The Dynamic Link 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 consumption 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 consumption, 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 consumption to economic growth. Financial development and energy consumption Granger cause each other. There is bidirectional causality between trade and energy consumption. The feedback relation exists between financial development and international trade. There is also bidirectional causality exists between capital and energy consumption, financial development and economic growth and, international trade and economic growth. This paper makes significant contribution in energy literature and opens up new direction for policy makers to explore new and alternative sources of energy to meet the rising demand of energy due to sustained rate of economic growth.

Keywords: Growth, Energy, Financial Development, Trade

Introduction

The relationship between output and energy consumption 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 (Stern, 1993, 2000).

The emerging and developing economies have been experiencing remarkable rates of growth in the 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 consumption and GDP (see Ozturk, 2010); and between trade and economic growth (see Giles and Williams, 2000; Dritsaki et al. 2004; Cuadros et al. 2004). Knowledge of the relation is important to policy makers for several reasons. If consumption of energy Granger causes output, energy conservation, unrelated to technological change, can have adverse impact on the former (Karanfil, 2009). If energy consumption 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, 2010b) appear to be the only published papers which aims at the relationship between energy consumption 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 that are grounded in sound theory produce better outcomes. Contemporary research also shows that the financial development directly impacts energy use and productivity (Shahbaz and Lean, 2012b; Shahbaz, 2012). 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 can differ by country. Studies conducted in same country may produce different result (see Karanfil, 2009; Payne, 2010) due to country-specific conditions, 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 1960-1999, 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 consumption and economic growth by incorporating capital and labor in case of China. Their empirical exercise found unidirectional causality running from energy consumption to economic growth. Wang et al. (2011) reported that energy consumption, capital and employment Granger cause economic growth. You (2011) opined that clean and renewable energy consumption stimulates economic growth. On contrary, Zhang and Xu (2012) found causality is running from energy consumption to economic growth. Furthermore, Shuyun and Donghua (2011) supported the feedback hypothesis between energy consumption and economic growth.

Clearly, there is a lack of consensus on the causality between energy consumption 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. The findings are expected to help craft appropriate energy/environment policies.

The objective of the paper is to use production function approach to explain the relationship between energy consumption 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 reviews the relevant literature; section 3 describes the methodological framework and data sources; section 4 reports and analyses the results and section 5 offers concluding remarks with policy implications.

1. Literature Review

Much of the studies on the link between economic growth and energy consumption, financial development and trade are carried on a piecemeal basis without a comprehensive model in mind and thus ignore the potential interaction among the series. Many macroeconomic series are often affected by permanent exogenous shocks which can create structural breaks and disrupt important relationship which can produce misleading results. Thus this paper reviews the literature under three subsections, e.g. (a) economic growth and energy consumption; (b) financial development and energy consumption (c) international trade and energy consumption. We discuss them in turn below.

2.1 Economic Growth and Energy Consumption

Four hypotheses can be identified to describe energy-growth nexus: growth hypothesis; conservation hypothesis; feedback hypothesis; and neutrality hypothesis. The growth hypothesis regards energy use vital for economic growth. A reduction in energy use lowers GDP -the economy is energy dependent. Under the conservation hypothesis, unidirectional causality runs from economic growth to energy use. So, policy to reduce energy consumption may not have much impact on economic growth. The feedback hypothesis assumes bi-directional causality - energy consumption and economic growth affect each other. In neutrality hypothesis lower energy consumption does not affect economic growth, and vice versa (Belke et al. 2011).

Kraft and Kraft, (1978) were the first study on the growth-energy nexus. Using US data from 1947 to 1974 they found unidirectional causality from GNP growth to energy consumption. However, using the same data set but from 1947-1972, Akarca and Long, (1980) did not find any link. They argue that inclusion 1973-1974 data can contaminate the series due to the effect of oil embargo. Erol and Yu (1988) used data from six industrialized countries and with a sample of 1952-1982. They found bidirectional causality for Japan, unidirectional causality from energy to economic growth for Canada, from economic growth to energy for Germany and Italy, and none for France and England. Masih and Masih, (1996) found causality from energy consumption to economic growth in India, and from economic growth to energy consumption in Pakistan and Indonesia, but none for Malaysia, Singapore and the Philippines. Soytas and Sari, (2003) found that economic growth Granger causes energy use in Italy and Korea, and unidirectional causality runs from energy use to economic growth in France, Germany, Japan and Turkey. Huang et al. (2008) found no causality between energy consumption and economic growth for low-income countries, but found unidirectional causality from economic growth to energy consumption for middle and high-income countries as did Aqeel and Butt, (2001); Shahbaz and Lean, (2012a); Shahbaz and Feridun, (2012) for Pakistan; Lee, (2006) for France, Italy and Japan, and Lee and Chien, (2010) for France and Japan. The reverse causality is reported by Lee, (2006) for Canada, UK, Germany Sweden, and Switzerland; Narayan and Smyth, (2008) for G-7 countries, Bowden and Payne, (2009) for the US. The lack of consensus in these papers can be due to methodological differences, use of different time periods, country heterogeneity in climate, different stages of economic growth and energy use patterns.

2.2 Financial development and energy consumption

Financial development includes increases in the flow of FDI, improved stock market and banking activities and favorable reforms; and domestic credit to private sector. Financial infrastructure can enhance economic growth and affect the demand for energy (Sadorsky, 2010, 2011; and Shahbaz and Lean, 2012b). Financial development lowers CO_2 emissions (Tamazian et al., 2009). Sadorsky, (2011a) pointed out that financial development improves access to financial resources that boosts demand for big ticket items and add to energy consumption which also have indirect positive impact to boost business activity. The overall effect is to raise energy demand.

Following Karanfil, (2009); Dan and Lijun, (2009) examined the effect of financial development on primary energy consumption in Guangdong, China. They found unidirectional causality from energy consumption to financial development. Sadorsky, (2010) also examined 22 emerging economies between 1990 and 2006 using different indicators of financial development. He found a small but positive effect of energy on economic growth. Shahbaz and Lean, (2012b) found that financial development boosts energy consumption through stock market development and that the two Granger cause each other, but the former dominates the later in Pakistan. Islam et al. (2013) found causality from financial development to energy consumption in Malaysia.

Financial development promotes economic growth by increasing efficiency (Xu, 2000; Bell and Rousseau, 2001). Improved financial development facilitates savings, borrowing and investment. With low borrowing cost, consumers tend to buy consumer durables which add to energy demand (Sadorsky, 2011b). Islam et al. (2013) argue that financial development facilitates the purchase of energy efficient appliances which lowers energy use. Mielnik and Goldemberg, (2002) found inverse relationship between FDI and energy intensity. Further evidence may help resolve the ongoing debate.

2.3 International trade and energy consumption

The relationship between international trade and energy consumption has been investigated by various researchers. For example, Narayan and Smyth, (2009) used multivariate Granger causality approach to investigate causal relationship between energy consumption, exports and economic growth in case of Middle Eastern countries[1]. Their empirical exercise did not show any relationship between exports energy consumption. Erkan et al. (2010) examined the relationship between energy consumption and exports in case of Turkey. They applied Johansen-Juselius cointegration approach and the VECM Granger causality approaches for long run and causal relationship between the variables respectively. Their results showed cointegration between exports and energy consumption while energy consumption Granger causes exports.

