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Policy Effects on Total System Energy Efficiency: Comparisons of Advanced and Developing Economies in the EAS region*

Phoumin HAN †

Venkatachalam ANBUMOZHI ‡

Economic Research Institute for ASEAN and East Asia (ERIA)

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Abstract *The study attempts to assess the policy effects and investigate the patterns of Total System Energy Efficiency (TSEE) in the economies of some selected Association of Southeast Asian Nations (ASEAN) and East Asia countries. Using time series data for 1971–2011, a dynamic lag model of TSEE was formulated. The study starts by constructing the variables of fuel input and fuel output based on engineering concepts. We expect that the TSEE in these economies is likely to be explained by both foreign direct investment (FDI) and domestic investment. And above all, the policy effect will be the prime investigation for all changes in TSEE. The study found that policy effects on TSEE are likely to have occurred in Japan, the People's Republic of China (PRC), the Philippines, Thailand, and India. However, a closer look and examination of each country's economy are needed to understand TSEE changes and fluctuations. Another key determinant of TSEE is inward FDI (FDI-inflow), as a result of which the PRC and India have shown positive impacts. Our findings led to the following key policy recommendations: (1) the PRC and India provided good examples of using FDI-inflows to impact TSEE. This implies that the transformation sector will need large investments and public financing will play crucial role in an improvement of the transformation sector; and (2) the developed economies of Japan, the Republic of Korea, and Australia provided mixed outcomes in terms of how the Cebu Declaration is likely to have had an effect. Japan showed some effect, but there was no effect on TSEE in South Korea and Australia. Thus, it is hard for the developed economies to jump further from the high base efficiency, unless there is a technological breakthrough of high efficiency like in Japan. Therefore, we will discuss technological transfer in the transformation sector such as high efficient power plants in the context of a public financing framework to ensure that such technologies could be deployed to the developing economies as well as globally.*

Keywords: Total System Energy Efficiency, Policy Effects/Impacts, and Energy Efficiency.
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† Han, Phoumin is Energy Economist at the Economic Research Institute for ASEAN and East Asia (ERIA). He can be reached at han.phoumin@eria.org

‡ Anbumozhi, Venkatachalam is Senior Energy Economist at the Economic Research Institute for ASEAN and East Asia (ERIA). He can be reached at v.anbumozhi@eria.org

1. Introduction

Much work has been done on energy efficiency by looking at various approaches to demand side measures or technological improvement in energy products and equipment. However, it is hard to measure the overall improvement of energy efficiency for an entire economy. One of the closest measures of energy efficiency is energy intensity, which measures a unit of energy use to produce a unit of production in the economy. This can be obtained simply by dividing Total Energy Consumption into Total Gross Domestic Product. Han and Kimura (2014) investigated the trade-off relationship between energy intensity and income level, and found that policy measures are key to coping with rising energy intensity. Attempts to measure energy efficiency improvement through the improved efficiency of transformation sectors in the whole economy have been lacking in most studies. Nonetheless, some studies focus on improved energy efficiency in the transformation sector through application of the Long-range Energy Alternatives Planning (LEAP) Model by comparing the Business-as-Usual (BAU) scenario with an Alternative Policy Scenario (APS).[1] For example, an *Analysis of Energy Efficiency and Saving Potential in East Asia Region* (Kimura, 2012) by the Economic Research Institute for ASEAN and East Asia (ERIA), shows that primary energy consumption in East Asia is projected to grow at a slower annual average pace of 3.0 percent than final energy demand, at 3.2 percent, with the slightly lower growth in primary energy consumption a result of improved efficiency in the energy transformation sector.

This study also reviews past studies as much as possible; but it only provides a perspective on the specific measurement of household energy efficiency, machine energy efficiency, or building energy efficiency. For example, there have been some studies of building energy efficiency using the frontier method by forming an efficient frontier of best practice technology and by comparing all buildings against that frontier (Kavousian, A. and Rajagopal, R, 2014). Another important method of measuring energy efficiency is from the engineering perspective, such as a comparison of Conventional Generation vs. Combined Head and Power Generation through thermal efficiency measurement (EPA, 2014).

