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Effects of financial developments and income on energy consumption

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ABSTRACT

Extending Sadorsky (2010), this paper focuses on nonlinear effects of financial development and income on energy consumption. Utilizing five alternative measures of financial development, it employs a panel threshold regression approach to reexamine the effect of financial development and income on energy consumption. The analysis relies on a sample of 53 countries for the period 1999–2008, showing a single-threshold effect on energy consumption when private credit, domestic credit, value of traded stocks, and stock market turnover are used as financial development indicators. It implies that the sample can be split into two regimes: high income, and non-high income. Energy consumption increases with income in emerging market and developing economies, while in advanced economies energy consumption increases with income beyond a point at which the economy achieves a threshold level of income. In addition, in the non–high income regime, energy consumption increases with financial development when both private and domestic credit are used as financial development indicators. However, when the value of traded stocks and stock market turnover are used as financial development indicators, it slightly declines with financial development in advanced economies, especially in high-income countries, but increases in the higher income countries of emerging market and developing economies.

1. Introduction

Financial development correlates with the degree of capital flows in financial institutions, capital markets, and foreign direct investment (FDI). Financial development also influences environmental quality via these three mechanisms (Zhang, 2011). Currently, there are two views regarding the effect of financial development on energy consumption. One view argues that the growing efficiency of financial intermediation can (in addition to increasing opportunities for investment) support increased lending to households and firms, thus encouraging consumers to purchase "large-ticket" items, thereby increasing the consumption in energy (when such items include automobiles and machinery). The increasing consumption of energy, in turn, elevates emissions of CO_2 into the air and of organic pollutants into water.

In contrast to the first view, developed financial institutions and capital markets can provide an opportunity to lend capital to the renewable energy sector, and provide debt as well as equity financing in funding green renewable energy projects, respectively (Dasgupta, Hong, Laplante, & Mamingi, 2004). Good financial development makes it possible to offer credits for environmentally friendly projects at low financing costs. Furthermore, FDI may lead to technology innovation by local firms, which can help reduce energy use (Alfaro, Chanda, Kalemli-Ozcan, & Sayek, 2004, 2006; Bailliu, 2000; Hermes & Lensink, 2003). Thus, financial development can serve as an incentive for increased energy substitution (which reduces energy consumption), while at the same time affording

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lending capital to the energy industry (which increases energy consumption). Based on these two different viewpoints, the effect of financial development on energy consumption is ambiguous. Sadorsky (2010, p.2529) also makes the same argument, noting that "there is an ambiguity as to what effect, if any financial development has on the demand for energy." However, few studies have attempted to investigate the effect of financial development on energy consumption through empirical analyses.

In empirical studies, most studies investigating energy demand in emerging economies have focused on the relationship between energy consumption and income. Although there is no strong consensus for the directionality of the relationship, Karanfil (2009) suggests adding potentially important variables such as financial development, because this potentially could impact the demand for energy. To date, however, knowledge about the relationship between financial development and energy demand can be obtained from few studies (Islam, Shahbaz, Ahmed, & Alam, 2013; Sadorsky, 2010; Shahbaz, Islam, & Butt, 2011a).

Previous studies have utilized different econometric approaches to test the relationship between financial development and energy consumption, such as a linear dynamic panel model (Sadorsky, 2010), autoregressive distributed lag (ARDL) bounds (Shahbaz, Islam, & Butt, 2011a), and Granger causality (Islam et al., 2013). Some studies found a positive relationship between financial development and energy consumption (Shahbaz, Islam, & Islam, 2010), whereas other studies did not (Islam et al., 2013). Regarding the lack of consensus, this paper suspects that it may involve whether: (a) previous studies have ignored heterogeneity across countries; or (b) the effect of financial development on energy consumption depends on levels of income. If there is heterogeneity across countries, ignoring such heterogeneity may lead to lack of a clear consensus on the relationship between energy consumption and financial development. Although Sadorsky's (2010) study uses a panel data model to consider heterogeneity across countries, the existence of a nonlinearity problem is ignored (there is estimation bias if the model ignores the existence of nonlinear problems). To address this gap, this paper uses a panel data set from 1999 to 2008 that includes 53 countries, and constructs a nonlinear model with threshold effects to reexamine the effect of financial development on energy consumption. From an econometric perspective, the panel threshold regression approach is preferable to other linear models due to heterogeneity across countries.

More specifically, a threshold regression developed by Hansen (1999) that explicitly deals with nonlinear relationship and heterogeneity issues is applied to examine the impacts of financial development and income on energy consumption for a group of 53 countries covering the period from 1998 to 2008. This paper uses several alternative measures of financial development. In so doing, it not only can more fully understand the effect of financial development and income on energy demand, but also can detect simultaneously whether a nonlinear effect is present. In addition (and addressing the second possible cause of the lack of consensus outlined above), this paper estimates the marginal effect of financial development and income on energy consumption in different regimes.[1]

We set out to achieve the following goals: (1) to test whether there are linear and nonlinear effects of financial development and income on energy consumption; (2) to show the relationship between each of the financial development indicators, gross domestic product (GDP) per capita, and energy consumption using scatter plots; and (3) to estimate the marginal impact of financial development and income on energy consumption in these different regimes. The present paper differs from previous studies in two ways: (1) This paper mainly focuses on the effects of financial development and GDP per capita on energy consumption, rather than on the bidirectional causality among these three variables; (2) This paper uses threshold effects to capture the non-monotonic relationship between financial development, GDP per capita, and energy consumption.

2. Review of the literature

2.1. The nexus between energy consumption and economic growth

The issue of energy consumption mainly focuses on the relationship between energy and income. Kalyoncu, Gürsoy, and Göcen (2013) recently reviewed the energy-growth nexus, and identified three prevailing viewpoints on this issue. The first view states that energy is an input of production, and thus forms a causality running from energy consumption to economic growth (Stern & Cleveland, 2004). A second view states that causality runs in the opposite direction – economic growth influences energy consumption (Aziz, 2011; Toman & Jemelkova, 2003). The third view is that the relationship is bidirectional – economic development affects energy consumption, and vice versa (Aziz, 2011). Most previous studies have focused on the causal relationship within bivariate time series. These studies ignore several important factors of energy consumption (such as financial development and the previous level of energy consumption), as well as the specific characteristics across countries, and thus have failed to identify any consensus in the energy-growth correlation.

One recent study has considered specific characteristics across countries, dividing these countries into three groups: low income, lower middle income, and upper middle income. Öztürk, Aslan, and Kalyoncu (2010) have ascertained that there is long-run Granger causality running from GDP to energy consumption in low-income countries, and bidirectional causality between energy consumption and GDP for middle-income countries. Although Öztürk et al. (2010) considered a panel dataset, they focused on a bivariate causality correlation, which excludes other factors that affect energy consumption such as financial development, the previous level of energy consumption, and energy prices. Lee and Chiu (2013) used 24 OECD countries and built a non-linear model of energy demand by using a smooth transition regression model with an error-correction term. To fill the gap in research on this subject, the present paper adds additional explanatory variables, and uses a panel dataset as well as the most appropriate econometric model to determine whether energy consumption is influenced by GDP per capita. Baltagi (2005, p. 7) pointed out that the advantages of panel data are "more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency."

[1] As discussed in greater detail below, this paper identifies two regimes (high income and non-high income) of influence of financial development and income on energy consumption.