Similarly, in case of Malaysia, (Lean and Smyth, 2010a, b) reported that exports and energy consumption (energy generation) do not seem to Granger cause each other.

Sami, (2011) used data of Japan to investigate the impact of exports on energy consumption by incorporating income per capita in energy demand function. The empirical analysis indicated cointegration between the variables and the VECM Granger causality confirmed unidirectional causality running from exports and economic growth to energy consumption. Sultan, (2011) also investigated the relationship between aggregate output, exports and energy consumption in case of Mauritius. The results reported that variables are cointegrated and energy consumption and exports Granger cause economic growth. Sadorsky, (2011b) used panel cointegration data estimation techniques for the period of 1980-2007 in case of Middle East[2]. He found short-run dynamics of Granger causality from exports to energy consumption, and a bi-directional feedback relationship between imports and energy consumption. The long run positive effects of both exports and imports on energy consumption were also observed. Using Turkish data, Halicioglu, (2011) investigated the causal relationship between economic growth, exports and energy consumption using multivariate Granger causality approach. The results showed long run relationship between the variables and unidirectional causality from exports to energy consumption in short run.

Hossain, (2012) applied multivariate Granger causality approach to examine causal relationship between economic growth, exports, remittances and energy consumption using the data of SAARC countries[3]. The results of Johansen Fisher panel cointegration approach confirmed cointegration between the series and neutrality effect found between exports and energy consumption. Sadorsky, (2012) also confirms the long run relationships between energy and exports; energy and imports; and energy and trade (exports and imports) using data of 7 South American countries[4]. For the short run dynamics, feedback relationship between energy consumption and exports, and energy consumption Granger causes imports is also revealed. In case of Pakistan, Shahbaz et al. (2013) reinvestigated relationship between energy consumption and economic growth by incorporating exports in energy demand function. They applied the ARDL bounds testing for long run and innovative accounting approach for causal relationship between the variables. Their results indicated that variables are cointegrated and energy consumption Granger causes exports.

2. Data and Methodological Framework

To investigate a long run relation between energy consumption and economic growth in case of China, the following Cobb-Douglas production function is employed:

$$G = AE^{\alpha_1} K^{\alpha_2} L^{\alpha_3} e^{u} \qquad (1)$$

where, G is real domestic output; E , K and L denote respectively, energy, capital and labor. The term A refers to technology and e the error term assumed *N(iid).* The output elasticity with respect to energy consumption, capital and labor is α_1, α_2 and α_3 respectively. When Cobb-Douglas technology is restricted to $(\alpha_1 + \alpha_2 + \alpha_3 = 1)$ we get constant returns to scale. In the model we allow technology to be endogenously determined by level of financial development and international trade within an extended Cobb-Douglas production function[5]. Financial development promotes economic growth via capital formation in making its efficient use;

encourages FDI inflow and transfer of superior technology and managerial skill. Entrepreneurs are the main actors in a free market who are the force behind innovation and technological progress. International trade helps technological advancements and its diffusion. The model thus can be written as:

$$A(t) = \phi.TR(t)^{\alpha} F(t)^{\delta} \tag{2}$$

Where ϕ is time-invariant constant, TR is indicator of trade openness and F is financial development[6]. Substituting equation-2 into equation-1:

$$G(t) = \phi.E(t)^{\delta_1} F(t)^{\delta_2} TR(t)^{\delta_3} K(t)^{\beta} L(t)^{1-\beta} \tag{3}$$

Following Lean and Smyth, (2010a); Shahbaz and Lean, (2012b) we divide both sides by population and get each series in per capita terms; but leave the impact of labor constant. By taking log, the linearized Cobb-Douglas production function is:

$$\ln G_t = \beta_1 + \beta_E \ln E_t + \beta_F \ln F_t + \beta_{TR} \ln TR_t + \beta_K \ln K_t + \mu_t \tag{4}$$

where, $\ln G_t$, $\ln E_t$, $\ln F_t$, $\ln TR_t$ and $\ln K_t$ represent real GDP, energy consumption, real domestic credit to private sector as a proxy for financial development, real trade openness and real capital use, respectively, each transformed into logarithm and expressed in per capita terms. In this paper we use three different indicators of trade openness in per capita terms; real exports, real imports, and real trade[7], which are then, estimated as separate equations. The term μ_t is a random error term. The specification also captures the relationship between energy use and economic growth where technology takes effect through financial development and international trade.

Prior to testing for cointegration, we check for stationarity of each series[8]. The study period is characterized by major changes in the global landscape which can potentially cause structural breaks. We check the stationarity properties using ADF with intercept and trend keeping in mind that such test is not appropriate in the presence of structural break in the series. So we apply the Zivot-Andrews (ZA) (1992) and Clemente et al. (1998) unit root tests to identify structural break. The former is used in one structural break; and latter in two breaks in the series. The Clemente et al. (1998) test has more power compared to the ZA (1992) test.

We choose the ARDL bounds testing approach in presence of structural break. It has several advantages. First, it is flexible and applies regardless the order of integration. Simulation results show that the approach is superior and provides consistent results for small sample (Pesaran and Shin, 1999). Moreover, a dynamic unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. The UECM integrates the short run dynamics with the long run equilibrium without losing any long run information. For estimation purposes, the following the ARDL model is used:

$$\begin{aligned}\Delta \ln G_t &= \alpha_1 + \alpha_T T + \alpha_D D + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_{TR} \ln TR_{t-1} + \alpha_K \ln K_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \ln G_{t-i} \\ &+ \sum_{j=0}^{q} \alpha_j \Delta \ln E_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \alpha_l \Delta \ln TR_{t-l} + \sum_{m=0}^{t} \alpha_m \Delta \ln K_{t-m} + \mu_t \end{aligned} \quad (5)$$

$$\Delta \ln E_t = \alpha_1 + \alpha_T T + \alpha_D D + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_{TR} \ln TR_{t-1} + \alpha_K \ln K_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \ln E_{t-i} + \sum_{j=0}^{q} \beta_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \beta_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \beta_l \Delta \ln TR_{t-l} + \sum_{m=0}^{t} \beta_m \Delta \ln K_{t-l} + \mu_t \quad (6)$$

$$\Delta \ln F_t = \alpha_1 + \alpha_T T + \alpha_D D + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_{TR} \ln TR_{t-1} + \alpha_K \ln K_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \ln F_{t-i} + \sum_{j=0}^{q} \beta_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \beta_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \beta_l \Delta \ln TR_{t-l} + \sum_{m=0}^{t} \beta_m \Delta \ln K_{t-m} + \mu_t \quad (7)$$

$$\Delta \ln TR = \alpha_1 + \alpha_T T + \alpha_D D + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_{TR} \ln TR_{t-1} + \alpha_K \ln K_{t-1} + \sum_{i=1}^{p} \vartheta_i \Delta \ln TR_{t-i} + \sum_{j=0}^{q} \vartheta_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \vartheta_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \vartheta_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \vartheta_m \Delta \ln K_{t-m} + \mu_t \quad (8)$$

$$\Delta \ln K_t = \alpha_1 + \alpha_T T + \alpha_D D + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_{TR} \ln TR_{t-1} + \alpha_K \ln K_{t-1} + \sum_{i=1}^{p} \rho_i \Delta \ln K_{t-i} + \sum_{j=0}^{q} \rho_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \rho_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \rho_m \Delta \ln TR_{t-m} + \mu_t \quad (9)$$

Where, Δ is difference operator, T is time trend and D indicates the structural break point based on findings of ZA (1992) test. Testing cointegration involves comparing the computed F-statistic with the critical bounds generated by Pesaran et al. (2001) - the upper critical bound (UCB) and lower critical bound (LCB). The null hypothesis $H_0 : \alpha_G = \alpha_E = \alpha_F = \alpha_{TR} = \alpha_K = 0$ of no cointegration is tested against the alternate $H_1 : \alpha_G \neq \alpha_E \neq \alpha_F \neq \alpha_{TR} \neq \alpha_K \neq 0$ of cointegration[9]. The series are cointegrated if the computed F-statistic exceeds the UCB; and not cointegrated if the computed F-statistic lies below the LCB. If computed F-statistic falls between the UCB and

LCB, the test is uncertain[10]. We use the critical bounds from Narayan (2005), which are more appropriate for small sample, 45 in this case, compared to Pesaran et al. (2001)[11]. The parameter stability is checked by applying the CUSUM and $CUSUM_{SQ}$ tests proposed by Brown et al. (1975).

