Economic development, energy market integration and energy demand: Implications for East Asia

Yu Shenga,b, Xunpeng Shic,*, Dandan Zhangd

a Crawford School of Public Policy, The Australian National University, Canberra, Australia
b Department of International Economics and Trade, Nankai University, Tianjin, PR China
c Economic Research Institute for ASEAN and East Asia, ERIA Annex Office, Sentral Senayan II, JL. Asia Afrika No. 8, Senayan, Jakarta Pusat 10270, Indonesia
d National School of Development, Peking University, Beijing, PR China

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ABSTRACT

This paper uses a general method of moment regression technique to estimate an energy demand function with a dataset covering 71 countries between 1965 and 2010. The estimated results show that countries undergoing rapid economic growth may show relatively higher income and price elasticities in the long run. The higher income elasticities and lower price elasticity in the short run of rapid growing countries may impose pressure on energy demand in the domestic and international markets. Energy market integration can help to reduce such pressure by smoothing energy demand through lowering its income elasticity and creating a flexible energy market through increasing its price elasticity. These findings have important implications for forecasting energy demand and promoting international cooperation in East Asia.

1. Introduction

Price and income are two primary factors shaping the energy consumption of a country, and estimation of the elasticities of these two factors is thus essential for defining the energy demand function. In previous empirical studies [1–5], the income and price elasticities of energy products have been widely estimated with either single-country time-series data or cross-country data. However, there is no general agreement on representative values of the income and price elasticities, and in particular it is still not clear why the magnitude of these elasticities may differ across countries with disparate economic development levels and institutional arrangements.

Using a comprehensive survey of quantitative studies on country-specific energy consumption, Dahl [6] shows that the demand for energy is price inelastic and slightly income elastic at the national level but there is no clear evidence that the developing world should be less price elastic or more income elastic than the industrialized world. In contrast, Brenton [5] and Ferguson et al. [2], when using cross-country energy consumption data to estimate different energy demand functions, find that the price elasticity for energy is usually higher in the poor countries than in the rich countries, and that the income elasticity for energy declines with rising income.

To explain the above inconsistent findings on the estimated energy demand elasticities, many studies including Maddala et al. [7], Garcia-Cerrutti [8], Lowe [9], Bernstein & Griffin [10], and Yoo [11] attempt to incorporate regional characteristics, such as country-specific energy consumption preferences and different energy-usage technology in production, into the estimation of the energy consumption function. These studies provided some interesting results with respect to the relationship between economic growth, policy making and energy consumption by providing new estimates of the cross-country income and price elasticities for energy. However, they could not explain two important phenomena [10]: (1) estimated energy consumptions using the cross-country data generally lack price elasticity, and they are significantly different from those in country-specific studies; (2) estimated energy consumptions using the single-country data usually show different trends over different time periods.

These two phenomena raise the interesting question of whether economic development and the institutional arrangements associated with the energy market, which are the two important features associated with the different phases of economic development and income levels of...
a country, can be identified as affecting the income- or price-energy consumption relationships.

This paper attempts to measure the income and price elasticities of energy consumption in a country and to link these elasticities to the country’s economic development and institutional arrangements related to Energy Market Integration (EMI). Contributing to the previous literature examining the relationship between energy consumption and income, such as Asafu-Adjaye [12] and Lee and Chang [13], our study is the first to highlight that the economic development stage and its related industrialization and urbanization may reshape the energy consumption behavior of a country by affecting its income and price elasticities. In addition, we also demonstrate the role that EMI may play in changing a country’s energy demand when the country passes through different economic development stages.

Implications from this study shed light on two policy issues in the East Asian Summit (EAS) region. The first policy issue is that since many EAS countries are less developed and will industrialize in the future, a projection of the relationship between energy demand and industrialization is critical in choosing how to deal with the potential energy supply challenge. The second policy issue is that the study provides the method for valuing the costs of, and benefits from, participating in EMI. An incentive for EAS countries to participate in EMI is that regional integration may help to secure the energy supply for sustainable economic growth whilst reducing income disparity in the region. However, to what extent this goal can be achieved and how much benefits each country can obtain from participating in EMI depend on the impact of regional integration on the income and price elasticities of energy demand.