Because of the lack of a concrete quantitative measure of efficiency improvement of transformation sectors in the whole economy, this study tries to formulate indicators to measure the efficiency of the transformation sector by calling it 'Total System Energy Efficiency

[1] The BAU scenario considers all current action plans and targets of energy efficiency in each economy; the APS considers the future targets and action plans to be committed to by each economy with regard to energy efficiency and targets in the respective countries of the EAS.

[TSEE]', and further postulates a hypothesis of policy effects on TSEE by comparing them before and after adoption of a policy. For regional comparison, the closest policy to evaluate the effect of regional commitments is the Cebu Declaration[2] adopted on the occasion of the Second East Asia Summit of 15 January 2007. The Declaration represents a commitment on the part of the ASEAN member countries to take policy action to tackle major energy issues, especially energy efficiency improvement. A comparison of TSEE across time and countries could show how effectively each country implements energy policy at the national level.

This study proceeds as follows after this introduction: (II) conceptual framework of Total System Energy Efficiency (TSEE) and empirical model, (III) data used in the study, (IV) results of the empirical study, and (V) conclusion and policy implications for EAS economies with regard to the implementation of the Cebu Declaration.

2. Conceptual Framework

2.1. Concept of Total System Energy Efficiency in the Transformation Sector

The concept of Total System Energy Efficiency (TSEE) has been applied in engineering processes to measure the efficiency of energy conversion such as power generation. But as it is quite hard to get all the necessary information on transformation technologies for each country in East Asia, we use the energy balance concept to calculate total system efficiency in the transformation sector.

Based on the methodology used by the International Energy Agency (IEA), Total Primary Energy Demand/Supply represents domestic demand only and is broken down into Power Generation, Total Final Energy Consumption, and Other Sector. From the data of energy balances of non-Organisation for Economic Co-operation and Development (OECD) countries

[2] The Cebu Declaration adopted on the occasion of the Second East Asia Summit on 15 January 2007 in Cebu, Philippines declared that 'We, the Heads of State/Government of the Member Countries of the Association of Southeast Asian Nations (ASEAN), Australia, People's Republic of China, Republic of India, Japan, Republic of Korea and New Zealand declare to work closely together towards the following goals: (1) Improve the efficiency and environmental performance of fossil fuel use; (2) Reduce dependence on conventional fuels through intensified energy efficiency and conservation programmes, hydropower, expansion of renewable energy systems and biofuel production/utilisation, and for interested parties, civilian nuclear power; (3) Encourage the open and competitive regional and international markets geared towards providing affordable energy at all economic levels; (4) Mitigate greenhouse gas emission through effective policies and measures, thus contributing to global climate change abatement; and (5) Pursue and encourage investment on energy resource and infrastructure development through greater private sector involvement.'

and OECD countries, we obtained Total Final Energy Consumption (TFEC), Total Final Energy Supply (TFES), and Total Final Energy Consumption of Electricity.

Following concepts from engineering, the efficiency of converting fuel to electricity is obtained as follows:

$$\frac{Electricity\ Output(toe)}{Fuel\ use\ or\ input(toe)} * 100 = Total\ System\ Energy\ Efficiency\ of\ Electricity\ Transformation \quad \text{Eq.1}$$

In the following, TSEE means Total System Energy Efficiency in Electricity Transformation Sector to simplify the writing of the econometric variable.

From equation (1), it is necessary to get the fuel input for converting fuel to electricity. However, the derived fuel input can be calculated as follows:

$$TPES = Fuel\ use\ for\ power\ generation + TFEC \quad \text{Eq.2}$$

Thus, the fuel use or fuel input for power generation is:

$$Fuel\ use\ for\ power\ generation = TPES - TFEC \quad \text{Eq.3}$$

From equation (1) and with the known variables in equations (2) and (3), TSEE for the whole economy can be calculated over time.