For the long run relation among the series we use the following equation:

$$\ln G_t = \theta_0 + \theta_1 \ln E_t + \theta_2 \ln F_t + \theta_3 \ln TR_t + \theta_4 \ln K_t + \mu_i \qquad (10)$$

where, $\theta_0 = -\beta_1 / \alpha_G, \theta_1 = -\alpha_E / \beta_1, \theta_2 = -\alpha_F / \beta_1, \theta_3 = -\alpha_{TR} / \beta_1, \theta_4 = -\alpha_K / \beta_1$ and μ_t is error term assumed to be normally distributed. Once the long run relationship is established among the series, we test the direction of causality using the following error correction representation[1]:

$$(1-L)\begin{bmatrix} \ln G_t \\ \ln E_t \\ \ln F_t \\ \ln TR_t \\ \ln L_K \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} b_{11i}b_{12i}b_{13i}b_{14i}b_{15i} \\ b_{21i}b_{22i}b_{23i}b_{24i}b_{25i} \\ b_{31i}b_{32i}b_{33i}b_{34i}b_{35i} \\ b_{41i}b_{42i}b_{43i}b_{44i}b_{45i} \\ b_{51i}b_{52i}b_{53i}b_{54i}b_{55i} \end{bmatrix} \times \begin{bmatrix} \ln G_{t-1} \\ \ln E_{t-1} \\ \ln F_{t-1} \\ \ln TR_{t-1} \\ \ln K_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha \\ \beta \\ \delta \\ \phi \\ \varphi \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix} \qquad (11)$$

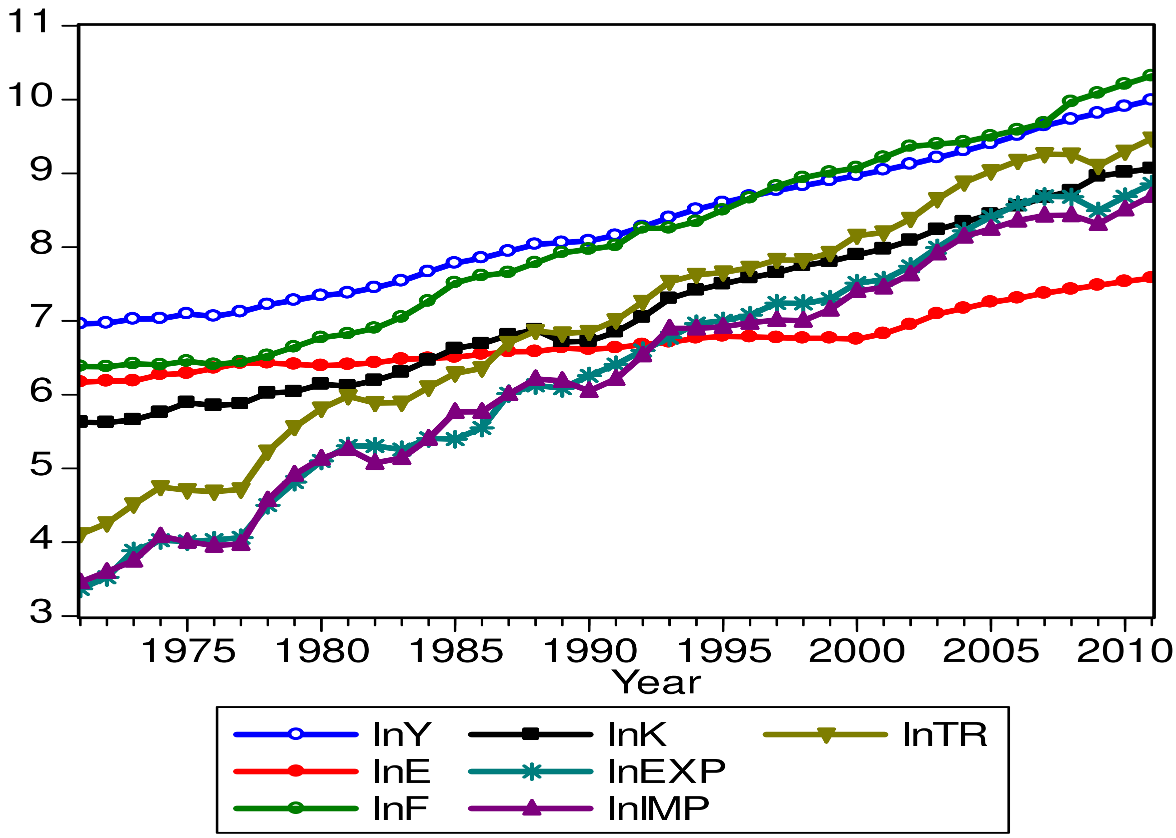
where, $(1-L)$ is the lag operator and ECT_{t-1} is the lagged residual obtained from the long run ARDL relationship; $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$, and ε_{5t} are error terms assumed to be N($0, \sigma$,). A long run causality requires a significant t-statistic on the coefficient of ECT_{t-1}. A significant F-statistic on

[1] If cointegration is not detected, the causality test is performed without an error correction term (*ECT*).

the first differences of the variables suggests short run causality. Additionally, joint long-and-short runs causal relationship can be estimated by joint significance of both ECT_{t-1} and the estimate of lagged independent variables. For instance, $b_{12,i} \neq 0 \forall_i$ shows that energy consumption Granger-causes economic growth while causality runs from economic growth to energy consumption is indicated by $b_{21,i} \neq 0 \forall_i$.

Data used in the paper are annual from 1971 to 2011, taken from the World Development Indicators (WDI-CD-ROM, 2012). The variables are real GDP, energy consumption (kg of oil equivalent), real domestic credit to private sector, real exports, real imports and real capital stock; each in per capita terms.

