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The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis

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ABSTRACT

This study investigates the relationship between energy use and economic growth by incorporating financial development, international trade and capital as important factors of production function in case of China over the period of 1971–2011. The ARDL bounds testing approach to cointegration was applied to examine long run relationship among the series while stationarity properties of the variables was tested by applying structural break test.

Our empirical evidence confirmed long run relationship among the variables. The results showed that energy use, financial development, capital, exports, imports and international trade have positive impact on economic growth. The Granger causality analysis revealed that unidirectional causal relationship running from energy use to economic growth. Financial development and energy use Granger cause each other. There is bidirectional causality between international trade and energy use. The feedback relation exists between financial development and international trade. There is also bidirectional causality exists between capital and energy demand, financial development and economic growth and, international trade and economic growth. This paper makes significant contribution in energy economics and opens up new direction for policy makers to explore new and alternative sources of energy which would be helpful in meeting the rising demand of energy due to sustained rate of economic growth.

1. Introduction

The relationship between output and energy use has drawn much research interest in recent years perhaps due to increased awareness of greenhouse gas emission (GHG) and its impact on sustainable environment. Despite the emergence of a bourgeoning literature on the topic, consensus remains elusive because results are often based on ad hoc approach compounded by omitted variables bias (see Akarca and Long, 1980; Yu and Hwang, 1984; Yu and Jin, 1992). It is against this backdrop that more recent studies have adopted multivariate approach by including capital and labor, inter alia (Shahbaz et al., 2012; Stern, 1993, 2000).

The emerging and developing economies have been experiencing remarkable rates of growth in international trade with a concomitant increase in energy use, raising the specter of gloomy future of GHG. This has raised interest in the underlying dynamics between energy demand and GDP (see Ozturk, 2010); and between international trade and economic growth (see Cuadros et al., 2004; Dritsaki et al., 2004; Giles and Williams, 2000). Knowledge of the relation is important to policy makers for several reasons. If energy use Granger causes output, energy conservation, unrelated to technological change, can have adverse impact on the former (Karanfil, 2009). If energy use Granger causes exports/imports, any reduction in energy use due to say, energy conservation polices may lower potential benefits from trade. Again, if conservation policies lower energy use then trade led-growth might not seem to work. If unidirectional Granger causality runs from exports or imports to energy use then conservation policies will have unfavorable effect on trade liberalization policies which may ultimately retard economic growth.

Narayan and Smyth (2009) and Lean and Smyth (2010a,b) appear to be the only published papers which aims at the relationship between energy demand and exports. It is now clear that exclusion of a relevant variable(s) not only makes the estimates inconsistent and biased, but also produces 'no-causality' (Lütkepohl, 1982). Even the direction of causality changed for some African nations, once capital and labor were included (Wolde-Rufael, 2009). Empirical models

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that are grounded in sound theory produce better outcomes. Contemporary research also shows that the financial development directly impacts energy use and productivity (Shahbaz, 2012; Shahbaz and Lean, 2012b). Thus, inclusion of both financial development and trade along with labor and capital appears well justified on theoretical grounds. The framework used here is based on a conventional energy demand model.

The long-run relationship and the direction of causality results are different in different countries. Studies conducted in same country may produce different result (see Karanfil, 2009; Payne, 2010) due to country-specific conditions and methodological differences. Results may also vary due to omitted variable bias or due to absence of inputs substitution possibilities (Akinlo, 2008; Ghali and El-Sakka, 2004; Stern and Cleveland, 2004). Using Australia data from 1960 to 1999, Fatai et al. (2004) found cointegration between energy use and electricity consumption; and unidirectional causality from output to electricity consumption. Narayan and Smyth (2005) found cointegration between electricity consumption, employment, and real income; and long-run causality from employment and real income to electricity consumption. Narayan and Prasad (2008) used a bivariate model and showed that long-run causality runs from electricity consumption to output. These findings however, differ from the results of Chontanawat et al. (2008), who did not find cointegration between per-capita energy use and per-capita GDP in Australia for a sample of 1960–2000. To avoid potential omitted-variable bias in the above mentioned papers, Yuan et al. (2008) applied neo-classical production function to investigate causality between energy use and economic growth by incorporating capital and labor in case of China. Their empirical exercise found unidirectional causality running from energy use to economic growth. Wang et al. (2011) reported that energy demand, capital and employment Granger cause economic growth. You (2012) opined that clean and renewable energy use stimulates economic growth. On contrary, Zhang and Xu (2012) found causality is running from energy use to economic growth. Furthermore, Shuyun and Donghua (2011) supported the feedback hypothesis between energy use and economic growth and the same inference is reported by Soile (2012) in case of Indonesia.