2.2. Empirical Model

This study formulates a model to evaluate policy effects on Total System Energy Efficiency (TSEF) in the electricity transformation sector by using a policy dummy variable for 2007, the year of the adoption of the Cebu Declaration, which reflects the overall commitment of leaders in East Asia to implement the common goal of energy policies, especially energy efficiency improvement.

The model of policy effects on Total System Energy Efficiency in this study starts with the inclusion of the binary variable of policy year dummy into the explanatory variable. The hypothesis behind this model is that the improvement in the transformation sector refers to the combined effects of policy and total investment that accrued from foreign direct investment (FDI) and domestic investment. We expect, therefore, that both these foreign and domestic investment variables will Granger cause Total System Energy Efficiency. Data on domestic investment are not available here, but 'per capita gross domestic product (GDP)' is used as the closest proxy variable. FDI inflow, per capita GDP (GDP_capita), and Total System Energy

Efficiency in the past year are likely to be major determinants of the overall improvement in Total System Energy Efficiency. The model could be written as:

$$TSEE_t = \beta_0 + \beta_1 Dummy[Policy\_Year]_t + \beta_2 GDPcapita_t + \beta_3 FDI\ \text{inf}\ low_t + \beta_4 Lag1\_TSEE_{t-1} + \beta_5 Lage2\_TSEE_{t-2} + \varepsilon_t$$

Eq.4

where TSEE is the variable of Total System Energy Efficiency in the electricity transformation sector; Dummy[Policy Year] is the binary variable taking the value of 1 in the year of the Cebu Declaration and onwards, and 0 (zero) value otherwise; GDP capita is per capita gross domestic product; two lags variable of the dependent variable TSEE.

3. Data and Variables

We use three datasets to obtain the variables of interest for the model. The first dataset comes from the Institute of Energy Economics, Japan (IEEJ), including variables such as Total Final Energy Consumption (TFEC) and the crude oil price of Japan. We also use the World Bank's World Development Indicators (WDI) to capture a time series variables such as GDP at constant 2005 prices, GDP deflator at constant 2005 prices, population figures, and inward FDI. The Policy Effect variable is the policy year from 2007 onwards after the adoption of the Cebu Declaration. The variable of Total System of Energy Efficiency is the derived calculation of Total Electricity output (toe) divided by Total Electricity input (toe) and multiplied by 100. Since India's data do not have the Total Electricity input (toe) variable, the estimated value of this variable is obtained by using the coefficient of regression from the PRC's historical data. The estimated value of India's Total Electricity input (toe) is calculated as follows: [23.78965+.7146076* FDI_Inflow+4.952781*Dummy_policy].

Tables 1 and 2 show average Total System Energy Efficiency by periods. The overall observation is that TSEE has improved over time.

Table 1: Average Total System Energy Efficiency Before and After Policy Effect

Country	Average/mean of the TSEF	
	Before the policy (1971–2006)	After the policy (2007–2011)
Australia	34.99396	39.99832
PRC	24.04984	31.433
Japan	44.60342	51.96318
Korea, Rep. of	31.52695	42.99537
Philippines	33.31233	29.68626
Thailand	46.09704	49.90128
India	21.3773	30.37979

PRC = People's Republic of China.
Source: Authors' calculation.

Table 2: Changes of Average Total System Energy Efficiency for 10-year Periods

Country	Average/mean of TSEF			
	Year (1971–1980)	Year (1981–1990)	Year (1991–2000)	Year (2001–2011)
Australia	27.13922	34.67352	38.79287	41.24711
PRC	19.91881	23.55674	26.77168	29.13518
Japan	41.97932	43.25504	46.04733	50.24745
Korea, Rep. of	26.46808	27.75002	33.89456	42.62006
Philippines	53.65451	26.93831	23.68697	27.71613
Thailand	40.71983	52.17479	45.54067	47.69518
India	14.27658	23.82152	24.10983	27.21841

PRC = People's Republic of China.
Source: Authors' calculation.

