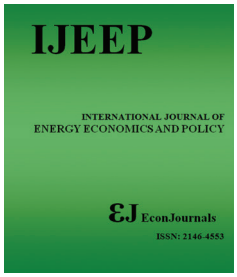

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Foreign Direct Investment, Financial Development, International Trade and Energy Consumption: Panel Data Evidence from Selected ASEAN Countries

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ABSTRACT

The main purpose of this study is to examine the linkage among energy consumption (*EC*), foreign direct investment (*FDI*), financial development (*FD*) and trade for the selected ASEAN countries namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand. After employing appropriate tests of stationarity, long-run-relationship and Granger causality test reveals that there exists significant long-run relationship among all explanatory variables namely *FDI* inflows, trade, *FD* and *EC*. The autoregressive distributed lag bound tests approach further confirms the long-run relationship among set of regressors. Results on Granger causality reveal that in the short-run unidirectional causality running from *FDI* inflows to *EC*, *EC* to *FD*, and *EC* to trade. Whereas, results also show that there exists bidirectional causality between trade and *EC*, *EC* and *FDI*, trade and *FDI*, *EC* and *FD*, trade and *FD* during the period under the study. The empirical results reveals that policy makers needs to formulate appropriate and prudent policy to encourage *FDI* inflows, improve financial sector development, expand exports volume and sustained energy supply, while keep in mind to achieve sustainable economic growth and development in the ASEAN region.

Keywords: Foreign Direct Investment, Financial Development, Trade, Energy Consumption, ASEAN
JEL Classification: Q43

1. INTRODUCTION

Energy consumption (*EC*) considered a fundamental driver of output, has a significant role in economic growth and development. It is a vital component in economic growth either directly or as a complement to other factors of production. Thus, the economies heavily dependent on energy use shall be significantly affected by changes in *EC*. For the past three decades, world has experienced spectacular increase of *EC* in order to sustain its growing economy (Alshehry and Belloumi, 2015; Bölük and Mert, 2014; Coers and Sanders, 2013). The world *EC* 7,095,887 kt and 12,715,769 kt were recorded in 1980 and 2013, respectively, with an average increase of 9368874.16 kt and 176.38% during this period (World Bank, 2014). The growth in world *EC*, 6.29%, 2.75%, 2.51% was recorded in 2010, 2011 and 2012, was recorded respectively. This facts reveals that although world *EC* shows decreasing trends, but growth still stands at 2.41% in 2013.

There are several factors that contribute to economic growth on one hand an increase the EC on the other hand. For example, financial development (*FD*) can boost economic growth, but also stimulates *EC* in the host country. In the recent literature, finance-energy nexus highlights the ways by which *FD* can potentially affect *EC*. At the household level, it is easier for consumers to gain an easy and cheap access to borrowed funds to purchase energy consuming products that directly affect energy demand. At the industrial level, it is easier for entrepreneurs to gain access to financial capital in order to expand existing businesses or start a new one, thereby creating a business effect. Increased stock market activity is regarded as an indicator of economic growth because it increases

risk diversification for consumers and businesses that result in increased fund availability for investment projects, and thereby creates a wealth effect. This builds up consumer and business confidence that leads to expansion in the economy and creates demand for energy intensive products (Çoban and Topcu, 2013; Sadorsky, 2010). Shahbaz and Lean (2012) mention that growth in financial sector raises energy demand in two-ways; firstly due to cross-sectoral growth; and secondly, as with increase in labor demand due to economic growth, income improves that boosts demand for energy consumable products, and thereby enhance *EC*.

Energy demand can influence international trade, while trade can also influence energy demand. In the first case, energy demand can influence trade because energy is an imperative input into the production and shipping of goods intended for international trade. The equipment and machinery required heavy quantity of energy in the process of producing and shipping goods for international trade. Thus, the higher the production and transportation of goods for international trade, the more the energy demands. Consequently, a revision of energy policy (such as energy conservation policy) may require an examination of international trade promotion policy to ensure their consistency. In the second case, international trade can affect *EC*, because an increase in international trade represents an increase in economic activities, which would increase the demand for energy.

In summary, there are three potential links between international trade and energy demand. It is likely that a feedback relationship exists between *EC* and international trade, whereby energy is important for explaining movements in international trade and international trade are important for explaining movements in energy demand (bi-directional). It is also possible for the relationship between *EC* and trade to be either one-way (unidirectional) or neutral. It is one-way when either energy demand influences trade or trade affects energy demand but not both. The neutral case is that the correlation between energy and trade is so small that it does not show up as a statistically significant relationship at conventional test levels.

The several studies investigate the relationship between *EC* and foreign direct investment (*FDI*). *FDI* can increase *EC* through the expansion of industrial, logistic and manufacturing sector development, whereas energy is essential to support the industrialized process. The relationship between *EC* and *FDI* is less focused area and need further investigation with help of advance econometric techniques and current data.