The paper is organized as follows. Section 2 summarizes the structural change in energy demand of some major countries. The analysis shows that there are often significant structural changes in energy demand when a country moves from a lower economic-development stage to a higher one, and different institutional arrangements associated with the energy market may impose different impacts on such structural changes in energy demand. Section 3 develops a dynamic panel data model, which incorporates economic growth stages and EMI into the estimation of the energy demand function. Section 4 presents the estimated results which show that countries in different stages of economic development, and with different involvement in EMI, would demonstrate different levels of demand for energy consumption. Section 5 presents conclusions and policy implications for East Asia.

2. Changing world energy demand and its determinants

The world’s demand for energy has experienced rapid growth over the past five decades, despite a slight drop due to two supply shocks in 1973 and 1979. Up to 2010, the total world energy demand had reached 12.0 billion tonnes of oil equivalent (toe) which is 3.2 times the level in 1965 (3.8 billion toe) [14]. Behind the steadily increasing trend of world energy demand, countries with different levels of economic development have demonstrated different energy demand patterns. Three characteristics of cross-country energy consumption trends throughout the world can be summarized as follows [15]. First, the energy demand in developed countries is still dominant in total world energy consumption, though increasing only slowly over time. Second, the energy demand in developing countries, in particular the newly industrialized economies (NIEs) in East Asia, is increasing rapidly and has become the new engine of total world energy consumption growth. Third, the growth in world energy demand comes in a wave pattern, with each wave dominated by the countries with rapid economic growth.

Between 1965 and 2010, the rate of growth of energy demand from the United States, the European Union (EU) and Japan was on average 1.5 percent, which was far lower than that from developing economies in East Asia, such as South Korea, Taiwan, ASEAN, China and India, which averaged around 5.8 percent. This implies that developing economies are increasingly becoming the major driving force of world energy demand.

Moreover, the driver behind world energy demand seems to change from one group of counties/economies to another over different time periods. World energy demand had been driven by the EU and Japan over the period of 1965—1970, but the driver shifted to the NIEs, such as South Korea, Taiwan and the ASEAN countries over the period 1980—1990. In recent years, the growth in world energy demand has mainly been coming from China, followed by India, in particular after 1990 [16]. This implies that the world’s energy demand increases in a wave pattern, as more countries/economies enter into a rapid economic growth stage with consequent industrialization and urbanization.

The above phenomena raise a number of questions:

- why has East Asia, rather than other parts of the world, become the new engine of world primary energy demand?
- what are the underlying factors affecting world energy demand trends?
- how have changing world income and fluctuations in the price of energy products affected world energy consumption?

To answer these questions, a number of previous studies, such as IEA [15], Karki et al. [17] and Yoo [11] argue that the rapid increase in the world income level and the rapidly fluctuating oil price in the international market have changed the pattern of world energy consumption, and that institutional arrangements associated with the energy market can play an important role in reshaping the income and price elasticities of energy demand across countries.

Fig. 1 shows the relationship between energy consumption per capita and GDP per capita in major Asia-Pacific countries between 1965 and 2010. Over the past four decades, there have been significant increases in the energy consumption of countries experiencing rapid economic growth. As the change in energy consumption is always associated with a specific income level (say, US$ 5000—US$ 10,000), this suggests that the GDP per capita range rather than the GDP per capita level play a more important role in affecting the energy demand across countries and over time, which provides us with a new perspective for empirical work.

Moreover, as countries are re-categorized into two groups according to the level of their involvement into EMI, it is easy to see that countries with different EMI level may have different energy consumption per capita. Fig. 2 shows that countries with relatively higher EMI indices have, on average, higher energy consumptions per capita compared with countries with relatively lower EMI levels. This implies that EMI (or its represented institutional arrangements) is an important factor affecting the relationship between economic consumption, income level and the price of energy products.