As we can see, Total System Energy Efficiency for these countries improved at different rates of increase. The factors underlying these varying rates of improvement depend on each country's economic activity and structure. The cross-country study may be limited in terms of explaining each country characteristics, but it provides some indication of why some countries perform much better than others.

Below is a summary of the statistics of variables used in the regression by country.

Table 3: Summary of Statistics of Variables Used

Country	Variable	Observation	Mean	Std. Dev.
Australia	TSEE	41	35.60425	5.848695
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	41	2.088656	1.638953
PRC	TSEE	41	24.95023	3.922067
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	30	2.946167	1.805955
Japan	TSEE	41	45.50095	3.935803
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	35	.0895249	.147645
Korea, Rep. of	TSEE	41	32.92554	6.922275
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	36	.4634852	.4775843
Philippines	TSEE	41	32.87013	14.33626
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	41	1.090037	.8652925
Thailand	TSEE	41	46.56097	6.033551
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	37	2.119797	1.613968
India	TSEE	41	22.47517	7.773835
	Dummy_policy	41	.1219512	.3312946
	FDI_Inflow	37	.624075	.8489404

PRC = People's Republic of China.
Source: Authors' calculation.

4. Results and Analyses

Table 4 reports the coefficient estimates of the dynamic lag of the Total System Energy Efficiency Model. To make cross-country comparisons easier, we interpret the coefficient estimates by grouping together countries that have the same sign or direction, i.e. positive (+) impact or negative (-) impact on Total System Energy Efficiency. We then interpret for each country the magnitude or impact of the explanatory variables.

Variable of Dummy Policy Year: Positive signs and coefficient estimates for Japan, the PRC, the Philippines, Thailand, and India show that they are likely to have seen an increase in Total System Energy Efficiency after the Cebu Declaration in 2007, as countries implemented measures to improve energy efficiency. The improvements we can see in this study are in the transformation sector, particularly the efficiency in the electricity sector of the whole economy. Australia and South Korea did not see any further improvements in TSEE from 2007 until

2011. But we need to examine each country's structural changes more closely to assess the impact on TSEE.

Table 4: Coefficient Estimates of Dynamic Lag Total System Energy Efficiency Model (TSEE)

Country	Variables	Coefficient	Std. Err.	t-value	P>t
Australia	Dummy_policy	-2.068573	1.427077	-1.45	0.157
	FDI_Inflow	.254933	.2137113	1.19	0.241
	GDP capita	.0001872	.0001446	1.29	0.204
	Lag1_TSEE	.6369531	.1726541	3.69	0.001
	Lag2_TSEE	.1118513	.1713415	0.65	0.518
	_cons	4.220599	1.976102	2.14	0.040
PRC	Dummy_policy	5.434041	1.748997	3.11	0.005
	FDI_Inflow	.9665598	.266915	3.62	0.001
	GDP capita	.0012487	.0008311	1.50	0.146
	Lag1_TSEE	-.1903865	.1863921	-1.02	0.317
	Lag2_TSEE	-.3634135	.1698374	-2.14	0.043
	_cons	36.07928	5.975776	6.04	0.000
Japan	Dummy_policy	3.444704	1.372853	2.51	0.018
	FDI_Inflow	-4.472231	2.894089	-1.55	0.133
	GDP capita	.0002283	.0001258	1.81	0.080
	Lag1_TSEE	.2850205	.2220955	1.28	0.210
	Lag2_TSEE	.2389558	.2142417	1.12	0.274
	_cons	15.27758	8.673241	1.76	0.089
Korea, Rep. of	Dummy_policy	-2.62004	1.555408	-1.68	0.102
	FDI_Inflow	-.5995465	.9555186	-0.63	0.535
	GDP capita	.0004543	.0002091	2.17	0.038
	Lag1_TSEE	.4522451	.185552	2.44	0.021
	Lag2_TSEE	.2241127	.1795704	1.25	0.222
	_cons	7.003898	3.86977	1.81	0.080
Philippines*	Dummy_policy	.8159147	1.837016	0.44	0.661
	FDI_Inflow	-.396882	.5070044	-0.78	0.442
	GDP capita	.0085339	.004593	1.86	0.077
	Lag1_TSEE	.3027859	.1516092	2.00	0.059
	Lag2_TSEE	.0018589	.1507677	0.01	0.990
	_cons	9.044158	6.543627	1.38	0.181
Thailand	Dummy_policy	2.347149	2.730261	0.86	0.397
	FDI_Inflow	-.9652276	.6378572	-1.51	0.140
	GDP capita	.0003998	.0015677	0.25	0.800
	Lag1_TSEE	.4007198	.1744734	2.30	0.029
	Lag2_TSEE	.1070559	.1566127	0.68	0.499
	_cons	24.82009	7.52911	3.30	0.002