Figure-1: Trends of Variables in China



3. Results and their Discussions

Primarily we applied ADF and P-P unit root tests to test the integrating properties of the variables in our study. The in formation about stationarity properties of the variables is prerequisite to apply the ARDL bounds testing approach to investigate long run relationship between the variables as well as to avoid the spurious of the results. The main assumption of the ARDL bounds testing is that variables should be stationary at level or 1st difference or variables have mixed order of integration such as I(0) / I(1). In doing so, we applied ADF and P-P unit root tests with intercept and trend. The results are reported in Table-1 reveal that all the variables show unit root problem at level. All the series are stationary at 1st difference. This implies that variables are integrated at I(1). The ADF and P-P unit root tests have been criticized due to ignoring the information about structural break stemming in the series. This shows that ADF and P-P tests provide biased results. For this purpose, we applied two unit root tests such as Zivot-Andrews, (1992) and Clemente et al. (1998). Former informs about single structural break and latter captures information about two structural breaks stemming in the series. The results of Zivot-Andrews are detailed in Table-2 which shows that non-stationary process is found in all series at level with intercept and trend but variables are found to be stationary at 1st difference. This confirms that energy consumption, economic growth, financial development, capital, exports, imports and international trade are integrated at I(1). The robustness of Zivot-Andrews unit root is confirmed by applying Clemente et al. (1998) and findings are same as indicated by ADF, P-P and Zivot-Andrews unit root tests.

Table-1: Unit Root Analysis

Variable	ADF Unit Root Test		P-P Unit Root Test	
	T. statistic	Prob. value	T. statistic	Prob. value
$\ln Y_t$	-2.8109 (1)	0.2021	-3.1637 (3)	0.1062
$\ln E_t$	-1.1923 (1)	0.8982	-0.6491 (3)	0.9701
$\ln F_t$	-3.1558 (5)	0.1098	-2.6203 (6)	0.3010
$\ln K_t$	-2.3381 (2)	0.4041	-2.4508 (3)	0.3495
$\ln EX_t$	-2.5771 (0)	0.2922	-2.7807 (3)	0.2124
$\ln IM_t$	-2.8674 (2)	0.1839	-2.6115 (6)	0.2571
$\ln TR_t$	-2.7461 (2)	0.2251	2.6020 (3)	0.2815
$\Delta \ln Y_t$	-3.7415 (2)**	0.0315	-4.5881 (3)*	0.0058
$\Delta \ln E_t$	-3.4819 (0)**	0.0555	-3.4989 (3)**	0.0479
$\Delta \ln F_t$	-4.0230 (1)**	0.0162	-4.9221 (3)*	0.0015
$\Delta \ln K_t$	-4.4258 (1)*	0.0059	-4.7242 (3)*	0.0026
$\Delta \ln EX_t$	-5.0742 (1)*	0.0011	-4.7703(3)*	0.0023
$\Delta \ln IM_t$	-5.5128 (1)*	0.0003	-4.6768 (3)*	0.0030
$\Delta \ln TR_t$	-5.2075 (1)*	0.0007	-4.4112 (3)*	0.0060

Note: * and ** indicates significant at 1% and 5% levels of significance. Lag length of variables is shown in small parentheses.

Table-2: Zivot-Andrews Structural Break Trended Unit Root Test

Variable	At Level		At 1st Difference	
	T-statistic	Time Break	T-statistic	Time Break
$\ln E_t$	-3.174 (1)	2002	-4.938 (0)*	1985
$\ln E_t$	-4.226 (1)	2001	-4.668 (2)**	1997
$\ln F_t$	-3.453 (1)	1978	-5.714 (1)*	1984
$\ln K_t$	-3.557 (1)	1990	-4.800 (0)**	1994
$\ln EX_t$	-3.554 (1)	1982	-5.118 (2)*	2005
$\ln IM_t$	-3.373 (1)	1986	-5.763 (2)*	1980
$\ln TR_t$	-4.404 (1)	1988	-5.273 (1)*	1980
Note: * and *** represent significance at 1%, and 10% level respectively. Lag order is shown in parenthesis.				

Armed with information about stationarity, we apply the ARDL bounds testing approach to cointegration in the presence of structural break. The ARDL bounds test is sensitive to lag length. To find the lag order we use the AIC criteria as reported in column-2, Table-4. The dynamic link between the series can be captured if appropriate lag length is used (Lütkepohl, 2006). The results of the ARDL bounds tests are reported in Table-4. As noted, we use critical bounds from Narayan (2005).

Table-3: Clemente-Montanes-Reyes Detrended Structural Break Unit Root Test

Variable	Innovative Outliers				Additive Outlier			
	T-statistic	TB1	TB2	Decision	T-statistic	TB1	TB2	Decision
$\ln Y_t$	-1.105 (2)	1975	1990	Unit Root Exists	-5.990 (2)*	1975	1989	Stationary
$\ln E_t$	-4.438 (3)	1984	2000	Unit Root Exists	-6.719 (3)*	1976	1999	Stationary
$\ln F_t$	-1.223 (3)	1981	1993	Unit Root Exists	-6.227 (3)*	1978	1984	Stationary
$\ln K_t$	-1.798 (1)	1989	2001	Unit Root Exists	-6.148 (3)*	1980	1988	Stationary
$\ln EX_t$	-2.794 (1)	1976	2001	Unit Root Exists	-6.140 (2)*	1976	1980	Stationary
$\ln IM_t$	-3.162 (3)	1976	1998	Unit Root Exists	-6.413 (5)*	1977	1984	Stationary
$\ln TR_t$	-3.106 (2)	1976	1998	Unit Root Exists	-6.407 (2)*	1976	1981	Stationary

Note: * indicates significant at 1% level of significance. Lag length of variables is shown in small parentheses.

Table-4: The Results of ARDL Cointegration Test

Bounds Testing to Cointegration				Diagnostic tests			
Estimated Models	Optimal lag length	Structural Break	F-statistics	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
$F_Y(Y/E,F,K,EX)$	2, 1, 2, 2, 2	2002	7.2941**	2.2434	[1]: 0.0093	[1]: 3.2478	[1]: 1.6007
$F_E(E/Y,F,K,EX)$	2, 2, 2, 2, 2	2001	1.8220	0.1561	[1]: 0.3292	[1]: 0.4765	[1]: 0.8028
$F_F(F/Y,E,K,EX)$	2, 2, 2, 1, 2	1978	8.0444*	0.4161	[1]: 0.0562	[5]: 2.4728	[1]: 0.0696
$F_K(K/Y,E,F,EX)$	2, 2, 2, 2, 2	1990	6.1165**	0.1498	[1]: 0.0001	[2]: 2.753	[1]: 1.8578
$F_{EX}(EX/Y,E,F,K)$	2, 1, 2, 2, 2	1982	12.3520*	0.1804	[1]: 0.0315	[1]: 0.3486	[1]: 0.0010
$F_Y(Y/E,F,K,IM)$	2, 1, 2, 2, 2,	2002	8.7578*	0.6208	[1]: 1.8725	[1]: 2.3047	[1]: 2.0173
$F_E(E/Y,F,K,IM)$	2, 2, 1, 2, 2	2001	3.3118	1.0613	[1]: 0.2524	[1]: 0.4263	[1]: 0.2713
$F_F(F/Y,E,K,IM)$	2, 1, 2, 2, 2	1978	5.2460***	0.8672	[1]: 0.0203	[1]: 0.0606	[4]: 2.6533
$F_K(K/Y,E,F,IM)$	2, 2, 2, 2, 2	1990	8.9007*	5.4387	[4]: 2.0525	[3]: 2.8302	[1]: 1.6490
$F_{IM}(IM/Y,E,F,K)$	2, 1, 2, 2, 2,	1986	11.9215*	1.1679	[1]: 0.3464	[1]: 0.0253	[1]: 1.2456
$F_Y(Y/E,F,K,TR)$	2, 1, 2, 2, 2	2002	7.8188*	0.6608	[1]: 0.1158	[1]: 4.7387	[1]: 2.7790