3. Methodology and data

As shown in Section 2, it is necessary to incorporate economic development stages and EMI into the estimation of the energy consumption function. Based on a standard consumption function, we assume that the energy demand is determined not only by changes in income and price but that it also varies with different economic development stages and institutional arrangements with which a particular country is associated. The energy demand function in double-log form for panel data regression can thus be written as:

\[ \ln C_{it} = \beta_0 + \beta_1 \ln P_{it} + \beta_2 \ln Y_{it} + \gamma S_{it} + u_i + e_{it} \]  

where \( C_{it} \) is the aggregated demand for all energy products in country \( i \) at time \( t \) which is measured with tonnes of oil equivalent and \( Y_{it} \) is the national income of country which is measured in US dollars at the 2000
price and adjusted by purchasing power parity across countries. Both of these variables are measured on a per capita basis so as to control for any variation in population growth. \( P_T \) is the real price of crude oil in the world market adjusted using country-specific factors (such as transportation costs and an individual country’s market condition). In addition, \( u_i \) is defined as the country specific effect which does not change over time, and \( e_t \) is defined as the random effect.

\( S_T \) is a group of variables representing structural change, i.e., economic development and EMI. Finding an appropriate measure of economic development stages of a country has long been a challenging task. In previous literature, many authors preferred to use trend proxies, such as the industrialization rate (or the share of secondary and tertiary industrial output in total GDP), the urbanization rate (the share of the urban population in the total) and the industrial structural index of workforce, as an approximation. Although those proxies reflect some characteristics of economic development, they are generally biased when incorporated into the estimation of the energy demand function. This is because energy consumption is usually related to all changes in the economy rather than to a specific characteristic i.e. industrialization or urbanization. For this reason, we use the range of GDP per capita (measured at 1984 constant prices and adjusted using purchasing power parity across countries) to generate a dummy variable (DI) for the identification of different economic development stages. The dummy takes the value of 1 if per capita income is greater than US$ 5000 and less than US$ 10,000, otherwise 0. We can do this, because, following Chenery et al. [19], economic development in this stage accommodates changes such as industrialization, urbanization among others significantly driving energy demand.

Following Sheng and Shi [20], the EMI index is defined as the average import of a country’s fossil fuel products from its trading partner (weighted by geographical distance between the two trading pairs) per head of its population. Since the index generally increases as the country imports more fossil fuel from neighboring countries and decreases as domestic consumption of fossil fuel products increases (or decreases), it can be used to reflect the extent to which the country is involved in neighborhood EMI. Technical details of the EMI measurement can be found at Sheng and Shi [16].

A key assumption of Equation (1) is that the income and price elasticities of energy demand are independent of economic development stages and thus all the effects associated with economic development can be squeezed into the coefficients of \( S_T \). This assumption is relaxed when the interaction terms between the dummy for economic development stages with income and price variables used in the regression. Moreover, as Equation (1) can be regressed with

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**Fig. 1.** Relationship between energy consumption per capita and GDP per capita: 1965-2010. Source: World Development Indicator Database, World Bank [18].

**Fig. 2.** Energy consumption per capita by EMI level: 1965-2010. Source: BP Energy Review [19] and World Development Indicator, World Bank [18].
observations (or sample countries) involving different EMI levels (or institutional arrangements associated with energy market), the comparison of these regression results can be used to examine the potential impact of EMI on the income and price elasticities of energy demand.

Estimation of the baseline model (defined by Equation (1)) seems to be simple when using the standard ordinary least squares (OLS) method. However, the OLS estimates would be misleading since energy consumption, income and price variables are all non-stationary in their level form, and this high auto-correlation problem may generate biased estimators [21]. To deal with this econometric problem, we use the general method of moment (GMM) regression technique developed by Arellano & Bond [22], Arellano & Bover [23] and Blundell & Bond [24]. The method minimizes a certain norm of the sample averages of the moment conditions (usually, functions of the model parameters and the data, such that their expectation is zero at the true values of the parameters) for maximum likelihood estimators. The GMM estimators are known to be consistent, and thus they are immune to the endogeneity between independent variables and the residuals (or the co-integration of the non-stationary series) and, as a result, both the long-term and short-term elasticities of energy consumption can be specified [16].

The data used in the above regression covered 71 countries and regions for the period 1965–2010. Data for the price variable (\(P_t\)) is calculated using the spot price in the international market adjusted by the consumer price index in each country. More specifically, the spot price of crude oil before 1984 is set as the price of Arabian Light posted at Ras Tanura and that after 1984 is set as Brent dated price. The data for energy consumption in each country and that for the real price of crude oil come from the BP Statistical Review of World Energy [14]. The data for population and GDP (calculated at constant prices and adjusted for purchasing power parity) come from the World Development Indicators Database [18].