Keeping in mind the vital and critical role of energy in the process of development, this study developed the link among *EC*, *FDI*, *FD* and international trade for selected ASEAN countries, namely, Indonesia, Malaysia, the Philippines, Singapore, and Thailand. With the growing demand for energy and constraints in the domestic resource availability, the ASEAN countries face a number of challenges in terms of provision of energy services. The energy demand is going to grow rapidly in the ASEAN region. Table 1 shows the *EC* of selected ASEAN countries during 2005-2013.

The recent discussion supports a strong linkage between *FDI*, international trade, *FD* and *EC* in ASEAN countries. In this study an analysis has been carried out to find a short- and long-run relationship among *EC* and its determinants in ASEAN countries applying date cover time period from 1980 to 2014. Evidently, several studies have analyzed the energy-growth, *FDI*-growth, finance-growth, international trade-growth nexuses in many developed and developing countries; however, empirical study on the energy–finance, *FDI*–energy and international trade–energy nexus have not been conduct in ASEAN countries.

The paper is organized as follows: After introduction which is provided in Section 1 above, literature review is conceded out in Section 2. Followed by data source and methodological framework are explained in Section 3. The estimation and interpretation of results are mentioned in Section 4. Finally conclusion of the paper will be presented in Section 5.

2. LITERATURE REVIEW

A review of literature reveals that there have been a number of studies on the economic related energy issues, which can be divided into four broad areas. The first of these broad areas focused on the relationship between *EC* and income. The second group is on the link between *EC* and *FD*, while the third category analysis the *EC* and *FDI*. The fourth covers the link between *EC* and trade.

With respect to the spread of studies reviewed across the globe, there are economic related energy studies at the global and regional levels as well as by income level (Al-Mulali and Sheau-Ting, 2014; Apergis and Payne, 2009; Khan et al. 2014; Yildirim et al., 2014; Nahman and Antrobus, 2005; Al-Mulali et al., 2015). There are also cross-country analysis among the studies reviewed (Abanda et al., 2012; Narayan, et al., 2010; Wolde-Rufael, 2010). A number of country specific studies which have been done include those for Taiwan Lee and Chang (2007) and Pao (2009), for Lebanon,

Table 1: Energy consumption (kg of oil equivalent)

ASEAN Countries	2005	2006	2007	2008	2009	2010	2011	2012	2013
Indonesia	165,365	176,238	179,460	183,725	182,884	186,604	199,781	211,296	209,008
Malaysia	54,618	58,690	63,506	63,715	69,969	73,006	69,857	72,645	75,907
Philippines	38,822	38,642	38,755	38,455	38,514	40,009	38,102	40,511	40,452
Singapore	25,634	30,845	21,94	23,509	21,818	25,162	28,262	34,279	33,446
Thailand	89,107	96,291	99,165	101,043	104,886	107,655	107,300	117,428	119,147

Source: World Bank

[1] World Bank. World development indicators. Washington, DC, USA: The World Bank; 2015. Online available at: http://data.worldbank.org/data-catalog/ world-development-indicators/World Bank-2015 [accessed 25.03.15].

Abosedra et al. (2009), China and India Jayanthakumaran et al. (2012); Fang (2011); Yuan et al. (2008) and Chang (2010). On Malaysia Alam et al. (2014), ASEAN, Azam et al. (2015) and other studies include Tang and Tan (2013); Lean and Smyth (2010a) and Lean and Smyth (2010b), Russia, Pao et al. (2011), Brazil Pao and Tsai (2011), Pakistan, Komal and Abbas (2015), Greece, Arabatzis et al. (2012), and Farhani and Ozturk (2015) for Tunusia.

2.1. Energy–Finance Nexus

For instant, studies on finance–energy nexus highlight the direct impact of *FD* on *EC* (Islam et al., 2013a; Shahbaz and Lean, 2012). *FD* affects *EC* indirectly via economic growth. This effect may be either positive or negative depending whether economic growth occurs in an efficient manner or not. Similarly, growth in financial sector improves funds available for investment projects that results in industrial growth leading to expansion in production activities. This in turn enhances economic growth, and increases the demand for new infrastructure and more energy, thereby positively influencing *EC* (Islam et al., 2013b; Shahbaz and Lean, 2012). However, the ability to adopt technological innovations in industrial sector development varies across countries that affect the intensity of *EC* (Islam et al., 2013b).

The empirical literature on finance–energy nexus follows one of the two approaches. The first approach estimates the model in terms of elasticity in the variables by including *EC* and *FD* jointly in a single equation without much theoretical base. The second approach estimates the model using conventional unit root, cointegration and causality tests. The present study is different from these approaches in that it uses a system generalised method of moments technique to separately capture the impact of *FD* over *EC* through economic growth. It, therefore, prepares a strong theoretical ground for empirical analysis. It explores the channel variable (economic growth) through which *FD* may likely affect *EC*. This channel variable is used to capture the effect of change in *FD* on *EC*, and to infer if increased *FD* is linked to more *EC* in Pakistan or *viz*. to the best of our knowledge, there is no published study that captured the indirect relation of *FD* and *EC*.