Clearly, there is a lack of consensus on the causality between energy use and income that points to the need for further research. The current study can be considered as a modest attempt to provide further evidence by using a theoretically more justified model to complement some of the existing research to better understand the underlying dynamics. This is main motivation for authors to fill gap research in case of China. The findings are expected to help craft appropriate economic, energy/environment, financial and trade policies to sustain economic growth in China.

The objective of the paper is to use production function approach to explain the relationship between energy use and economic growth (Stern, 1993, 2000) where GDP depends on energy use, capital and others inputs such as financial development and international trade. The extended Cobb–Douglas production framework helps us to explore a long run relation among the variables: energy use, economic growth, capital, financial development and international trade. The variables are chosen to capture the particular characteristics of Chinese economy. For a long run relation we implement the Autoregressive Distributed Lag (ARDL) and the Johansen Juselius approaches to cointegration, and the vector error correction model (VECM) for short run dynamics. The study period 1971–2011 is relatively long and hallmarked by major changes in the global landscape. These events may potentially cause structural break in the time series. In testing for the stationarity properties, this factor has been taken into account. The paper contributes by taking a comprehensive approach to examine the energy-economic growth nexus for China within a theoretically justified model that has not been done so far.

The rest of the paper is organized as follows. Section 2 provides brief overview of Chinese economy. Section 3 reviews the relevant literature; Section 4 describes the methodological framework and data sources; Section 5 reports and analyses the results and, Section 6 offers concluding remarks with policy implications.

2. An overview of Chinese economy

China has maintained rapid economic growth for the last three decades and the average annual income growth in the recent years has been 9%. As a growing economy, China has experienced in rapid development of its industries, especially the energy intensive industries. The energy demand has increased tremendously in the last decades. According to U.S. Energy Information Administration (2011), currently China is the second largest energy consumer behind the United States, with a total energy use of 85 quadrillion British thermal units. A 71% of the total energy use is supplied by coal, which is followed by oil (19%), hydroelectric sources (6%), natural gas (3%), nuclear power (1%), and other renewable (0.2%) respectively. Furthermore, China is also one of the biggest energy producers in the world. The country has recoverable reserves of 176.8 billion tons of coal, 21.2 billion tons of crude oil, 14.3 billion tons of non-conventional oil, 22.03 trillion cubic meters of natural gas, and 400 GW of hydropower (Wang et al., 2011).

China has significant influence in the world's energy sector as its energy use as well as production is very high in the world energy market. China is the second largest oil consumer after the United States. China is both the largest consumer and the largest producer of coal in the world. The tremendous amount of fossil fuels used in energy use also makes China the number one source of GHG emissions in the world, causing serious environmental concerns both domestically and internationally. Environmental issues should be major factor influencing future energy development and use in China. China already is experiencing serious environmental problems that are caused by energy activities, especially air pollution from industrial, transportation, and residential fuels combustion. As economic development in China continues, environmental problems in general will worsen with the projected rapid increases in energy demand. The Chinese government recognized the fact that energy consumption has to be brought under control to achieve sustainable growth with an ever increasing energy demand. The 11th Five-Year Plan has called on the nation to reduce energy intensity by 20% in the next 5 years.

Since the introduction of opening-up policy and reforms in 1978, Chinese financial sector has experienced significant development. The commercial banking, stock markets system and new regulatory bodies were established. Stock markets were introduced in China in 1990, even though the role of stock and bond markets is still rather limited, one being in Shanghai and another one being in Shenzhen. However, the banking sectors contribute to the major share of financial transactions in China. Thus it seems reasonable when analyze finance-growth nexus to focus our attention on banks, which have the biggest share in financial sector. Debt market in China, though developing, is still relatively narrow, segmented and lacking liquidity. The first unofficial bond markets began to develop in the 1980s. The government began to regularize the bond market in the early 1990s. Trading of government bonds was launched on the interbank market in 1997. The corporate bond market was reserved for several selected state owned enterprises and remained very small. In sum, the banking sector plays the biggest role in the Chinese financial sector which possibly has the strongest connection with economic growth.

International trade expansion has been one of the most phenomenal developments of China's economy in the era of systemic reform and opening up to the world market which began in 1978. Trade-to-GDP ratio rose remarkably over the last two decades. China's has trade surplus with its trading partners over the last decade. Net export has an effect on money supply in the domestic credit market and, as a result, could indirectly affect output in the private sectors. From our discussion of the Chinese economy, we can see that trade openness, economic growth, energy use and financial development are dynamically interrelated.