$F_E(E/Y, F, K, TR)$	2, 2, 2, 2, 2	2001	1.9407	0.2163	[1]: 0.8207	[1]: 0.6020	[1]: 0.4976
$F_F(F/Y, E, K, TR)$	2, 1, 2, 2, 2	1978	5.0635***	0.4053	[1]: 0.0165	[4]: 2.8407	[1]: 0.6402
$F_K(K/Y, E, F, TR)$	2, 2, 2, 2, 2	1990	1.120	0.2671	[1]: 1.5535	[4]: 2.01163	[1]: 0.6148
$F_{TR}(TR/Y, E, F, K)$	2, 1, 2, 2, 2	1988	9.4893*	3.2016	[2]: 2.1182	[4]: 2.5852	[1]: 0.4545
Significant level	Critical values (T= 41)#						
	Lower bounds $I(0)$	Upper bounds $I(1)$					
1 per cent level	6.053	7.458					
5 per cent level	4.450	5.560					
10 per cent level	3.740	4.780					

Note: The asterisks *, ** and *** denote the significant at 1, 5 and 10 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. # Critical values are collected from Narayan (2005).

The results from exports model point four cointegrating vectors once we treated economic growth, financial development, capital and exports as predicted variables. The computed F-statistics exceeds the UCB at 1, 5 and 10 per cent levels respectively. The same inference can be drawn for models when we use imports and trade as indicators of trade openness as well as capital at 1 and 5 per cent levels. This confirms cointegration among economic growth, energy consumption, financial development, international trade and capital in case of China over the period of 1971-2011.

Table-5: Results of Johansen Cointegration Test

Hypothesis	Trace Statistic	Maximum Eigen Value
$Y_t = f(E_t, F_t, K_t, EX_t)$		
$R = 0$	87.2865*	49.8532*
$R \le 1$	37.4333	22.3306
$R \le 2$	15.1026	9.3783
$R \le 3$	5.7242	5.6886
$R \le 4$	0.0355	0.0355
$Y_t = f(E_t, F_t, K_t, IM_t)$		
$R = 0$	94.7030*	49.5783*
$R \le 1$	45.1247	27.5562
$R \le 2$	17.5685	12.0183
$R \le 3$	5.5501	5.4167
$R \le 4$	0.1333	0.1333

$Y_t = f(E_t, F_t, K_t, T_t)$		
R = 0	91.6230*	50.1158*
R ≤ 1	41.5072	25.0084
R ≤ 2	16.4987	11.2792
R ≤ 3	5.2194	5.1718
R ≤ 4	0.0476	0.0476
Note: * shows significant at 1% level of significance.		

We now report the results of Johansen and Juselius, (1990) cointegration test to check the robustness of a long-run relationship. The results in Table-5 confirm one cointegrating vector when we use exports, imports and trade as indicators of international trade. The results are robust. After establishing cointegration among the series we explore the long and short run relationship among energy consumption, financial development, capital and international trade on economic growth in case of China. The results reported in Table-6 show that energy consumption is positively related to economic growth and it is statistically significant at the 1 per cent level. All else constant, a 1 per cent growth in energy consumption is expected to increase economic growth by 0.1849-0.1872 per cent, suggesting that the former plays a role in promoting domestic production of China. The effect of financial development on economic growth is positive and statistically significant at the 1 per cent level. A 1 per cent in increase in financial development raises economic growth on an average by 0.3594 - 0.3755 per cent, ceteris paribus. Financial development plays dominant role to stimulate economic growth. Capital promotes economic growth as theory predicts and the relation is significant at 1 per cent level. The results suggest that a 0.3363-0.3473 per cent economic growth is associated with a 1 percent increase in capital accumulation in the country, on an average all else the same. The results indicate that exports, imports and international trade have positive impact on economic growth and are statistically significant at the 5 and 10 per cent levels, respectively. A 1 (10) and 5 per cent increase in exports, imports and international trade is expected to cause economic growth to go up by 0.0394, 0.0197 and 0.0306 per cent respectively, keeping all else constant. The elasticity of economic growth with respect to export on the highest, almost twice compared to imports and almost 29% higher compared to international trade in China.

Table-6: Long and Short Runs Results

Dependent variable = $\ln Y_t$						
Long Run Analysis						
Variables	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Constant	1.4776*	7.8180	1.3778*	6.8292	1.4052*	7.2233
$\ln E_t$	0.1849*	4.2263	0.1872*	3.9232	0.1869*	4.0672
$\ln F_t$	0.3594*	11.644	0.3755*	11.3209	0.3670*	11.3766
$\ln K_t$	0.3363*	7.4553	0.3473*	7.0385	0.3407*	7.1722
$\ln EX_t$	0.0394*	2.9963	…	…	…	…
$\ln IM_t$	…	…	0.0197***	1.7644	…	…
$\ln TR_t$	…	…	…	…	0.0306**	2.1923
Short Run Analysis						
Variables	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.0185**	2.0388	0.0239**	2.6212	0.0217**	2.3963

$\ln E_t$	0.1279***	1.7826	0.1300***	1.7483	0.1320***	1.8117
$\ln F_t$	0.2549*	4.5729	0.2385*	3.6861	0.2429*	4.0072
$\ln K_t$	0.2598*	7.2848	0.2669*	6.1514	0.2577*	7.0613
$\ln EX_t$	0.0395**	2.3146	…	…	…	…
$\ln IM_t$	…	…	0.0092	0.4411	…	…
$\ln TR_t$	…	…	…	…	0.0264	1.3396
ECM_{t-1}	-0.3828**	-2.1770	-0.3335***	-1.7158	-0.3506***	-1.8715
R^2	0.7564		0.7209		0.5867	
F-statistic	20.4964*		17.0551*		10.7904*	
D. W	1.6208		1.5541		1.7237	
Short Run Diagnostic Tests						
Test	F-statistic	Prob. value	F-statistic	Prob. Value	F-statistic	Prob. value
$\chi^2 NORMAL$	5.9608	0.0507	2.6356	0.2677	4.2401	0.1200
$\chi^2 SERIAL$	1.9849	0.1544	2.3153	0.1157	2.1457	0.1340
$\chi^2 ARCH$	0.2912	0.5927	0.6510	0.4210	0.3583	0.5531
$\chi^2 WHITE$	0.9394	0.5129	1.2267	1.3306	1.1933	0.3366
$\chi^2 REMSAY$	1.8985	0.1375	2.1242	0.1032	2.1316	0.1022
Note: *, ** and *** show significant at 1%, 5% and 10% level of significance respectively.						

