ASEAN Beyond 2015: The Imperatives for Further Institutional Changes	Jan 2014
2013-38	Toshihiro OKUBO, Fukunari KIMURA, Nozomu TESHIMA	Asian Fragmentation in the Global Financial Crisis	Dec 2013
2013-37	Xunpeng SHI and Cecilya MALIK	Assessment of ASEAN Energy Cooperation within the ASEAN Economic Community	Dec 2013
2013-36	Tereso S. TULLAO, Jr. And Christopher James CABUAY	Eduction and Human Capital Development to Strengthen R&D Capacity in the ASEAN	Dec 2013
2013-35	Paul A. RASCHKY	Estimating the Effects of West Sumatra Public Asset Insurance Program on Short-Term Recovery after the September 2009 Earthquake	Dec 2013
2013-34	Nipon POAPONSAKORN and Pitsom MEETHOM	Impact of the 2011 Floods, and Food Management in Thailand	Nov 2013
2013-33	Mitsuyo ANDO	Development and Resructuring of Regional Production/Distribution Networks in East Asia	Nov 2013

No.	Author(s)	Title	Year
2013-32	Mitsuyo ANDO and Fukunari KIMURA	Evolution of Machinery Production Networks: Linkage of North America with East Asia?	Nov 2013
2013-31	Mitsuyo ANDO and Fukunari KIMURA	What are the Opportunities and Challenges for ASEAN?	Nov 2013
2013-30	Simon PEETMAN	Standards Harmonisation in ASEAN: Progress, Challenges and Moving Beyond 2015	Nov 2013
2013-29	Jonathan KOH and Andrea Feldman MOWERMAN	Towards a Truly Seamless Single Windows and Trade Facilitation Regime in ASEAN Beyond 2015	Nov 2013
2013-28	Rajah RASIAH	Stimulating Innovation in ASEAN Institutional Support, R&D Activity and Intelletual Property Rights	Nov 2013
2013-27	Maria Monica WIHARDJA	Financial Integration Challenges in ASEAN beyond 2015	Nov 2013
2013-26	Tomohiro MACHIKITA and Yasushi UEKI	Who Disseminates Technology to Whom, How, and Why: Evidence from Buyer-Seller Business Networks	Nov 2013
2013-25	Fukunari KIMURA	Reconstructing the Concept of "Single Market a Production Base" for ASEAN beyond 2015	Oct 2013
2013-24	Olivier CADOT Ernawati MUNADI Lili Yan ING	Streamlining NTMs in ASEAN: The Way Forward	Oct 2013
2013-23	Charles HARVIE, Dionisius NARJOKO, Sothea OUM	Small and Medium Enterprises' Access to Finance: Evidence from Selected Asian Economies	Oct 2013
2013-22	Alan Khee-Jin TAN	Toward a Single Aviation Market in ASEAN: Regulatory Reform and Industry Challenges	Oct 2013
2013-21	Hisanobu SHISHIDO, Shintaro SUGIYAMA, Fauziah ZEN	Moving MPAC Forward: Strengthening Public-Private Partnership, Improving Project Portfolio and in Search of Practical Financing Schemes	Oct 2013
2013-20	Barry DESKER, Mely CABALLERO-ANTHONY, Paul TENG	Thought/Issues Paper on ASEAN Food Security: Towards a more Comprehensive Framework	Oct 2013

No.	Author(s)	Title	Year
2013-19	Toshihiro KUDO, Satoru KUMAGAI, So UMEZAKI	Making Myanmar the Star Growth Performer in ASEAN in the Next Decade: A Proposal of Five Growth Strategies	Sep 2013
2013-18	Ruperto MAJUCA	Managing Economic Shocks and Macroeconomic Coordination in an Integrated Region: ASEAN Beyond 2015	Sep 2013
2013-17	Cassy LEE and Yoshifumi FUKUNAGA	Competition Policy Challenges of Single Market and Production Base	Sep 2013
2013-16	Simon TAY	Growing an ASEAN Voice? : A Common Platform in Global and Regional Governance	Sep 2013
2013-15	Danilo C. ISRAEL and Roehlano M. BRIONES	Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines	Aug 2013
2013-14	Allen Yu-Hung LAI and Seck L. TAN	Impact of Disasters and Disaster Risk Management in Singapore: A Case Study of Singapore's Experience in Fighting the SARS Epidemic	Aug 2013
2013-13	Brent LAYTON	Impact of Natural Disasters on Production Networks and Urbanization in New Zealand	Aug 2013
2013-12	Mitsuyo ANDO	Impact of Recent Crises and Disasters on Regional Production/Distribution Networks and Trade in Japan	Aug 2013
2013-11	Le Dang TRUNG	Economic and Welfare Impacts of Disasters in East Asia and Policy Responses: The Case of Vietnam	Aug 2013
2013-10	Sann VATHANA, Sothea OUM, Ponhrith KAN, Colas CHERVIER	Impact of Disasters and Role of Social Protection in Natural Disaster Risk Management in Cambodia	Aug 2013
2013-09	Sommarat CHANTARAT, Krirk PANNANGPETCH, Nattapong PUTTANAPONG, Preesan RAKWATIN, and Thanasin TANOMPONGPHANDH	Index-Based Risk Financing and Development of Natural Disaster Insurance Programs in Developing Asian Countries	Aug 2013
2013-08	Ikumo ISONO and Satoru KUMAGAI	Long-run Economic Impacts of Thai Flooding: Geographical Simulation Analysis	July 2013