India	Dummy_policy	4.95278	4.02e-07	1.2e+07	0.000
	FDI_Inflow	.7146078	2.11e-07	3.4e+06	0.000
	GDP capita	7.65e-10	8.28e-10	0.92	0.362
	Lag1_TSEE	2.47e-08	2.81e-08	0.88	0.386
	Lag2_TSEE	-4.45e-08	2.10e-08	-2.12	0.042
	_cons	23.78965	5.17e-07	4.6e+07	0.000

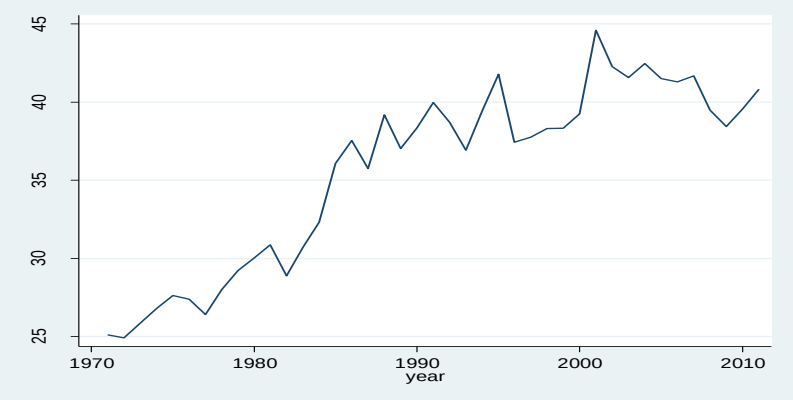
PRC = People's Republic of China.
*For the Philippines, the data used for regression are from 1985–2011, due to a lack of adequate data from 1971–1984.
Source: Authors' calculation.

FDI variable – ***FDI inflow***: The coefficient estimates on the FDI variable are positive and significant in the PRC and India. This means that FDI in these two countries, and also in Singapore, occurred mainly in the transformation sector, such as power plants and other related transformation sectors in the economy. In the Philippines, Thailand, South Korea, Australia, and Japan, FDI does not seem to have had an effect on TSEE. This could suggest that FDI in these countries may not have occurred mainly in the transformation sector, but in other sectors of the economy.

Per capita GDP variable: Coefficient estimates on the per capita GDP variable are positively significant for Japan and South Korea, suggesting that there was domestic investment in the transformation sector in these countries. The selected countries in the study seem to indicate that domestic investment in the transformation sector has not significantly affected the TSEE in the economy.

Australia: The coefficient estimate of the policy effect from 2007 onwards does not have any impact on Total System Energy Efficiency. This can also be seen in Figure 1 of the historical data on TSEE in Australia. However, Australia's TSEE saw a drastic improvement from 1970 to 2002, which may suggest that the drop in TSEE seen in 2002–2009 is a result of power plants reaching the end of their economic lives and a lack of maintenance.