However, evidence also implies that *FD* lessens *EC* by achieving efficiency in its use for which amendments in infrastructure is required. This comes from investment in research and development of advanced technologies that is linked to the development of financial sector. Besides, if consumers use energy efficient products like home appliances, it lowers energy use (Islam et al., 2013b). Çoban and Topcu (2013) also assert that *FD* makes accessibility to advance technology easier that leads to energy efficiency, hence reduces *EC*. Kakar et al. (2011) have asserted that *FD* can significantly contribute to efficient economic growth by reducing *EC* in Pakistan. Several studies have explored the impact of *FD* over *EC* incorporating other variables in the model.

2.2. Energy–*FDI* Nexus

Some studies have established connections between *EC* and *FDI* (Khan et al., 2014; Komal and Abbas, 2015; Pao and Tsai, 2011; Pao et al., 2011; Shahbaz et al., 2013). In a country specific analysis Pao and Tsai (2011) reported a unidirectional link for *EC* and *FDI* among Brazil, Russia, India and China (BRIC). In the case of Khan et al. (2014) estimates showed that *FDI* has a unidirectional relationship with *EC* in both middle and high income countries, while in low income countries gross domestic product (GDP) and *FD* produce positive impact on *EC*. However, *FDI* and relative prices showed a negative relationship with *EC*. In the same vein, Shahbaz et al. (2013) documented a unidirectional link between *EC* and *FD* in Indonesia. The study also revealed a bi-directional causality between economic growth and *FD* and between *FD* and *EC*. Similarly, Komal and Abbas (2015) indicated that *FD* had significant positive effect on *EC* via the channel of economic growth.

Lee (2013) investigates the *FDI* net inflows, economic growth and *EC* using panel data of 19 nations of G20 countries from 1991 to 2009. The results reveal that *FDI* plays significant role in economic growth, conversely, there is no evidence of *FDI*–energy link in G20 countries. However, Mielnik and Goldemberg (2002) examine positive link between *FDI*–energy nexus in a sample of 20 developing countries. Similarly, Sadorsky (2010) also provide the evidence of statistically positive *FDI*–energy link in a 22 developing countries. In another study Anwar and Nguyen (2010) explore the *FDI*–energy link for the panel of 61 provinces of Vietnam over the time period 1996-2005. The results indicate that there is exists bidirectional causality between *FDI* and *EC* in all provinces of Vietnam. Some studies have also analyzed the energy embodied in trade, which include Machado et al. (2001); Hong et al. (2007); Liu et al. (2010) and Tang et al. (2013).

2.3. Energy–Trade Nexus

Trade–energy nexus was examined by Narayan and Smyth (2009) in a panel of six Middle Eastern countries, namely, Iran, Israel, Kuwait, Oman, Saudi Arabia, and Syria. The results of the study revealed that in the short-run, Granger causality runs from electricity consumption to real GDP (income); and from real GDP to exports. In order to provide further results, the link between trade (export and import) and *EC* was investigated by Sadorsky (2011b) in a sample of eight Middle Eastern countries. The results of Granger causality indicates the bi-directional causality between trade and energy used. Furthermore, results of fully modified ordinary least squares estimated long run elasticities indicates that, a unit percentage rise in per capita exports raises per capita *EC* by 0.11%, whereas a 1% rise in per capita imports boosts per capita *EC* by 0.04%. He concluded that, in both the short and long-run, increased trade impact energy demand in the Middle East. Similarly, Lean and Smyth (2010a) analyzed the link between electricity generation and trade in Malaysia. They reported that, Granger causality runs from electricity generation to international trade. However, Lean and Smyth (2010b) reported no evidence that international trade and electricity consumption have Granger causality relationship for the same country. This implies that causality between international trade and energy depends on whether analysis is conducted from supply side or demand side energy dimension.

Sadorsky (2012) assessed the relationship between *EC*, output and trade for a sample of seven South American countries. Empirical results reveal that there exist a long-run relationship between output, capital, labor, energy, and exports; and output, capital,

labor, energy, and imports. In the same vein, trade (exports or imports) and *EC* have a causal relationship. The results also indicate a short-run bi-directional relationship between *EC* and exports; output and exports; and output and imports. Further, a short-run causal relationship runs from *EC* to imports. Further, Dedeoğlu and Kaya (2013) found a bi-directional causal relationship between *EC*, GDP, export and import for the OECD countries. In the same vein, Al-Mulali and Sheau-Ting (2014) found that in all regions excluding Eastern Europe, trade components (export and import) have long run positive impact on *EC* and CO_2 emission.