No.	Author(s)	Title	Year
2013-07	Yoshifumi FUKUNAGA and Hikaru ISHIDO	Assessing the Progress of Services Liberalization in the ASEAN-China Free Trade Area (ACFTA)	May 2013
2013-06	Ken ITAKURA, Yoshifumi FUKUNAGA, and Ikumo ISONO	A CGE Study of Economic Impact of Accession of Hong Kong to ASEAN-China Free Trade Agreement	May 2013
2013-05	Misa OKABE and Shujiro URATA	The Impact of AFTA on Intra-AFTA Trade	May 2013
2013-04	Kohei SHIINO	How Far Will Hong Kong's Accession to ACFTA will Impact on Trade in Goods?	May 2013
2013-03	Cassey LEE and Yoshifumi FUKUNAGA	ASEAN Regional Cooperation on Competition Policy	Apr 2013
2013-02	Yoshifumi FUKUNAGA and Ikumo ISONO	Taking ASEAN+1 FTAs towards the RCEP: A Mapping Study	Jan 2013
2013-01	Ken ITAKURA	Impact of Liberalization and Improved Connectivity and Facilitation in ASEAN for the ASEAN Economic Community	Jan 2013
2012-17	Sun XUEGONG, Guo LIYAN, Zeng ZHENG	Market Entry Barriers for FDI and Private Investors: Lessons from China's Electricity Market	Aug 2012
2012-16	Yanrui WU	Electricity Market Integration: Global Trends and Implications for the EAS Region	Aug 2012
2012-15	Youngho CHANG, Yanfei LI	Power Generation and Cross-border Grid Planning for the Integrated ASEAN Electricity Market: A Dynamic Linear Programming Model	Aug 2012
2012-14	Yanrui WU, Xunpeng SHI	Economic Development, Energy Market Integration and Energy Demand: Implications for East Asia	Aug 2012
2012-13	Joshua AIZENMAN, Minsoo LEE, and Donghyun PARK	The Relationship between Structural Change and Inequality: A Conceptual Overview with Special Reference to Developing Asia	July 2012
2012-12	Hyun-Hoon LEE, Minsoo LEE, and Donghyun PARK	Growth Policy and Inequality in Developing Asia: Lessons from Korea	July 2012
2012-11	Cassey LEE	Knowledge Flows, Organization and Innovation: Firm-Level Evidence from Malaysia	June 2012
2012-10	Jacques MAIRESSE, Pierre	Globalization, Innovation and Productivity in	June