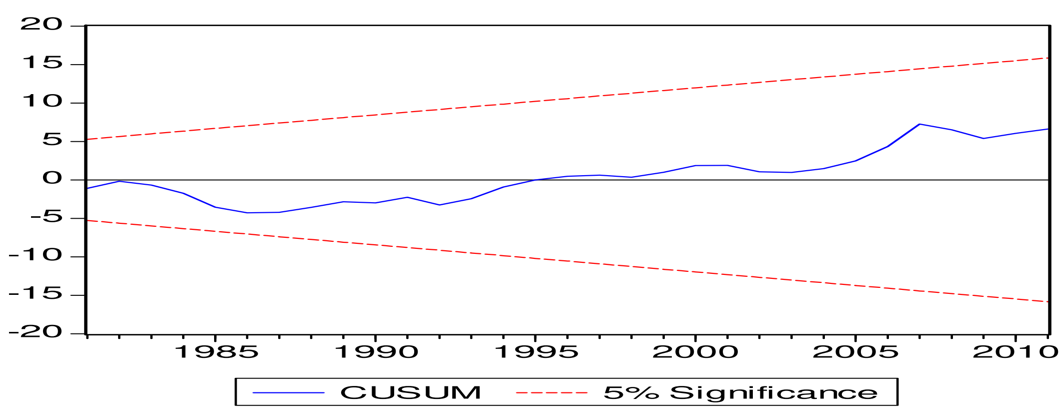
Table-6 also reports short run results. The impact of energy consumption, financial development, capital, exports and international trade on economic growth is positive. It is significant at 10% and 1% levels respectively. A rise in capital is positively linked with economic growth. The effect of imports and international trade though positive, it is statically insignificant while exports has positive and statistically significant effect on economic growth. The negative and statistically significant estimates for each of the ECM_{t-1}, -0.3828, -0.3335 and -0.3506 (for exports, imports and international trade models, respectively) lend support to long run relationship among the series in case of China. The coefficients are all statistically significant at 5 and 10 per cent levels respectively. The short run deviations from the long run equilibrium are corrected by 38.28%, 33.35% and 35.06% towards long run equilibrium path each year. The diagnostic tests show that error terms of short run models are normally distributed; and free of serial correlation, heteroskedasticity, and ARCH problems in all three models. The Ramsey reset test shows that functional form for the short run models are well specified.

The test conducted by the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) suggests stability of the long and short run parameters (Figures 2 – 7). The graphs of CUSUM which confirm stability of parameters (Brown et al. 1975) but and CUSUMsq test does not lie within the 5 per cent critical bounds. The plots of the CUSUMsq of squares statistics are not well within the critical bounds. CUMSUMSQ test will have higher power if the there is a break in the slope coefficients or variance of the error term (Paul Turner, Applied Economics Letters, 2010). Since Chinese economy went through major structural changes over the last two decades, breaks in the slopes are fully justified and thus CUMSUMSQ tests results are outside the bound.

Furthermore, we apply Chow forecast test to examine the significance structural breaks in an economy for the period 1971-2011. Structural breaks are a common problem in macroeconomic series as they are usually affected by exogenous shocks or regime changes. Structural changes in energy policy or economic development, reforms in energy regulation, or institutional developments in 1980's and 1990's in China have certainly affected the macroeconomic series of our study. China adopted an open door policy since 1978. Structural reforms, market incentives, and decentralization policies were introduced to attract foreign investment in the power sector and the sector experienced rapid growth since the late 1980s.The direction, strength, and stability of the relationship among energy consumption, GDP, financial development and trade have occupied central importance in the conduct of energy policy in China. In this study, F-statistics computed in Table-7 suggests that there is no significant structural break in the economy during the sample period. The chow forecast test is more reliable and preferable than graphs (Leow, 2004). This confirms that the ARDL estimates are reliable and efficient.

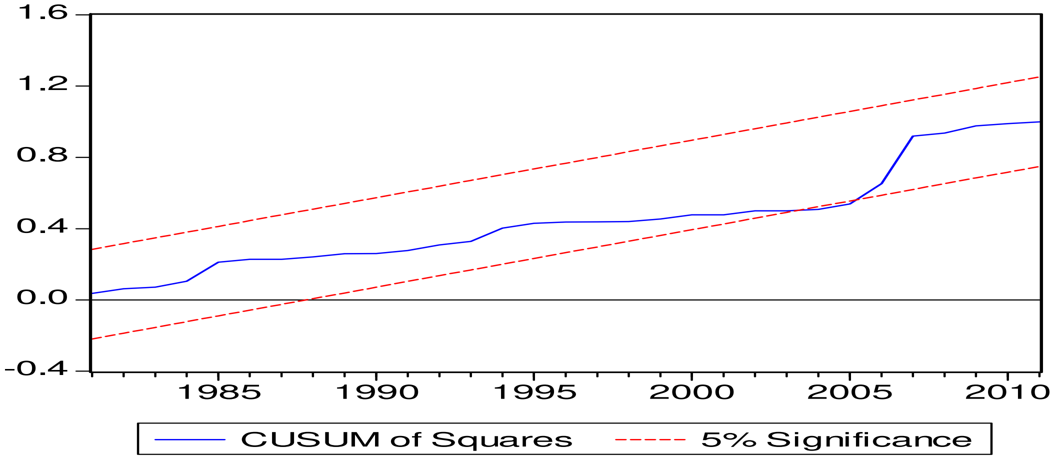
I. Exports Model

Figure-2: Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

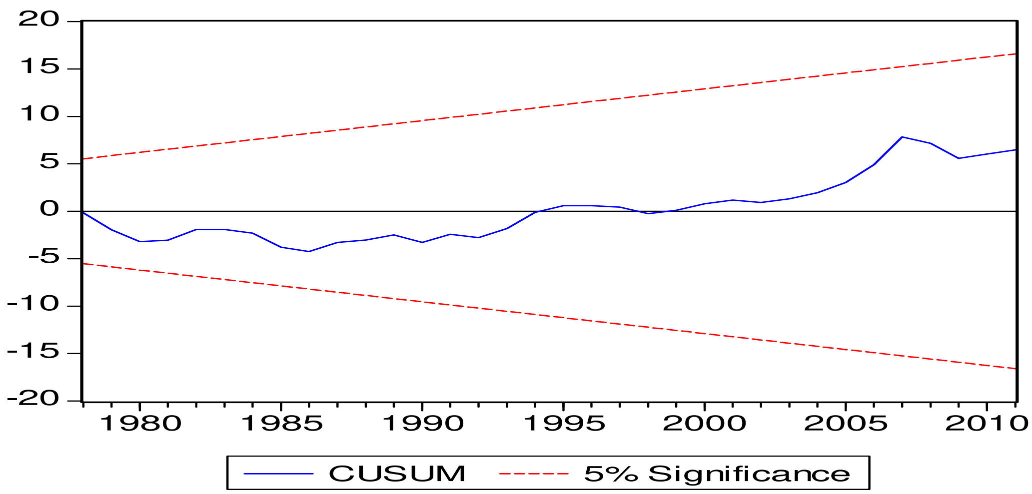
Figure-3: Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