From the above review, it is clear that few studies exist for ASEAN countries where energy and international trade, *FD* and *FDI* are also important for economic growth and development as in the case of countries already analyzed in the literature. Besides, the findings are mixed and inconclusive, while none of the studies reviewed focuses on selected ASEAN countries like Indonesia, Malaysia, Thailand, Philippines and Singapore. This important gap coupled with the need to consider the effect of different kinds of energy on trade motivates this study. To further buttress the key contributions of the present study, Table 2 provides an elaborate documentation of the empirical evidence so far.

3. METHODOLOGY AND DATA SOURCE

3.1. Model Specification

There are several studies such as Azam et al. (2015); Haseeb and Azam (2015); Komal and Abbas (2015); Lin and Moubarak (2014); Omri and Kahouli (2014); Ocal and Aslan (2013) and Fondja Wandji (2013) explore the relationship between *EC* and economic growth by include other factors like *FD*, international trade and *FDI*. The basic model of *EC* and other variables is following;

$$\ln(EC)_t = \alpha_0 + \alpha_1 \ln(FDI)_t + \alpha_2 \ln(TR)_t + \alpha_3 \ln(FD)_t + \varepsilon_t \quad (1)$$

Where,

EC	=	Energy consumption	kg of oil equivalent per capita
FDI	=	Foreign direct investment	Net inflows (% of GDP)
TR	=	International trade	Domestic credit provided by banking sector
FD	=	Financial development	Imports + exports (% of GDP)
ln	=	Natural log	
ε	=	White noise error term	

Table 2: Summary of empirical studies on finance-energy, trade-energy and FDI-energy nexus

Author	Time period	Methodology	Countries	Direction of causality
Shahbaz et al. (2013)	1971-2011	ARDL	Indonesia	*TR*↔*EC*
Farhani et al. (2014)	1980-2010	ARDL, TY causality	Tunisia	*TR*→*EC*
Sbia et al. (2014)	1975-2011	VECM	Bahrain	*TR*→*EC*
Ozturk and Bilgili (2015)	1980-2009	Dynamic panel OLS	51 Sub-Sahara African countries	*TR*→*EC*
Nasreen and Anwar (2014)	1980-2011	Panel model	15 Asian countries	*TR*↔*EC*
Ren et al. (2014)	2000-2010	GMM estimation	China (industrial sector)	*FDI*→*EC* *TR*≠*EC*
Dedeoğlu and Kaya (2013)	1980-2011	Panel data	OECD	*TR*↔*EC*
Zhang (2011)	1990-2009	Granger causality and variance decomposition	China	*FD*→*EC*
Al-Mulali and Sab (2012)	1980-2008	Granger causality	Sub Saharan African countries	*FD*↔*EC*
Al-Mulali and Sab (2012)	1980-2008	Pedroni cointegration	19 developed and developing countries	*FD*↔*EC*
Islam et al. (2013b)	1971-2099	ARDL	Malaysia	*FD*→*EC*
Ozturk and Acaravci (2013)	1960-2007	Bounds F-test	Turkey	*FD*→*EC* *TR*→*EC*
Sadorsky (2011a)	1996-2006	Panel GMM	Central and Eastern Eurpean	*FD*→*EC*
Sadorsky (2010)	1990-2006	Panel GMM	Emerging countries	*FD*→*EC*
Shahbaz and Lean (2012)	1971-2009	ARDL	Tunisia	*FD*→*EC*
Pao and Tsai (2011)	1992-2007	Fisher cointegration test	BRIC countries	*FD*→*EC*
Tang and Tan (2013)	1972-2009	Johansen-Juselius cointegration	Malaysia	*EC*→*FD*
Kakar et al. (2011)	1980-2009	VECM	Pakistan	*EC*→*FD*
Shahbaz et al. (2013)	1971-2011	ARDL, Granger causality	China	*FD*↔*EC*
Mehrara and Musai (2012)	1970-2009	ARDL	Iran	*FD*↔*EC*
Mudakkar et al. (2013)	1975-2011	TY	SAARC countries	*FD*↔*EC*
Çoban and Topcu (2013)	1990-2011	GMM	European Union	*FD*≠*EC*
Omri and Kahouli (2014)	1990-2011	GMM	65 countries	*FD*→*EC*
Erkan et al. (2010)	1970-2006	Granger causality	Turkey	*EC*→*TR*
Narayan and Smyth (2009)	1974-2002	VECM	Iran, Israel, Syria, Kuwait, Saudi Arab	*TR*→*EC*
Shahbaz et al., (2013)	1972-2010	ARDL, VECM	Pakistan	*TR*→*EC*
Nnaji et al. (2013)	1970-2009	ARDL	Nigeria	*TR*→*EC*
Ghani (2012)	1980-2007	VECM	Selected developing countries	*TR*≠*EC*
Lee (2013)	1980-2011	Granger causality	G20 countries	*FDI*→*EC*
Foon Tang (2009)	1970-2005	VVECM	Malaysia	*FDI*→*EC*
Zaman et al. (2012)	1975-2010	ARDL	Pakistan	*FDI*→*EC*

