Financial development and energy consumption nexus in emerging economies

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ABSTRACT

This study aims to examine the relationship between financial development, energy price, real income and energy consumption in 17 emerging economies. In doing so, the financial development has been handled with three different dimensions (banking sector, stock market and bond market i.e) and the effects of each financial development dimension on energy consumption is investigated. For this purpose, the annual data of 1991-2015 is analyzed using with common correlated effect (CCE) estimator to take into account the cross-sectional dependence. The results show that bond market development is the most efficient dimension to reduce the energy consumption.

Keywords: Energy consumption; financial development; energy price; cross-sectional dependence; emerging economies

1.Introduction

Resolving the determinants of energy consumption has become the crucial research topic over the last decade. Determining the factors affecting energy demand is crucial to reduce the energy dependence of the countries and to reduce the CO2 emissions that are emitted through energy consumption. In this regard, many studies examine the effect of some control variables on energy demand such as urbanization, industrialization and population growth etc. Financial development is also accepted as one of the most important factor to determine the level of energy demand. Energy demand can be influenced by financial development with various ways. First, financial development facilitates access of consumers to durable goods that increase energy consumption. Second, the businesses benefit from the financial system in terms of access to the financial capital that will allow them to grow their existing business and increase their production which directly affects energy demand. Third, the increased stock market activity with the financial development also creates a wealth effect that affects both consumer and business confidence and increased economic confidence boosts demand for energy-intensive goods.

In energy economics literature, it seems there are contradictory results based on using financial development indicator, using technique and observed country group. For instance, the positive effect of financial development on energy consumption has been found by Sadorsky (2010) for emerging economies, Sadorsky (2011) for European frontier economies, Shahbaz and Lean (2012) for Tunisia, Ozturk and Acaravci (2013) for Turkey, Zeren and Koc (2014) for India, Thailand and Turkey, Aslan et al. (2014) for Middle Eastern countries. However, some studies found the inverse relationship between financial development and energy consumption such as; Islam et al. (2013) for Malaysia, Sbia et al. (2014) for United Arab Emirates, Ali et al. (2015) for Nigeria, Destek (2015)

for Turkey, Topcu and Payne (2017) for 32 high income countries. Moreover, there are limited studies that confirmed the inverted U-shaped relationship between financial development and energy consumption such as Coban and Topcu (2013) for EU countries and Mahalik et al. (2017) for Saudi Arabia.

Despite the existence of many researches that examine the relationship between financial development and energy consumption, studies that examine the effects of different financial development dimensions on energy consumption are limited. Based on this reason, this study aims to examine the impact of different financial development indicators on energy consumption for the period from 1991 to 2015 in emerging economies. The contribution of this study is twofold. First, to the best of our knowledge, this is the first study to explore the financial development and energy consumption and to compare the different financial development indicators (banking sector, stock market and bond market) on energy demand in emerging economies. Second, to take into account the cross-sectional dependence among emerging economies, this paper uses the second generation panel data methodologies.

2.Empirical model and data

The annual data of 1991-2015 is examined to investigate the relationship between financial development and energy consumption in 17 emerging economies: Brazil, China, Colombia, Czech Republic, Greece, Hungary, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, S. Africa, S. Korea, Thailand and Turkey. The panel version of the empirical model is as following;

$$lnEC_{it} = \delta_0 + \delta_1 lnGDP_{it} + \delta_2 lnEP_{it} + \delta_3 lnFIN_{it} + \varepsilon_{it} \quad (1)$$

where t, i and μ_{it} refer to time period, cross-section and residual term, respectively. In addition, EC refers to energy consumption measured in per capita kg of oil equivalent, GDP represents economic growth which is measured in real gross domestic per capita in 2010 constant US dollars, EP indicates the energy prices and measured in Brent crude oil price of 2010 constant US dollars and FIN represents the financial development index which includes three sub indices and overall financial development index (FD). The financial development index includes banking sector development index (FD1), stock market development index (FD2) and bond market development index (FD3). The banking sector development index is constructed with using deposit money bank assets to GDP, financial system deposit to GDP, liquid liabilities to GDP and private credit by deposit money banks to GDP. The stock market development index covers the stock market capitalization to GDP, stock market turnover ratio and stock market total value traded to GDP. The bond market development index includes the outstanding domestic private debt securities to GDP, the outstanding domestic public debt securities to GDP, the outstanding international private debt securities to GDP and the outstanding international public debt securities to GDP. Following the studies of Tang and Tan (2014), Shahbaz et al. (2016) and Topcu and Payne (2017), the financial development index and the sub indices are computed with principal component analysis (PCA). The data of EC and GDP were obtained from WDI (World Development Indicators) of World Bank. Moreover, the series of FD indicators were downloaded from GFDD (Global Financial Development Database) of World Bank. Finally, the data of EP was extracted from British Petroleum Statistical Review database.

3. Methodology and empirical results

In recent years, with the developments of econometric techniques, it has become important to examine the shock reflectance between countries in panel data analyzes. Therefore, in this study, we first examine the cross-sectional dependence among emerging economies using with cross-sectional dependence test (CD hereafter) of Pesaran (2004). The CD test is computed as follows;

$$\mathrm{CD} = \sqrt{\left(\frac{2\mathrm{T}}{\mathrm{N}(\mathrm{N}-1)}\right)} \sum_{\mathrm{i}=1}^{\mathrm{N}-1} \sum_{\mathrm{j}=\mathrm{i}+1}^{\mathrm{N}} \left(\hat{\rho}_{\mathrm{ij}}\right) \mathrm{N}(0,1) \qquad (2)$$

where *N* and *T* states respectively the cross-section dimension and the time period. In addition, $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the residuals.