No.	Author(s)	Title	Year
	MOHNEN, Yayun ZHAO, and Feng ZHEN	Manufacturing Firms: A Study of Four Sectors of China	2012
2012-09	Ari KUNCORO	Globalization and Innovation in Indonesia: Evidence from Micro-Data on Medium and Large Manufacturing Establishments	June 2012
2012-08	Alfons PALANGKARAYA	The Link between Innovation and Export: Evidence from Australia's Small and Medium Enterprises	June 2012
2012-07	Chin Hee HAHN and Chang-Gyun PARK	Direction of Causality in Innovation-Exporting Linkage: Evidence on Korean Manufacturing	June 2012
2012-06	Keiko ITO	Source of Learning-by-Exporting Effects: Does Exporting Promote Innovation?	June 2012
2012-05	Rafaelita M. ALDABA	Trade Reforms, Competition, and Innovation in the Philippines	June 2012
2012-04	Toshiyuki MATSUURA and Kazunobu HAYAKAWA	The Role of Trade Costs in FDI Strategy of Heterogeneous Firms: Evidence from Japanese Firm-level Data	June 2012
2012-03	Kazunobu HAYAKAWA, Fukunari KIMURA, and Hyun-Hoon LEE	How Does Country Risk Matter for Foreign Direct Investment?	Feb 2012
2012-02	Ikumo ISONO, Satoru KUMAGAI, Fukunari KIMURA	Agglomeration and Dispersion in China and ASEAN: A Geographical Simulation Analysis	Jan 2012
2012-01	Mitsuyo ANDO and Fukunari KIMURA	How Did the Japanese Exports Respond to Two Crises in the International Production Network?: The Global Financial Crisis and the East Japan Earthquake	Jan 2012
2011-10	Tomohiro MACHIKITA and Yasushi UEKI	Interactive Learning-driven Innovation in Upstream-Downstream Relations: Evidence from Mutual Exchanges of Engineers in Developing Economies	Dec 2011
2011-09	Joseph D. ALBA, Wai-Mun CHIA, and Donghyun PARK	Foreign Output Shocks and Monetary Policy Regimes in Small Open Economies: A DSGE Evaluation of East Asia	Dec 2011
2011-08	Tomohiro MACHIKITA and Yasushi UEKI	Impacts of Incoming Knowledge on Product Innovation: Econometric Case Studies of Technology Transfer of	Nov 2011

No.	Author(s)	Title	Year
		Auto-related Industries in Developing Economies	
2011-07	Yanrui WU	Gas Market Integration: Global Trends and Implications for the EAS Region	Nov 2011
2011-06	Philip Andrews-SPEED	Energy Market Integration in East Asia: A Regional Public Goods Approach	Nov 2011
2011-05	Yu SHENG, Xunpeng SHI	Energy Market Integration and Economic Convergence: Implications for East Asia	Oct 2011
2011-04	Sang-Hyop LEE, Andrew MASON, and Donghyun PARK	Why Does Population Aging Matter So Much for Asia? Population Aging, Economic Security and Economic Growth in Asia	Aug 2011
2011-03	Xunpeng SHI, Shinichi GOTO	Harmonizing Biodiesel Fuel Standards in East Asia: Current Status, Challenges and the Way Forward	May 2011
2011-02	Hikari ISHIDO	Liberalization of Trade in Services under ASEAN+n : A Mapping Exercise	May 2011
2011-01	Kuo-I CHANG, Kazunobu HAYAKAWA Toshiyuki MATSUURA	Location Choice of Multinational Enterprises in China: Comparison between Japan and Taiwan	Mar 2011
2010-11	Charles HARVIE, Dionisius NARJOKO, Sothea OUM	Firm Characteristic Determinants of SME Participation in Production Networks	Oct 2010
2010-10	Mitsuyo ANDO	Machinery Trade in East Asia, and the Global Financial Crisis	Oct 2010
2010-09	Fukunari KIMURA Ayako OBASHI	International Production Networks in Machinery Industries: Structure and Its Evolution	Sep 2010
2010-08	Tomohiro MACHIKITA, Shoichi MIYAHARA, Masatsugu TSUJI, and Yasushi UEKI	Detecting Effective Knowledge Sources in Product Innovation: Evidence from Local Firms and MNCs/JVs in Southeast Asia	Aug 2010
2010-07	Tomohiro MACHIKITA, Masatsugu TSUJI, and Yasushi UEKI	How ICTs Raise Manufacturing Performance: Firm-level Evidence in Southeast Asia	Aug 2010