Source: Authors' compilation. →: Unidirectional causality, ↔: Bidirectional causality, ≠: No causality, EC: Energy consumption, TR: International trade, FD: Financial development, FDI: Foreign direct investment, VECM: Vector error correction model, ARDL: Autoregressive distributed lag, PP: Phillips–Perron, GMM: Generalized method of moments, OLS: Ordinary least squares

Time series data of all the variables has been taken from World Development Indicators which is published by World Bank (2015). Furthermore, the long-run and short-run elasticities estimated by Johansen cointegration techniques and autoregressive distributed lag (ARDL) testing approach and Granger causality tests employed with Wald *F*-statistics is fairly simple and its mechanics are simple to understand, as compared to other econometric techniques. Therefore, the study follows the framework of Tang and Tan (2014) for estimating the long-run relationship between the *EC*, international trade, *FDI* and *FD* variables in the context of selected ASEAN countries.

3.2. Estimation Procedure

Contrasted to all other methods, that apply time series data, it is crucial to differentiate that except the diagnostic tools applied account for the dynamics of the link within a chronological "causal" framework, the complexity of the interrelationships concerned may not be completely limited. For this underlying principle, there is a state of applying the advances in time series version. The subsequent chronological procedures are assumed as element of the methodology applied.

3.2.1. Unit root test

For the purpose to verify the degree, these series splits univariate integration properties; this study utilized unit root stationarity tests. The augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) are the appropriate tests to verify the null hypothesis that a unit root exists.

3.2.2. Lag length selection

The most frequent method in deciding the optimal lag length is to estimate a vector auto regression (VAR) model, including all our variables in non-difference data. This VAR model should be estimated for a large number of lags, then reducing down by re-estimating the model for one lag less until reach zero lags. In each of these models, study inspects the values of akaike information criteria (AIC) and Bayesian information criteria (SBC). The model that minimizes the AIC and the SBC is selected as the one with the optimal lags length.

3.2.3. Cointegration analysis

Only a cointegrated series can leads further long run relationship. If the model consists with the more than three variables (multivariate model) and I(1) variables are bonded by more than one cointegration vector; the Engle and Granger procedure is not suitable to apply. Consequently, this study utilized maximum likelihood ratio introduced by Johansen and Juselius (1990) to classify the numbers of cointegrated vectors in the proposed model. The study of Johansen and Juselius (1990) argue that this method is more suitable for multivariate model. Johansen and Juselius (1990) and Johansen (1991) propose that the multivariate co-integration methodology can be defined as:

$$\text{Ln}(EC)=(FDI,TR,FD) \quad (2)$$

Which is a vector of P = 3 elements. Considering the following autoregressive representation:

$$Yt = \eta_0 + \sum_{T=1}^{K} \eta_i Y_{t-1} + \mu_t \quad (3)$$

Johansen's method involves the estimation of the above equation by the maximum likelihood technique, and the testing of the hypothesis H_0 ($\eta = \Omega£$) of "*r*" cointegrating relationships, where "*r*" is the rank or the matrix η ($0 < r < P$), Ω is the matrix of weights with which the variable enters cointegrating relationships and £ is the matrix of co-integrating vectors. The null hypothesis of non-cointegration among variables is rejected when the estimated likelihood test statistic $\varphi_i = \{-n\sum_{t=r+1}^{p} \ln(1-\hat{\lambda}_i)i\}$ exceeds its critical value. Given estimates of the Eigen-value $(\hat{\lambda}_i)$ the Eigen vector ($£_i$) and the weights (Ω_i), we can find out whether or not the variables in the vector are cointegrated in one or more long-run relationships among the dependent variables.

3.2.4. Bounds testing approach

Following Pesaran et al. (2001), this study assemble the VAR of order p, denoted VAR (p), for the following growth function:

$$Z_t = \lambda + \sum_{i=1}^{p} \eta_i z_{t-i} + \varepsilon_t$$

Where, *Z* is the vector of both *x* and *y,* where *y* is the dependent variable defined as *EC*, x_t is the vector matrix which represents a set of explanatory variables like *FDI*, international trade (*TR*) and *FD* indicator *t* is a time or trend variable. According to Pesaran et al. (2001) y_t must be I(1) variable, but the regressors x_t can be either I(0) or I(1).We further developed a vector error correction model (ECM) in Equation (4) as follows:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-1} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \quad (4)$$

Where, Δ is the first difference operator. The long run multiplier matrix λ as:

$$\lambda = [\lambda_{YY}\lambda_{YX}]*[\lambda_{XY}\lambda_{XX}]$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either I(0) or I(1). If $\lambda_{YY} = 0$, then *Y* is I(1). In contrast, if $\lambda_{YY} < 0$, then *Y* is I(0).