Figure 1: Trend of TSEE in Australia

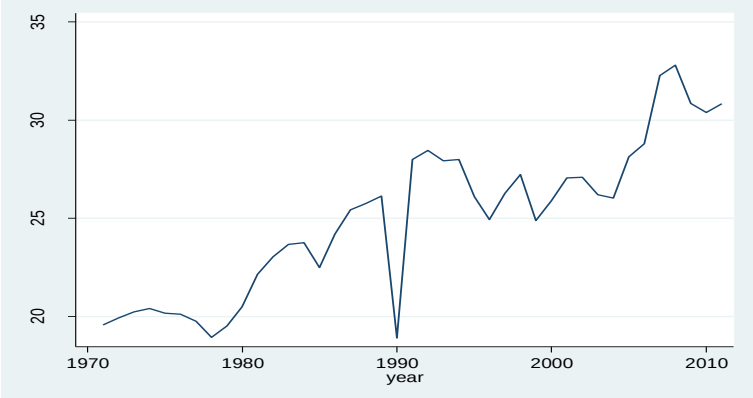


Source: Authors' calculation.

FDI and per capita GDP seem not to have had an effect on TSEE – FDI and Domestic Investment may have occurred mainly in sectors of the economy other than the transformation sector.

PRC: Both coefficients on Policy Year and FDI inflows are significant and positive, meaning TSEE in the PRC improved and FDI is likely to have occurred mostly in the transformation sector.

Figure 2: Trend of TSEE in the PRC

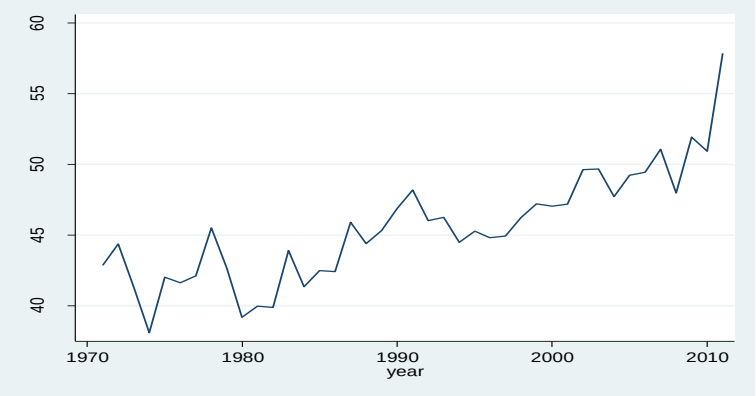


Source: Authors' calculation.

The PRC's TSEE improved drastically from 1970 to 2011, as can be seen in Figure 2. A sharp drop in TSEE in 1990, which further increased sharply after that, needs to be examined. It could have resulted from structural transformation and aggressive policies to replace old power plants with new ones.

Japan: Both coefficients on Policy Year and per capita GDP are statistically significant and positive, suggesting the Cebu Declaration had a positive impact on TSEE in Japan. It is likely domestic investment occurred mainly in the transformation sector, including power plants. Historically, Japan saw drastic improvements in the transformation sector, as shown in Figure 3. From the data in 2011, Japan has the highest TSEE due to a highly efficient transformation sector. By 1970, Japan already had high TSEE starting from above 40 percent of the low base to the high base of above 55 percent.

Figure 3: Trend of TSEE in Japan

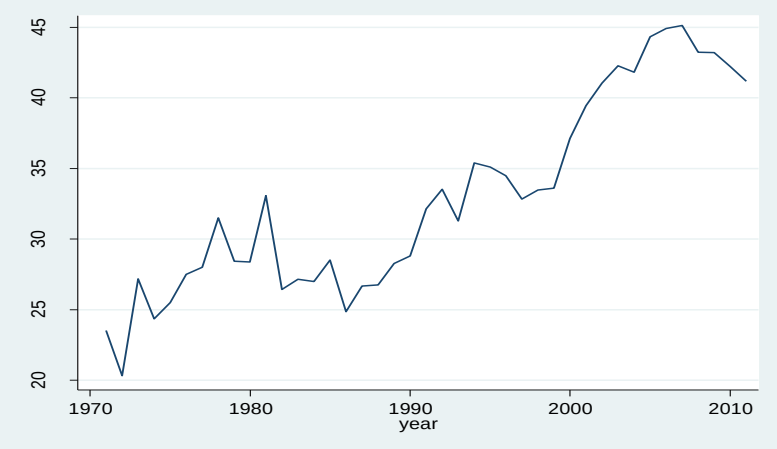


Source: Authors' calculation.