No.	Author(s)	Title	Year
2010-06	Xunpeng SHI	Carbon Footprint Labeling Activities in the East Asia Summit Region: Spillover Effects to Less Developed Countries	July 2010
2010-05	Kazunobu HAYAKAWA, Fukunari KIMURA, and Tomohiro MACHIKITA	Firm-level Analysis of Globalization: A Survey of the Eight Literatures	Mar 2010
2010-04	Tomohiro MACHIKITA and Yasushi UEKI	The Impacts of Face-to-face and Frequent Interactions on Innovation: Upstream-Downstream Relations	Feb 2010
2010-03	Tomohiro MACHIKITA and Yasushi UEKI	Innovation in Linked and Non-linked Firms: Effects of Variety of Linkages in East Asia	Feb 2010
2010-02	Tomohiro MACHIKITA and Yasushi UEKI	Search-theoretic Approach to Securing New Suppliers: Impacts of Geographic Proximity for Importer and Non-importer	Feb 2010
2010-01	Tomohiro MACHIKITA and Yasushi UEKI	Spatial Architecture of the Production Networks in Southeast Asia: Empirical Evidence from Firm-level Data	Feb 2010
2009-23	Dionisius NARJOKO	Foreign Presence Spillovers and Firms' Export Response: Evidence from the Indonesian Manufacturing	Nov 2009
2009-22	Kazunobu HAYAKAWA, Daisuke HIRATSUKA, Kohei SHIINO, and Seiya SUKEGAWA	Who Uses Free Trade Agreements?	Nov 2009
2009-21	Ayako OBASHI	Resiliency of Production Networks in Asia: Evidence from the Asian Crisis	Oct 2009
2009-20	Mitsuyo ANDO and Fukunari KIMURA	Fragmentation in East Asia: Further Evidence	Oct 2009
2009-19	Xunpeng SHI	The Prospects for Coal: Global Experience and Implications for Energy Policy	Sept 2009
2009-18	Sothea OUM	Income Distribution and Poverty in a CGE Framework: A Proposed Methodology	Jun 2009
2009-17	Erlinda M. MEDALLA and Jenny BALBOA	ASEAN Rules of Origin: Lessons and Recommendations for the Best Practice	Jun 2009

No.	Author(s)	Title	Year
2009-16	Masami ISHIDA	Special Economic Zones and Economic Corridors	Jun 2009
2009-15	Toshihiro KUDO	Border Area Development in the GMS: Turning the Periphery into the Center of Growth	May 2009
2009-14	Claire HOLLWEG and Marn-Heong WONG	Measuring Regulatory Restrictions in Logistics Services	Apr 2009
2009-13	Loreli C. De DIOS	Business View on Trade Facilitation	Apr 2009
2009-12	Patricia SOURDIN and Richard POMFRET	Monitoring Trade Costs in Southeast Asia	Apr 2009
2009-11	Philippa DEE and Huong DINH	Barriers to Trade in Health and Financial Services in ASEAN	Apr 2009
2009-10	Sayuri SHIRAI	The Impact of the US Subprime Mortgage Crisis on the World and East Asia: Through Analyses of Cross-border Capital Movements	Apr 2009
2009-09	Mitsuyo ANDO and Akie IRIYAMA	International Production Networks and Export/Import Responsiveness to Exchange Rates: The Case of Japanese Manufacturing Firms	Mar 2009
2009-08	Archanun KOHPAIBOON	Vertical and Horizontal FDI Technology Spillovers:Evidence from Thai Manufacturing	Mar 2009
2009-07	Kazunobu HAYAKAWA, Fukunari KIMURA, and Toshiyuki MATSUURA	Gains from Fragmentation at the Firm Level: Evidence from Japanese Multinationals in East Asia	Mar 2009
2009-06	Dionisius A. NARJOKO	Plant Entry in a More LiberalisedIndustrialisationProcess: An Experience of Indonesian Manufacturing during the 1990s	Mar 2009
2009-05	Kazunobu HAYAKAWA, Fukunari KIMURA, and Tomohiro MACHIKITA	Firm-level Analysis of Globalization: A Survey	Mar 2009
2009-04	Chin Hee HAHN and Chang-Gyun PARK	Learning-by-exporting in Korean Manufacturing: A Plant-level Analysis	Mar 2009
2009-03	Ayako OBASHI	Stability of Production Networks in East Asia: Duration and Survival of Trade	Mar 2009

No.	Author(s)	Title	Year
2009-02	Fukunari KIMURA	The Spatial Structure of Production/Distribution Networks and Its Implication for Technology Transfers and Spillovers	Mar 2009
2009-01	Fukunari KIMURA and Ayako OBASHI	International Production Networks: Comparison between China and ASEAN	Jan 2009
2008-03	Kazunobu HAYAKAWA and Fukunari KIMURA	The Effect of Exchange Rate Volatility on International Trade in East Asia	Dec 2008
2008-02	Satoru KUMAGAI, Toshitaka GOKAN, Ikumo ISONO, and Souknilanh KEOLA	Predicting Long-Term Effects of Infrastructure Development Projects in Continental South East Asia: IDE Geographical Simulation Model	Dec 2008
2008-01	Kazunobu HAYAKAWA, Fukunari KIMURA, and Tomohiro MACHIKITA	Firm-level Analysis of Globalization: A Survey	Dec 2008