After imposing the restrictions $\lambda_{YY} = 0$, $\mu \neq 0$ and $\alpha = 0$, the hypothetical function can be stated as the following unrestricted ECM:

$$\Delta \ln(EC)_t = \beta_0 + \beta_1 \ln(EC)_{t-1} + \beta_2 \ln(FDI)_{t-1} + \beta_3 \ln(TR)_{t-1} + \beta_4 \ln(FD)_{t-1} + \sum_{i=1}^{p} \beta_5 \Delta \ln(EC)_{t-i} + \sum_{i=0}^{q} \beta_6 \ln(FDI)_{t-i} + \sum_{i=0}^{r} \beta_7 \Delta \ln(TR)_{t-i} + \sum_{i=0}^{t} \beta_8 \Delta \ln(FD)_{t-i} + \mu_t \quad (5)$$

Where, Δ is the first-difference operator and μ_t is a white-noise disturbance term. Equation (5) also can be viewed as an ARDL

of order (p, q, r, s, t). The equation indicates that *EC* tends to be influenced and explained by its past values. The structural lags are established by using AIC, Pesaran et al. (2001) suggested using the standard joint significance *F*-test on the lagged levels variables. After regression of Equation (5), the Wald test (*F*-statistic) was computed to differentiate the long-run relationship between the concerned variables. The Wald test can be carry out by imposing restrictions on the estimated long-run coefficients of *FDI*, *TR* and *FD*.

The null and alternative hypotheses are as follows:

$H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

(There is no long-run relationship exists)

Against the alternative hypothesis:

$H_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$

(There is a long-run relationship exists)

The computed *F*-statistic value will be evaluated with the critical values tabulated by Pesaran et al. (2001).

3.2.5. Granger causality analysis

The Granger causality test is then used to determine the direction of causality among the four variables in this study. However, if the variables are I(1) and cointegrated, the Granger causality test within the first difference VAR model will be misleading. In such circumstances, ECM as follows:

$$\Delta \ln(EC)_t = \alpha_1 + \sum_{i=1}^{k} b1i\Delta \ln(EC)_{t-i} + \sum_{i=0}^{k} c1i\Delta(FDI)_{t-i} + \sum_{i=0}^{k} d1i\Delta \ln(TR)_{t-1} + \sum_{i=0}^{k} e1i\Delta \ln(FD)_{t-1} + \gamma 1\varepsilon_{t-1} + \eta 1t \quad (6)$$

$$\Delta \ln(FDI)_t = \alpha_1 + \sum_{i=1}^{k} b1i\Delta \ln(FDI)_{t-i} + \sum_{i=0}^{k} c1i\Delta(EC)_{t-i} + \sum_{i=0}^{k} d1i\Delta \ln(TR)_{t-1} + \sum_{i=0}^{k} e1i\Delta \ln(FD)_{0-1} + \gamma 2\varepsilon_{t-1} + \eta 2t \quad (7)$$

$$\Delta \ln(TR)_t = \alpha_1 + \sum_{i=1}^{k} b1i\Delta \ln(TR)_{t-i} + \sum_{i=0}^{k} c1i\Delta(EC)_{t-i} + \sum_{i=0}^{k} d1i\Delta \ln(FDI)_{t-1} + \sum_{i=0}^{k} e1i\Delta \ln(FD)_{t-1} + \gamma 3\varepsilon_{t-1} + \eta 3t \quad (8)$$

$$\Delta \ln(FD)_t = \alpha_1 + \sum_{i=1}^{k} b1i\Delta \ln(FD)_{t-i} + \sum_{i=0}^{k} c1i\Delta(EC)_{t-i} + \sum_{i=0}^{k} d1i\Delta \ln(FDI)_{t-1} + \sum_{i=0}^{k} e1i\Delta \ln(TR)_{t-1} + \gamma 4\varepsilon_{t-1} + \eta 4t \quad (9)$$

The equations above consist of short and long run elements; Δ and ln are the notations for first difference and natural logarithm, respectively. The residuals η_t are assumed to be normally distributed and white noise. From the above equations, ε_{t-1} is the one period lagged error correction term derived from the cointegrating equation.

4. RESULTS AND DISCUSSION

The standard ADF and PP unit root test was exercised to check the order of integration of these variables. The results obtained are reported in Table 3. Based on the ADF and PP test statistic, it was concluded that given variables are non-stationary at their level. However, variables are stationary at their first difference like I(1) variables.

4.1. Johansen and Juselius Cointegration Test Results

The relationship between dependent variable (*EC*) and the independent variables (*FDI*, *TR* and *FD*) is observed using the multivariate cointegration methodology proposed by Johansen (1988) and Johansen and Juselius (1990). The Johansen's cointegration test designates at least one cointegrating vector. Thus, long-run relationship is maintained by the data generating method. Using Johansen and Juselius (1990) multivariate cointegration tests, the study finds that a statistically significant relationship exists between independent variables on *EC* in ASEAN countries. The following cointegrating vector has been determined in Table 4.