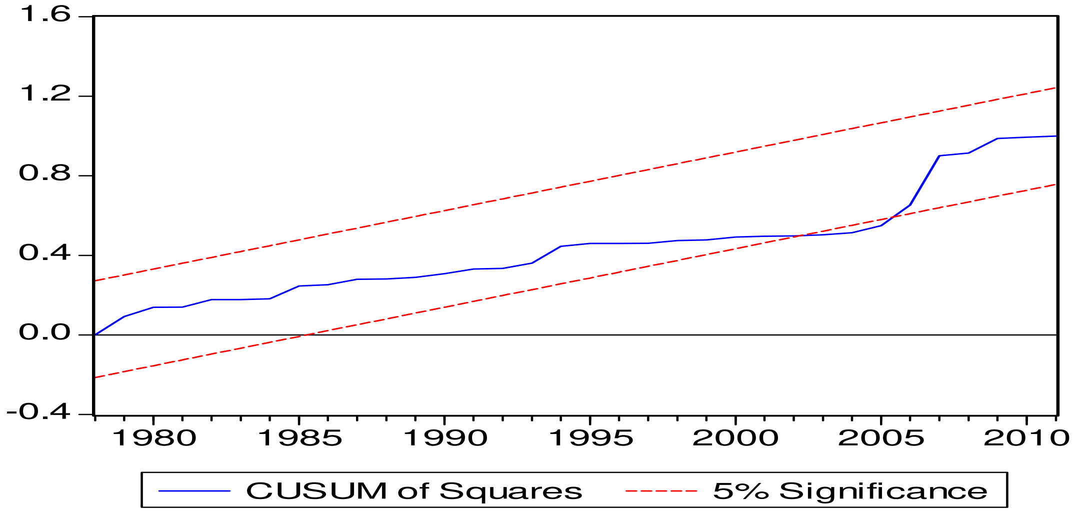
II. Imports Model

Figure-4: Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

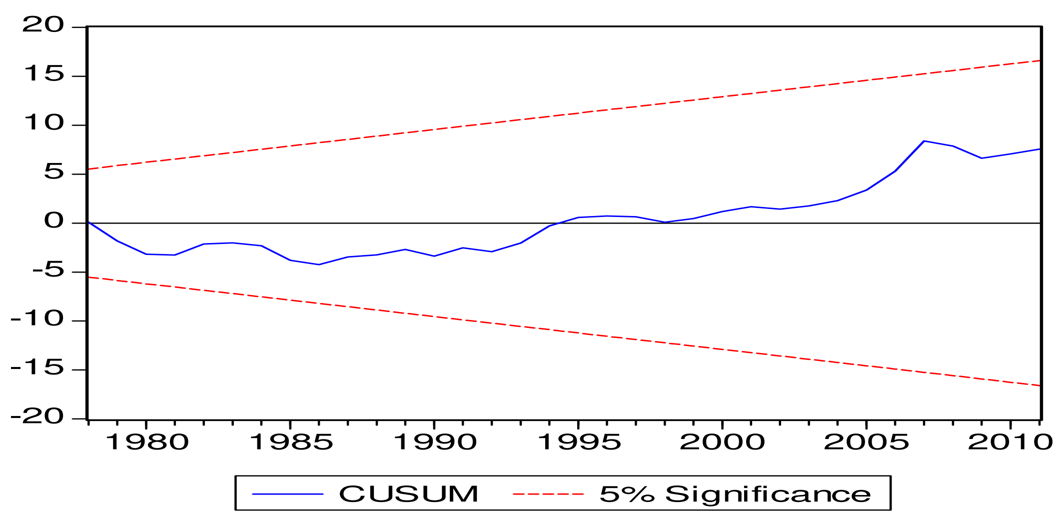
Figure-5: Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

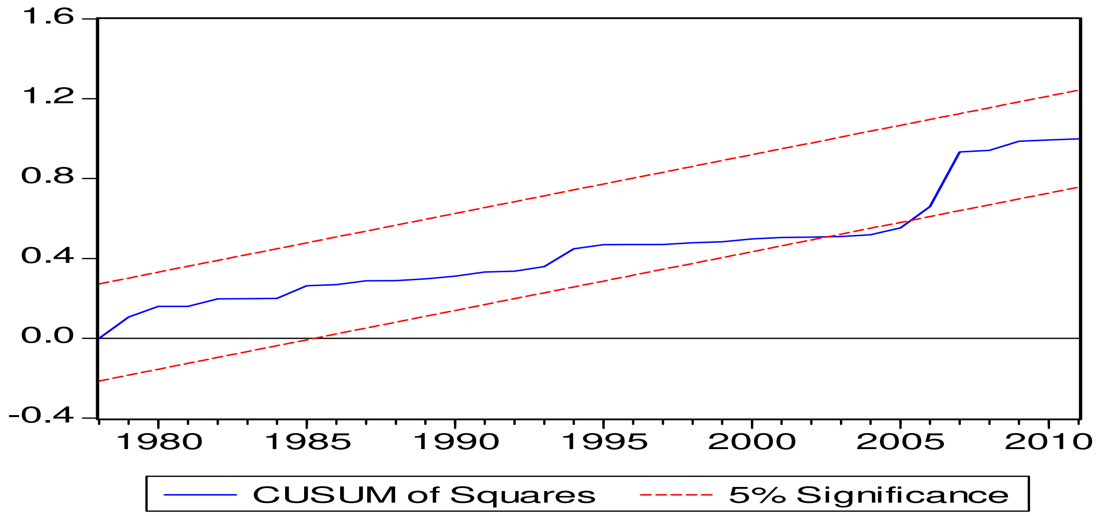
III. Trade Model

Figure-6: Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Figure-7: Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Table-7: Chow Forecast Test

Chow Forecast Test: Forecast from 2003 to 2011			
F-statistic	1.6990	Probability	0.2404
Log likelihood ratio	2.1553	Probability	0.1318

The VECM Granger Causality Analysis

If cointegration is confirmed, there must be uni- or bidirectional causality among the series. We examine this relation within the VECM framework. Such knowledge is helpful in crafting appropriate energy policies for sustainable economic growth. Table-8 reports results on the direction of long and short run causality. The results suggest feedback relation between financial development and economic growth; capital and economic growth, exports and economic growth, imports and economic growth, and international trade and economic growth. The bidirectional causality is found between financial development and energy consumption; financial development and exports (imports), international trade; capital and financial development in China in long run. In long run, energy consumption Granger causes economic growth, financial development; capital, exports, imports and international trade. The unidirectional causality running from energy consumption to financial development is consistent with Dan and Lijun, (2009) in case of Guangdong (China) but contradictory with Islam et al. (2013) and, Shahbaz and Lean, (2012b) who reported feedback effect between financial development and energy consumption in case of Malaysia and Tunisia respectively.

The causality from energy consumption, financial development, capital, exports, imports and international trade to economic growth supports the energy-led-growth, finance-led-growth, capital-led-growth, exports-led-growth, imports-led and trade-led-growth hypotheses. The findings suggest that economic growth, financial development, capital, exports, imports and international trade corroborate finance-led-energy, exports-led-energy, imports-led-energy, trade-led-energy and capital-led-energy hypotheses.