The cross-sectional dependence test results are shown in Panel A of Table 1. According to the results, the null of there is no cross-sectional dependence among countries can be rejected strongly. This result means that a shock in one of the emerging country may easily be transmitted to the other countries.

[INSERT TABLE 1 HERE]

After determining the validity of cross-sectional dependence, we should use a second generation panel unit root test which allows the cross-sectional dependence. In this direction, the CIPS unit root test of (Pesaran, 2007) is used to examine the stationary properties of variables. The construction of CIPS unit root test as follows;

$$CIPS\ (N,T) = \left(\frac{1}{N}\right) \sum_{i=1}^{N} t_i\ (N,T) \qquad (3)$$

where *CIPS (N, T)* is the cross-sectional augmented form of IPS panel unit root test and *t*-statistics are obtained with the computation of individual ADF statistics. To sum up, CIPS statistic is retrieved from the average of CADF statistic for each cross-section.

The results of the CIPS unit root test are also illustrated in Panel B of Table 1. As a seen in Table 1, the null hypothesis of unit root is not rejected at the level form of variables. However, the null hypothesis can be rejected at the first differenced form and all series have become stationary.

In the third step of analysis, we utilized with the mean group (MG) estimation method of Pesaran and Smith (1995) which allows the heterogeneity in the panel. The MG estimation is based on the equation as follows;

$$\hat{\delta}_{MG} = N^{-1} \sum_{i=1}^{N} \hat{\delta}_i \quad (4)$$

where $\hat{\delta}_{MG}$ is the mean group coefficient and $\hat{\delta}_i$ is the ordinary least squares (OLS) estimation of each cross-section.

The mean group estimation results are presented in Table 2. In all models, the coefficient of real GDP per capita is positive and statistically significant. However, the increasing energy prices negatively affect the energy consumption per capita. When the financial development index evaluated, it seems the coefficient of both overall financial development index and stock market development index are statistically insignificant. On the other hand, both the coefficient of banking market development and bond market development are negative and statistical significant.

[INSERT TABLE 2 HERE]

In the final step of the analysis, we utilized with the common correlated effect of mean group (CCE-MG) estimation method of (Pesaran, 2006) which allows both the heterogeneity and cross-sectional dependence. Based on the main panel model of this study (Eq. 1), the residual term (ε_{it}) is a multifactor residual term and constructed as follows;

$$e_{it} = \lambda_i^{'} UF_t + u_{it} \tag{5}$$

where UF_t is the $m\ x\ 1$ vector of unobserved common factors. In addition Pesaran (2006) utilizes with cross-sectional averages to deal with cross-sectional dependence of residuals as observable proxies for common factors such as $\overline{lnX_t} = \frac{1}{N}\sum_{i=1}^{N} lnX_{it}$. Finally, obtained regression model is as follows;

$$lnEC_{it} = \delta_0 + \delta_1 lnGDP_{it} + \delta_2 lnEP_{it} + \delta_3 lnFD_{it} + \gamma_0 \overline{lnEC_{it}} + \gamma_1 \overline{lnGDP_{it}} + \gamma_2 \overline{lnEP_t} + \gamma_3 \overline{lnFD_{it}} + e_{it} \tag{6}$$

Pesaran (2006) indicates that OLS estimators of the individual slope coefficients of CCE = $(\delta_1, \delta_2, \delta_3)$ are called as "common correlated effect" estimators.

[INSERT TABLE 3 HERE]

As illustrated in Table 3, according to the CCE-MG estimation results, real income per capita positively affects the energy consumption. Similar to the MG results, the coefficient of energy price is negative but statistically insignificant. In addition, unlike the MG results, the CCE-MG results show that only the coefficient of the bond market development index is statistically significant. Based on the fact that the CCE-MG

estimation method allows the cross-sectional dependence, the CCE-MG estimation results are more robust than MG estimation results therefore it can be said that bond market development is the most efficient indicator to reduce the energy consumption.

4.Conclusions and policy implications

This study aims to examine the relationship between financial development energy consumption in 17 emerging economies: Brazil, China, Colombia, Czech Republic, Greece, Hungary, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, S. Africa, S. Korea, Thailand and Turkey. For this purpose, the annual data for the period from 1991 to 2015 is investigated using with second generation panel data methodologies to consider the cross-sectional dependence among emerging economies. In doing so, energy price and real income are also used as control variable.

The empirical results show that there is the cross-sectional dependence among emerging economies. It means that a shock in one of the emerging country may spill-over the other countries. Based on the mean-group estimation results, we found that the real income is positively correlated with energy consumption and the energy price negatively affects energy consumption. In addition, banking market development and bond market development have negative and statistical significant effect on energy consumption. In order to take into account the cross-sectional dependence and to assess the robustness of the mean group results, we also utilized with common correlated effect estimator and found that only the coefficient of the bond market development index is negative and statistically significant.

Regarding the policy implication, it can be said that the developments in the financial system of emerging economies and the policies to reduce energy demand do not

contradict. Moreover, the developments in the bond market benefit the more efficient use of energy. On the other hand, the development of banking and stock markets should also be directed towards investments that enhance energy efficiency and access to environmentally friendly technologies.

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