This starts with the null hypothesis of no co-integration ($r = 0$) among the variables. It is found that the trace statistic of 42.12 exceeds the 90% critical value of the λ_{trace} statistic. It is possible to reject the null hypothesis ($r = 0$) of no co-integration vector in favor of the general alternative $r > 0$. As evident in Table 4, the null hypothesis of $r \leq 1$, $r \leq 2$, $r \leq 3$ and $r \leq 4$ cannot be rejected at 1%, 5% or 10% level of confidence. Consequently, it is concluded that there are only one cointegration relationships, involving variables like *EC*, *FDI*, *TR* and *FD*. Similarly, λmax statistic rejects the null hypothesis of no co-integration vector as the calculated value λmax = 23.43 exceed the 90% critical value.

Table 3: The unit root test results

Variables	Level		First difference	
	ADF	PP	ADF	PP
EC	−0.341	−0.354	−3.889*	−3.991*
FDI	−2.122	−2.132	−7.812***	−7.987***
TR	−0.660	−0.832	−5.186*	−5.234*
FD	−3.423	−3.514	−8.132**	−8.421**

*.**.***Significance at the 1%, 5% and 10% level, respectively. The model with constant and trend was used to estimate the unit root tests. The optimal lag length of ADF is determined by AIC, while the bandwidth for the PP tests were determined using the Bartlett-Kernel procedure, FDI: Foreign direct investment, EC: Energy consumption, TR: International trade, FD: Financial development, ADF: Augmented Dickey-Fuller, PP: Phillips-Perron

Table 4: Multivariate Johansen-Johansen cointegration test results

Null hypotheses	λ_{trace} test statistics	λ_{max} test statistics
$r=0$	42.12***	23.43***
$r\leq1$	32.39	19.12
$r\leq2$	5.23	3.43
$r\leq3$	2.12	1.05
$r\leq4$	1.50	1.34

***Significance at the 10% level

Thus, based on λmax statistic, there is one co-integration vectors. The presence of the co-integration vectors shows that there exists a long-run relationship among the variables.

4.2. Bounds Testing Approach

This study further examined the existence of long-run relationship between the variables. Table 5 reports the results of bounds test with *F*-statistics when each variable is considered as a dependent variable in ARDL regressions. Based on the Narayan and Narayan (2005) tabulated values, only *EC* model specification *F*(*EC/FDI,TR,FD*) is significant at 1% level. However, Narayan (2005) critical value bounds of the *F*-statistic are reported in Table 5.

Thus the null hypothesis of no cointegration is rejected in case of first model, implying long-run cointegration relationships between them; else remaining models are accepted null hypothesis of no cointegration, therefore, the present study use first model where *EC* is the dependent variable (Table 6).

4.3. Estimating the Long-Run Relationship

In order to check the stability of the long-run among *EC*, *FDI*, *TR*, and *FD* this study assess the ECM. The long-run results are presented in Table 7, with the exception of *FDI* and other explanatory variables positively affect *EC* in the long-run. Moreover, all variables are statistically significance at the 1%, 5% and 10% level. The long-run results show that if there is 1% increase in *FDI*, *TR* and *FD*, on average the *EC* in ASEAN countries would increases by 0.325%, 0.024% and 0.043%, respectively. The result concludes that sound and developed financial system attract investors, boost the stock market and improve the efficiency of economic activities in the ASEAN countries.

Table 5: Narayan (2005) critical value bounds

Significance level (%)	Lower bounds	Upper bounds
1	4.590	6.368
5	3.276	4.630
10	2.696	3.895

Table 6: Bounds testing approach to cointegration

Model	*F*-statistics
F (EC/FDI, TR, FD)	8.123*
F (FDI/EC, TR, FD)	1.212
F (TR/EC, FDI, FD)	1.433
F (FD/EC, TR, FDI)	0.432

*1% significance level, FDI: Foreign direct investment, EC: Energy consumption, TR: International trade, FD: Financial development

Table 7: Long-run elasticities

Long-run results (dependent variable: ln $(EC)_t$)			
Variables	**Coefficient**	**Standard error**	***t*-statistics**
Constant	3.213	0.121	14.234**
ln (*FDI*)	0.325	0.012	3.123*
ln (*TR*)	0.024	0.019	2.561**
ln (*FD*)	0.043	0.012	5.231***

*,** and ***Statistical significance at the 1%, 5% and 10% levels, respectively, FDI: Foreign direct investment, EC: Energy consumption, TR: International trade, FD: Financial development

4.4. Estimating the Short-Run Relationship

In order to check the stability of the short-run relationship among *EC*, *FDI*, *TR*, and *FD* this study assess the ECM in Table 8. As the variables are cointegrated, the short-run elasticities are evaluated using the ECM. The coefficient for error correction term is negative (−0.371) and statistically significant at the 10% level, implying the presence of a long-run relationship.