The FDI variable does not have any effect; it has a negative sign and is insignificant. This had been expected as FDI does not play a role of much importance, Japan not being a significant FDI host country.

Republic of Korea *(henceforth, South Korea)*: The coefficient of per capita GDP is statistically significant and positive, suggesting South Korea has had very large domestic investment in the transformation sector. As shown in Figure 4, South Korea saw a drastic improvement in TSEE, from a low base of about 25 percent to just above 40 percent of TSEE.

Figure 4: Trend of TSEE in the Republic of Korea



Source: Authors' calculation.

FDI inflow and Policy Year seem not to have had an effect on TSEE, which had been expected as the efficiency of power plants in South Korea improved drastically up to 2008. A reduction in efficiency in the latter part (from 2008 onwards) is likely to have been the result of power plants reaching the end of their economic lives, which prompted a greater need for maintenance.

Philippines: The coefficient of per capita GDP is statistically significant and positive for the Philippines, suggesting that domestic investment has been allocated mainly in the transformation sector.

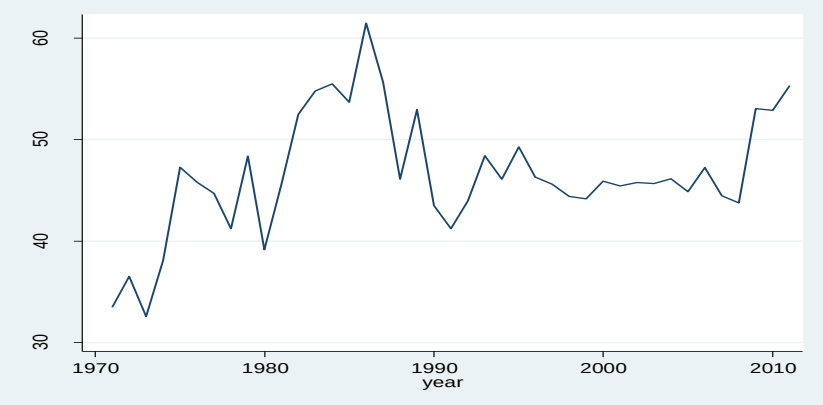
Figure 5: Trend of TSEE in the Philippines

Source: Authors' calculation.

As can be seen in Figure 5, TSEE in the Philippines improved from 2000 onwards. However, the data are difficult to interpret as they show a lot of fluctuations up until 2000, which may be due to structural changes in the economy.

Thailand: Thailand's TSEE started from a high base of above 30 percent and shows much fluctuation from 1970 to 1990, as can be seen in Figure 6, which could be due problems with the data. From 1990 onwards, however, TSEE improved, showing a more steady development. All variables in the regression analysis are not significant, but the positive sign of the Policy Year provides some indication that after 2007, the year of the Cebu Declaration, there were some effects in terms of TSEE improvement.

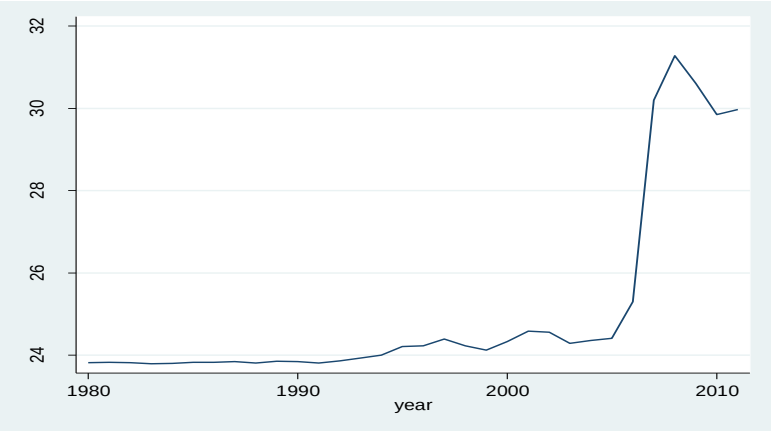
Figure 6: Trend of TSEE in Thailand



Source: Authors' calculation.