4. Empirical results

Following Roodman [25], we specify suitable instrumental variables from the lagged or differentiated dependent and independent variables and use the difference GMM methods to investigate the relationship between integrated series with dynamic panel data. The Johansen (1991) order test is employed for this purpose.

Before estimating any relationship between energy consumption and its explanatory variables, one may need some identification strategy either from an economic or a statistical perspective. Based on Roodman [25], and Blundell and Bond [24], we find that the system GMM estimator is preferred to the difference GMM estimator. Furthermore, we use the Arellano-Bond test for AR(1) and AR(2) in first differences to choose the suitable lagged periods for dependent and independent variables and the Sargan test to specify the combination of instrumental variables for the system GMM estimation. Detailed discussion on these econometric tests can be found at Sheng and Shi [16]. Finally, we eliminate the insignificant independent variables from the regressions. The results with only intercept for economic development and with intercept and interaction terms are shown in Table 1. A further split of the sample into countries with high and low EMI indexes is used to examine the impact of EMI on the income and price elasticities of energy demand, and results are shown in Table 3.

4.1. Baseline estimation

The estimation results show that there exist some significant income and price elasticities of energy demand, using the cross-country data over time for the estimation. In particular there are significant time structures for these elasticities. This result provides some potential explanation on why there are inconsistent estimations of income and price elasticities in the previous cross-country studies [6].

From column 1 of Table 1, both the short-run and long-run income and price elasticities of energy demand can be calculated from converting the regression function into the structural function of energy demand function (column 3 of Table 2).

The short-run and the long-run price elasticities are 0.007 and 0.012 respectively. Price elasticities less than one are consistent with our expectation, since energy products are necessities in consumption. Moreover, the absolute value of short-run price elasticity lower than long-run price elasticity is also as expected, suggesting that the long-term energy demand is more price elastic. A feasible explanation is that energy products lack substitutes, especially in the short run. In the long run, the exploration of energy-saving technology and new energy products may reduce reliance on traditional energy products. For example, when oil prices increase, customers can only reduce energy consumption immediately by cutting back on vehicle usage. In the longer run, however, they can use more fuel-efficient vehicles.

The short-run and the long-run income elasticities are 0.582 and 0.478 respectively. As the short-run income elasticity is higher than the long-run figure, it seems that when the impact of economic development has been controlled, energy demand is more responsive to income

### Table 1

<table>
<thead>
<tr>
<th>Dependent variable: ln (C_t)</th>
<th>No dummy</th>
<th>With dummy</th>
<th>With interaction</th>
</tr>
</thead>
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<tr>
<td>ln (C_t) 1</td>
<td>0.919***</td>
<td>0.918***</td>
<td>0.908***</td>
</tr>
<tr>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td></td>
</tr>
<tr>
<td>ln (P_t) 1</td>
<td>−0.008***</td>
<td>−0.008***</td>
<td>−0.007***</td>
</tr>
<tr>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>ln (P_{t1}) 1</td>
<td>0.007***</td>
<td>0.007***</td>
<td>0.006***</td>
</tr>
<tr>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>(d_GDP \times \ln P_t) 1</td>
<td>0.006***</td>
<td>0.006***</td>
<td>−0.008*</td>
</tr>
<tr>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>(d_GDP \times \ln P_{t1})1</td>
<td>0.006***</td>
<td>0.006***</td>
<td>−0.008*</td>
</tr>
<tr>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>ln (Y_t) 1</td>
<td>0.555***</td>
<td>0.555***</td>
<td>0.582***</td>
</tr>
<tr>
<td>(0.027)</td>
<td>(0.027)</td>
<td>(0.032)</td>
<td></td>
</tr>
<tr>
<td>ln (Y_{t1}) 1</td>
<td>−0.522***</td>
<td>−0.523***</td>
<td>−0.538***</td>
</tr>
<tr>
<td>(0.027)</td>
<td>(0.027)</td>
<td>(0.033)</td>
<td></td>
</tr>
<tr>
<td>(d_GDP \times \ln Y_t) 1</td>
<td>0.006***</td>
<td>0.283***</td>
<td>0.257***</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.096)</td>
<td>(0.065)</td>
<td></td>
</tr>
<tr>
<td>(d_GDP \times \ln Y_{t1})1</td>
<td>−0.235***</td>
<td>−0.237***</td>
<td>−0.332***</td>
</tr>
<tr>
<td>(0.056)</td>
<td>(0.056)</td>
<td>(0.068)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.241***</td>
<td>−0.237***</td>
<td>−0.332***</td>
</tr>
<tr>
<td>(0.065)</td>
<td>(0.065)</td>
<td>(0.068)</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>2272</td>
<td>2272</td>
<td>2272</td>
</tr>
<tr>
<td>Wald test</td>
<td>50,533</td>
<td>50,546</td>
<td>50,790</td>
</tr>
</tbody>
</table>