Table-8: VECM Granger Causality Analysis

Dependent Variable	Type of causality					
	Short Run					Long Run
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln E_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln EX_{t-1}$	ECT_{t-1}
$\Delta \ln Y_t$	…	0.1991 [0.8206]	17.6942* [0.0000]	25.0392* [0.0341]	1.7900 [0.1855]	-0.5142** [-2.9195]
$\Delta \ln E_t$	0.5477	…	0.1734	0.7906	0.5103	…

	[0.5841]		[0.8416]	[0.4631]	[0.6065]	
$\Delta \ln F_t$	7.6713* [0.0022]	0.3415 [0.7136]	…	1.5172 [0.2368]	0.4960 [0.6142]	-0.5764* [-2.8777]
$\Delta \ln K_t$	19.3602* [0.0000]	1.1915 [0.3187]	7.6470* [0.0022]	…	1.1836 [0.3210]	-0.6765* [-4.2189]
$\Delta \ln EX_t$	3.2859** [0.0523]	0.7253 [0.4930]	2.9993*** [0.0610]	0.6314 [0.5392]	…	-0.2100** [-2.5529]
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln E_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln IM_{t-1}$	
$\Delta \ln Y_t$	…	0.5194 [0.6004]	13.0776* [0.0001]	25.5463* [0.0000]	0.3637 [0.6848]	-0.5244** [-2.6540]
$\Delta \ln E_t$	1.0378 [0.3670]	…	0.2032 [0.8172]	0.0128 [0.9872]	1.0253 [0.3713]	…
$\Delta \ln F_t$	7.1989* [0.0030]	0.0972 [0.9076]	…	2.0422 [0.1486]	0.1405 [0.8695]	-0.6334* [-3.7959]
$\Delta \ln K_t$	14.6381* [0.0000]	1.1555 [0.3294]	6.1307* [0.0064]	…	1.5405 [0.2119]	-0.6218* [-3.9466]
$\Delta \ln IM_t$	1.3380 [0.2786]	0.5834 [0.5646]	0.7147 [0.4980]	0.3441 [0.6846]	…	-0.2761** [-2.2846]
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln E_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln TR_{t-1}$	
$\Delta \ln Y_t$	…	0.7194 [0.4955]	10.0547* [0.0005]	16.2805* [0.0000]	0.2406 [0.7877]	-0.3780** [-2.1581]
$\Delta \ln E_t$	0.7566	…	0.2840	1.3674	0.4956	…

	[0.4783]		[0.7548]	[0.2707]	[0.6143]	
$\Delta \ln F_t$	7.8373 [0.0020]	0.2141 [0.8085]	…	1.7297 [0.1958]	0.0489 [0.9523]	-0.6471* [-3.1462]
$\Delta \ln K_t$	15.9184* [0.0000]	1.1987 [0.3167]	6.6438* [0.0044]	…	1.0528 [0.3623]	-0.6603* [-4.1762]
$\Delta \ln TR_t$	4.3022** [0.0235]	0.3489 [0.7080]	2.1046 [0.1410]	0.0918 [0.9125]	…	-0.2230* [-2.9598]
Note: *, ** and *** denote the significance at the 1, 5 and 10 per cent level, respectively.						

In short run, bidirectional causality is found between financial development and economic growth and same is drawn between capital and economic growth once we used exports as an indictor of trade openness. Economic growth and financial development Granger cause exports. The unidirectional causality exists running from financial development to capital. Using imports as an indicator of trade openness, we find neutrality effect between imports and economic growth and same conclusion can be drawn between financial development and imports. Finally, using international trade as an indicator of trade openness, we note unidirectional causality running from economic growth to international trade. Rest results are same with previous findings.

4. Conclusion and Future Research

This paper examines the long run relationship among energy consumption and economic growth, financial development, international trade and capital for China. Prior to testing for causality, we applied the Zivot-Andrews (ZA) (1992) and Clemente et al. (1998) unit root tests, which can accommodate structural breaks in the data. The ARDL bound test and Johansen and Juselius, (1990) test were carried out used to examine cointegration. Our results indicate that there is a unidirectional relationship running from electricity consumption to real GDP. An increase in energy consumption would raise real GDP. Our empirical findings support the notion that there has been a decoupling of energy consumption and economic growth. The rate of growth of energy consumption is not a direct one-to-one correlation with GDP growth. Thus, the Chinese economy can grow without corresponding increase in environmental pressure. Chinese economy is becoming more energy efficient over the years. To achieve sustainable growth with an ever increasing energy demand, the Chinese government taking steps that will bring energy consumption under control. A series of policies, notices, measures, and government reorganizations were put in place to support the realization of this goal (Zhou et al., 2010). One important step has been the completion of the Three Gorges Dam in 2008, which is now the world's largest hydropower plant. China is taking steps to build dozens of new nuclear reactors over the next 20 years. The energy intensity in China have been below unity over the last decade, which means one unit of energy consumption can support more than one unit of real GDP.

Financial development and economic growth Granger causes each other in both in the short and long run. Financial development enhances domestic production through investment activities and boost economic growth. The unidirectional causality running from energy consumption to financial development is consistent with Dan and Lijun, (2009) in case of Guangdong (China). Chinese economy growing through efficient use of energy, well developed and growing financial markets, export oriented trade policy as confirmed by the Granger causality tests. However, economic growth does not Granger causes energy consumption, which implies that well developed financial sector favoring efficient use of energy in China.

The paper can be seen as an examination of the Chinese policy to support economic growth by encouraging export growth, and financial development and efficient use of energy. As the Chinese economy growing, government should take steps to reduce CO_2 and Green house gas (GHS) emission. Therefore, in the absence of a clearly articulated and implemented sustainable development policy, China's growth may have adverse affect on environment in the long run. The finding that financial development leads to energy consumption only in the long run, but energy consumption causes the financial development both in the long and the short run offers some hope. This implies that financial loans used by both the consumers and the investors will add to energy demand. In the short run China could benefit from two pronged policy: promote financial development and export oriented trade policy. Emphasis should be placed on investing in renewable energy sources and adopt other energy savings methods including energy mix and mitigation options in the long run. Failure to address the short run needs may not bring happy ending in the long run. The concern is that the economy might become completely energy dependent and suffer the consequences of high CO_2 emission. As a long run goal, financial development strategy should be adopted for creating a sound energy infrastructure and thus achieve efficiency in the overall energy use. As the facts point to, the results so far have been mixed.

The economic growth literature emphasizes the importance of financial development on economic prosperity. Among others, an aim of the energy literature is to examine the relationship between financial development and energy consumption. The empirical models used here fit the data reasonably well and pass most diagnostic tests. The results show that higher energy consumption Granger causes financial development measured by domestic credit to the private sector as share of. These findings deserve close scrutiny for a number of reasons. Emerging economies that continue to develop financial markets should see energy demand rise above and beyond those caused by rising income. However, the paper finds evidence that China was able to control this energy demand through efficient use of energy. Any energy demand projections in emerging economies at the exclusion of financial development as an explanatory variable might provide inaccurate estimate actual energy demand and unduly interfere with the conservation policies.

China should take extra caution in providing the necessary environment and infrastructure that must precede financial development policy. Containing greenhouse gas emissions may be harder if these targets are set without taking into account the impact of financial development on the energy demand.

Footnotes

1. Iran, Israel, Kuwait, Oman, Saudi Arabia and Syria.
2. Bahrain, Iran, Jordan, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates.
3. Bangladesh, India and Pakistan.
4. Argentina, Brazil, Chile, Ecuador, Paraguay, Peru, Uruguay.
5. See Shahbaz, (2012) for more details.
6. We have used three indicators of trade openness such real exports per capita, real imports per capita and real trade per capita (exports + imports / population).
7. Trade intensity equals exports plus imports as share of GDP.
8. The ARDL bounds test works regardless of whether or not the regressors are I(1) or I(0) / I(1), but the presence of I(2) or higher order makes the F-test unreliable (See Ouattra, 2004).
9. Pesaran et al. (2001) provide two critical values - when the regressors are *I(0)* and *I(1).*
10. In such case, error correction method is appropriate method to investigate the cointegration (Bannerjee et al. 1998). This indicates that error correction term will be a useful way of establishing cointegration between the variables.
11. The critical bounds by Narayan (2005) are appropriate for small sample (30 – 80). The critical bounds by Pesaran et al. (2001) are significantly smaller (Narayan and Narayan, 2005).

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