India: The coefficient estimates on Policy Year and FDI inflow are statistically significant and positive for India, meaning there was a policy effect on the transformation sector in terms of efficiency improvement. Further, FDI inflows are likely to have been invested in the transformation sector, thus having had an effect on TSEE.

Figure 7: Trend of TSEE in India



Source: Authors' calculation.

TSEE in India showed a drastic improvement from a low base of above 24 percent in 1980 to above 30 percent in 2011.

5. Conclusions

Our study found that policy effects on TSEE seem to have occurred in Japan, the PRC, the Philippines, Thailand, and India. Our results confirmed that such effects occurred after the Cebu Declaration in 2007 in which ASEAN countries committed to implementing measures to improve energy efficiency. The improvements examined in our study are in the transformation sector, particularly in terms of efficiency in the electricity sector of the whole economy. Australia and South Korea may not have seen any further improvements in TSEE from 2007 until 2011. Still, a closer look at each country's particular circumstances is necessary to assess structural changes in the economy, and their potential impact on TSEE.

The study further found that FDI had a positive impact on TSEE in the PRC and India. This suggests that FDI in the PRC and India also occurred in the energy transformation sector and supported economic growth. In the Philippines, Thailand, South Korea, Australia, and Japan, FDI does not seem to have had any effect on TSEE. This could be because the FDI may not have been directed at the transformation sector but at other sectors in the economy. The other component of investment is domestic investment. In Japan and South Korea, domestic investments seem to have an impact on TSEE. A closer examination of each country's economy is needed to understand the phenomenon of TSEE changes and fluctuations.

6. Policy Implications

Our study generates empirical findings and provides observations on historical trends of key variables such as Total System Energy Efficiency and on whether the Cebu Declaration could have translated into positive changes in each economy in terms of TSEE. Our policy recommendations are as follows:

For countries starting with a low base of TSEE

- The PRC and India have provided good examples of using FDI inflows to impact TSEE. This implies that the transformation sector will need large investments and to some extent also public financing for it to improve, albeit very implicitly.
- The Cebu declaration will need to be assessed more concretely for developing economies as a policy effect is yet to be observed in the developing economies in terms of changes in TSEE.

For countries starting with a high base of TSEE

- The developed economies of Japan, South Korea, and Australia showed mixed results in terms of how the Cebu Declaration is likely to have had an effect. There was some effect in Japan, but no effect on TSEE in South Korea and Australia. It is hard for developed economies to achieve sharp increases from a high base efficiency, unless there are technological efficiency breakthroughs like in Japan. Therefore, the technological transfer for the transformation sector such as high-tech power plants needs to be discussed in the context of public financing framework to ensure that such technologies could be deployed to the developing economies as well as around the globe.

References

EPA–United States Environmental Protection Agency (2014), Methods of Calculating Efficiency. Downloadable at http://www.epa.gov/chp/basic/methods.html

Han, P. and F. Kimura (2014), 'Trade-off Relationship between Energy Intensity – thus Energy Demand – and Income Level: Empirical Evidence and Policy Implications for ASEAN and East Asia Countries', *ERIA Discussion Paper* 2014–15, Jakarta: ERIA. Available at: http://www.eria.org/publications/discussion_papers/trade-off-relationship-between-energy-intensity--thus-energy-demand---and-income-level-empirical-evi.html.

Kavousian, A. and Rajagopal, R. (2014), 'Data-Driven Benchmarking of Building Energy Efficiency Utilizing Statistical Frontier Models', *Journal of Computing in Civil Engineering*, 28(1), pp.79–88.

Kimura, S. (2012), *Analysis of Energy Efficiency and Saving Potential in East Asia Region*. Jakarta: ERIA. Available at

http://www.eria.org/publications/research_project_reports/analysis-on-energy-saving-potential-in-east-asia-region-1.html

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