Note: *The numbers in brackets are the standard errors.

### Table 2

<table>
<thead>
<tr>
<th>Price elasticity</th>
<th>All samples</th>
<th>Rapid growing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long run</td>
<td>−0.012</td>
<td>−0.033</td>
</tr>
<tr>
<td>Short run</td>
<td>−0.007</td>
<td>−0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income elasticity</th>
<th>All samples</th>
<th>Rapid growing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long run</td>
<td>0.478</td>
<td>0.717</td>
</tr>
<tr>
<td>Short run</td>
<td>0.582</td>
<td>0.839</td>
</tr>
</tbody>
</table>
in the short run. This phenomenon can be interpreted as showing that, as time goes on, consumers are more likely to apply energy-saving technology which may improve the efficiency of energy usage in production, given the same level of economic development. Alternatively, long-term income growth is more likely to create demand for new substitutes for energy products [26], and thus the income elasticity will be lower in the long run as compared to the short run.

The above finding on the trans-temporal structure of the price and income elasticities of energy demand also helps to explain the inconsistency between the existing price elasticity estimates and the reality. In contrast to the significant negative relationship between the international oil price and energy demand, previous studies using cross-country data always show there is no significant price elasticity (see IEA [15]). This is partly because the analytical approach adopted in those studies only considers the short-run effects. As there is no substitution for energy products in production and consumption in the short term, it is of no surprise that there is no significant price elasticity.

### 4.2. Impact of economic development on energy consumption

Economic development stages play an important role in affecting energy demand through changing the income and price elasticities. To further illustrate this point, we incorporate the dummy for economic development stage (as shown in column 2 of Table 1) and its interaction terms with price and income variables (as shown in column 3 of Table 1) into the energy demand function and re-estimate the income and price elasticities of energy consumption.

The estimated results obtained from the new regressions show that countries at different economic development stages may show different energy demand patterns. We convert the estimated coefficients obtained from the regression into the corresponding price and income elasticities (column 4 of Table 2). In particular, countries experiencing rapid economic growth may have relatively higher price and income elasticities. Estimated price and income elasticities for countries experiencing rapid economic growth are 0.033 and 0.717 in the long run, which are higher than those for countries at all development stages, say 0.012 and 0.478. Similar results are also found for the short-run income elasticities estimates. This suggests that more energy will be consumed for the same amount of income growth in both short and long runs. However, compared with all samples, price elasticity in rapid growing economies is less elastic in the short run but more elastic in the long run. The finding of low price elasticity in shorn run is consistent with the observation that rapid growing regions are more price inelastic to crude oil [27]. The relative high price elasticity long run in rapid growing countries is reasonable as those countries that consuming more energy will have more opportunities to save energy when there is a price shock.

Moreover, the estimated coefficients of the dummy for economic development stage are positive and significant at the 1 per cent level (column 2 of Table 1). This suggests that an economy when coming to the development stage of industrialization and urbanization may significantly increase energy consumption, in addition to the increases arising from price and income effects. An explanation for this phenomenon is that when an economy undergoes transformation from an agricultural society to an industrialized society, the labor-intensive sectors are more likely to be substituted by the capital- and energy-intensive sectors [28]. However, as the economy moves further into the advanced development stage, the capital-intensive and energy-intensive sectors are substituted by the service sectors. In other words, the relationship between economic growth and energy demand will change when a country starts and finishes the industrialization and urbanization process. Projections made without considering such structural changes may result in questionable energy outlooks.