4.5. Results of Granger Causality Analysis

As the variables are cointegrated, this study proceeds to examine the short- and the long-run Granger causality in the ECM framework. Table 9 presents the results of Granger causality among *EC*, *FDI*, *TR* and *FD* in ASEAN region. With regard to short-run causality, results find a unidirectional causality running from *FDI* to *EC*, *EC* to *FD* and *EC* to *TR*. Apart from that, there are also evidences of bidirectional causality: (a) Between *TR* to *EC*, (b) between *EC* to *FDI* (c) between *TR* to *FDI*, (d) between *FDI* to *TR*, (e) between *EC* to *FD*, (f) *TR* to *FD* in ASEAN region. Turning to the long-run causality, the results show that at the 1%, 5% and 10% significance level, there are three unidirectional causalities in ASEAN region.

5. CONCLUSION AND POLICY ANALYSIS

Evidently the significance of *FDI* inflows, trade, financial sector development and *EC* cannot be ignored in the process of economic growth and development. Therefore, objective of the present

Table 8: Short-run elasticities

Short-run results (dependent variable: Δ ln $(EC)_t$)			
Variables	**Coefficient**	**Standard error**	***t*-statistics**
Constant	0.012	0.003	2.223
ln (*FDI*)	0.056	0.022	1.096
ln (*TR*)	0.021	0.012	0.251
ln (*FD*)	0.007	0.020	0.216
$\varepsilon_t - 1$	−0.371	0.156	−2.342***
Adjusted R^2	0.451		
F-statistics	12.124		
DW statistics	1.882		

*,** and ***Statistical significance at the 1%, 5% and 10% levels, respectively. FDI: Foreign direct investment, EC: Energy consumption, TR: International trade, FD: Financial development

Table 9: Granger causality test results

Null hypothesis	Source of causation	
	Short-run causality-Wald test statistics	**Long-run causality**
Δln*FDI*→Δln*EC*	10.431*	2.098
Δln*TR*→Δln*EC*	0.987**	1.987*
Δln*FD*→Δln*EC*	1.565	2.032**
Δln*EC*→Δln*FDI*	5.512*	1.341***
Δln*TR*→Δln*FDI*	4.123*	3.367**
Δln*FD*→Δln*FDI*	0.789	9.098
Δln*EC*→Δln*TR*	4.981***	2.098
Δln*FDI*→Δln*TR*	12.712**	1.342*
Δln*FD*→Δln*TR*	2.031	2.823**
Δln*EC*→Δln*FD*	5.432**	7.897*
Δln*FDI*→Δln*FD*	4.765	1.219***
Δln*TR*→Δln*FD*	1.372**	5.234*

*,** and ***Statistical significance at the 1%, 5% and 10% levels, respectively. The optimal lag order is determined by AIC, AIC: Akaike information criteria, FDI: Foreign direct investment, EC: Energy consumption, TR: International trade, FD: Financial development

study is to examine the linkage among *EC*, *FDI* inflows, *FD* and international trade for the selected ASEAN countries namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand. It is important to understand that whether due to the enhanced level of inward *FDI*, international trade and financial sector development, how the demand for energy increasing in the ASEAN region. The study followed all appropriate tests of stationarity, where the results shows that set of variables used in this study are non-stationary at their level. However, variables are stationary at their first difference like I(1) variables. The Johansen and Juselius (1990) multivariate cointegration tests reveals that there exists a statistically significant long-run relationship among all explanatory variables namely *FDI* inflows, trade, *FD* and *EC*. The ARDL bound tests approach also confirms the long-run cointegration relationship among set of explanatory variables used in the study.

The short and the long-run Granger causality test in the ECM framework exhibits Granger causality among *EC*, *FDI* inflows, trade and *FD* for the selected countries in ASEAN region. The empirical results on causality reveal that in the short-run unidirectional causality running from *FDI* inflows to *EC*, *EC* to *FD*, and *EC* to trade. Whereas, results also show that that there exists bidirectional causality in trade and *EC*, *EC* and *FDI*, trade and *FDI*, *EC* and *FD*, and trade and *FD* during the period under the study.

The empirical findings of this study suggest some policy measures in order to improve social well-being and achieve prosperous economic development in the region. Therefore, policy makers needs to formulate conducive and investment friendly environment policy to enhance more *FDI* inflows. The available resources must be used maximally, while keep in mind sustainability in order to expand largely level of exports. Active financial sector needs to be further improved through suitable policies. Similarly, energy supply should be sustained on sustainable basis thorough appropriate and effective policy to achieve sustainable economic growth and development in the ASEAN region.

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