Combining the above two points, Fig. 3 provides the simulated relationship between energy consumption per capita and the stage of economic development, which shows that the marginal contribution of industrialization toward percentage changes in energy consumption does not peak until the per capita income level reaches 10,000 US dollars. These findings can be used to explain the "wave" pattern of increases in energy demand from East Asia, with countries experiencing rapid economic growth sequentially during the past four decades. Moreover, using such a method, one can estimate the future trend of changing world energy demand, as more NIEs such as China and India are moving along the economic development path characterized by a pattern of continuous change and breaking-points. The new estimates based on our model project more energy demand from China and India in the next decade, if industrialization and urbanization are maintained at a relatively high speed.

### 4.3. Role of energy market integration in affecting energy consumption

How do different institutional arrangements associated with their energy market affect the energy demand of countries at different economic development stages? To answer this question, we adopt a regression (similar to that for economic development) to re-estimate the price and income elasticities of energy consumption with a dummy
for EMI. As in Sheng and Shi [20], the dummy for EMI is evaluated against the 
average EMI index: countries with EMI indexes higher than average 
taking 1 and countries with EMI indexes less than the average taking 0. 
The estimation results are shown in Table 3.

Given the same conditions, energy consumption per capita in 
countries with higher levels of involvement in EMI is significantly higher 
when the price and income elasticities are well controlled. The esti-
mated coefficients in front of the dummy for EMI from both regressions 
are positive and significant at the 1 per cent level (shown in columns 1 
and 3 of Table 3). However, when the interaction terms between 
the dummy for EMI and price and income variables (as a substitute for the 
dummy for EMI itself) are added into the regression, the estimation 
result shows that the coefficients in front of the dummy variable of EMI 
become insignificant. This suggests that the impact of EMI on energy 
consumption is through changing the income and price elasticities.

Furthermore, to understand the impact of EMI on the energy 
consumption behaviors of countries at different economic develop-
ment stages, we convert the estimated coefficients obtained from 
the regression into the corresponding price and income elasticities 
(Table 4). It worth highlights that, on average, the countries with 
a higher level of involvement in EMI tend to have a relatively lower 
income elasticity and higher price elasticity in both short and long runs. 
Similar results are also found for the sample of rapid growing countries. 
These findings may show that EMI tends to improve the flexibility of 
a country in meeting its energy demands through international coop-
eration in the world energy market.

5. Conclusions and implications

This study uses a GMA regression technique to estimate a cross-
country demand function for energy products, using 45-year long 
data from 71 countries, and examines the income and price elasticities 
of energy consumption between 1965 and 2010.

The results show that countries with different economic develop-
ment stages demonstrate different levels of energy demand and thus 
the associated price and income elasticities. In particular, we found 
that countries undergoing rapid economic growth may show relatively 
higher income and price elasticities in the long run. The higher income 
elasticities and lower price elasticity in the short run of rapid growing 
countries may increase additional pressure on energy demand in 
domestic and international markets. EMI can help to reduce such 
pressure by smoothing domestic energy demand through lowering its 
income elasticity and creating a flexible energy market through 
increasing its price elasticity.

These findings can be used in explaining the recent boom in EAS’s 
demand for energy products. It may also indicate a means of reducing 
the pressure of energy demand arising from economic growth in the EAS 
region through strengthening the integration of the regional energy 
market, which has important implications for forecasting energy 
demand and promoting international cooperation in the EAS region. At 
least two policy implications can be drawn.

First, this study may offer policy makers a chance to better understand 
EAS countries’ future paths of energy demand. Current energy 
outlooks for the EAS region, such as Kimura [29], often assume 
a linear relationship between economic growth and energy demand, 
using historic trends. This will create a serious problem for projec-
tions: countries with low/high historic energy consumption levels will 
stay at a low/high path, which is unrealistic. However, as shown in 
Fig. 1 and 3, in the advanced stage of economic development, the 
growth of energy demand would slow down. Thus, the change of relationship 
will change the regional energy outlooks significantly. Earlier developing 
countries, like China may demand less energy in the future while later developing 
countries, like Cambodia, may demand more. Therefore, compared with outlooks without consid-
furing future structural changes, the region could be relatively 
relaxed about the demand from China, but it needs to pay more 
attention to later developing countries. Also, the later developing 
countries need to prepare for their booming energy demand 
and consequential environmental impact. Improvement of supply 
capacity in the later developing countries thus should be a policy 
priority. In contrast, earlier developing countries should switch focus 
from the supply side to the demand side, such as energy saving and 
green energy.

Second, since EMI can smooth demand and increase the flexibility 
of energy markets, it should be promoted, in particular, among 
economies that are undergoing industrialization and commercializa-
tion. Rapid economic growth may lead to an increase in energy 
demand of a country. Given the constraint of energy supply, this may 
raise prices of energy products in the domestic and international 
markets, and restrict further economic development. EMI helps to 
smooth energy demand, however, by decreasing the income elas-
tics and increasing price elasticities of energy consumption. With 
increased price elasticity, the economy will be more resilient to 
price volatility. As a consequence, EMI helps to alleviate the 
bottleneck of energy shortage faced by countries with rapid 
economic growth.

<table>
<thead>
<tr>
<th>Dependent variable: $ln C_t$</th>
<th>Development dummy only</th>
<th>Interaction terms</th>
<th>Development dummy only</th>
<th>Interaction terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ln P_t$</td>
<td>0.007***</td>
<td>(0.011)</td>
<td>0.003***</td>
<td>(0.009)</td>
</tr>
<tr>
<td>$ln P_{t-1}$</td>
<td>0.011***</td>
<td>(0.014)</td>
<td>0.009***</td>
<td>(0.018)</td>
</tr>
<tr>
<td>$d_{EMI} \times ln P_t$</td>
<td>0.021***</td>
<td>(0.010)</td>
<td>0.021***</td>
<td>(0.009)</td>
</tr>
<tr>
<td>$d_{EMI} \times ln P_{t-1}$</td>
<td>0.016*</td>
<td>(0.004)</td>
<td>0.016*</td>
<td>(0.009)</td>
</tr>
<tr>
<td>$ln Y_t$</td>
<td>0.523***</td>
<td>(0.028)</td>
<td>0.386***</td>
<td>(0.046)</td>
</tr>
<tr>
<td>$ln Y_{t-1}$</td>
<td>0.516***</td>
<td>(0.028)</td>
<td>0.368***</td>
<td>(0.045)</td>
</tr>
<tr>
<td>$d_{EMI} \times ln Y_t$</td>
<td>0.010*</td>
<td>(0.005)</td>
<td>0.005</td>
<td>(0.004)</td>
</tr>
<tr>
<td>$d_{EMI}$</td>
<td>0.012***</td>
<td>(0.028)</td>
<td>0.043***</td>
<td>(0.008)</td>
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<tr>
<td>Constant</td>
<td>0.032*</td>
<td>(0.037)</td>
<td>0.027</td>
<td>(0.019)</td>
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<tr>
<td>Number of observations</td>
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<td>272</td>
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<td>955</td>
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<tr>
<td>Wald test</td>
<td>48.177</td>
<td>48.533</td>
<td>15.035</td>
<td>14.902</td>
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Note: The numbers in brackets are the standard errors. "***", "**", and "*" represent 
the coefficients are significant at 10 per cent, 5 per cent and 1 per cent level 
respectively.

<table>
<thead>
<tr>
<th>Table 4</th>
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<tr>
<td>The impact of EMI on the price and income elasticities.</td>
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<table>
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<th>All sample</th>
<th>Rapid growing countries</th>
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<tr>
<td>Base</td>
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<td>Price elasticity</td>
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<td>Long run</td>
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<tr>
<td>Short run</td>
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<td>Income elasticity</td>
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<td>Short run</td>
<td>0.521</td>
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</table>
Acknowledgments

This paper is one of the outcomes of the Economic Research Institute for ASEAN and East Asia (ERIA) project on 'Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies' in the financial year 2011. We thank ERIA for the financial support and the participants in the two project meetings as well as Fukunari Kimura for the very helpful comments.

References