Finance-Growth-Energy Nexus and the Role of Agriculture and Modern Sectors: Evidence from ARDL Bounds Test Approach to Cointegration in Pakistan

Shahbaz, Muhammad and Islam, Faridul and Sabihuddin Butt, Muhammad

COMSATS Institute of Information Technology, Lahore Campus, Pakistan, Morgan State University, USA, Applied Economic Research Centre, Pakistan

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Muhammad Shahbaz
COMSATS Institute of Information Technology,
Lahore Campus, Pakistan
Email: shahbazmohd@live.com

Faridul Islam
Professor and Chair
Department of Economics
Morgan State University
Baltimore, MD 21251
P: 443-885-3438, F: 443-885-4361
Email: Faridul.Islam@morgan.edu

Muhammad Sabihuddin Butt
Applied Economic Research Centre, Pakistan
Email: fasih@aerc.edu.pk

Abstract

This paper explores the relationship between financial development and energy consumption by incorporating economic growth, agriculture and modern sectors in Pakistan over the period of 1972-2011. The Autoregressive Distributive Lag (ARDL) bounds testing approach to cointegration, assuming structural breaks, confirms cointegration. Innovation accounting approach, used to examine the direction of causality, shows that economic growth causes energy demand. We also fine bidirectional causality between financial development and energy consumption; and between modern sector growth and energy consumption. Energy consumption Granger causes agriculture growth. The results offer valuable insights for policymakers in crafting appropriate energy policy for Pakistan.

Keywords: Energy Consumption, Economic Growth, Financial Development, Pakistan

JEL Classification: C32, O53, Q20, Q43

Introduction

Energy economics in general and the link between energy consumption and economic growth in particular, has drawn considerable attention from the academicians and policymakers in recent times. The topic is important due to the derived demand nature of energy. Energy drives the wheels of an economy. The significant spurt in global energy demand can be ascribed to two main sources: (i) rapid economic growth in the emerging nations; and (ii) maintenance of the relatively high living standards in the developed nations. The intuitive idea that raising growth rate of per capita GDP requires more energy has been confirmed by the pioneering study of Kraft and Kraft (1978). For the US, they found unidirectional causality from GNP to energy use during the period 1947-1974.

The sizeable literature on the output-energy or output-pollution nexus portrays only a partial picture. For example, Lee and Chang (2008) included capital stock and labor to examine energy demand for some Asian nations. They found a positive link between economic growth and energy demand which gets stronger as more relevant variables are included. Apergis and Payne (2009a, 2009b, 2010) and Wolde-Rufael (2009a) argue that rise in energy demand in emerging economies is closely linked to the growth of income. As population grows, pressure on limited rural resources forces people to move to urban areas which add in energy demand. For a sustained economic growth, the increased energy demand over a long period must be met from new sources, or by developing cost-effective alternative sources. Using both bivariate and multivariate models for New Zealand, Bartleet and Gounder (2010) found that causality runs from real GDP to energy use. They also note that capital stock plays an important role in determining the direction of causality.

The objective of this paper is to explore a long-run relationship among economic growth, energy consumption, financial development, contribution of agriculture and modern sectors in Pakistan by implementing the Autoregressive Distributive Lag (ARDL) bounds testing approach to cointegration. We use annual data from 1972 to 2011. The study period spanning four decades is hallmarked by major changes in the local and global landscape which can potentially cause structural break in the series. Not factoring such feature can lead to model misspecification; and produce low power of unit root test (see, Perron, 1989). To finesse this, we apply the Zivot-Andrews (1992) unit root test which accommodates single unknown structural break. The motivation behind undertaking the study on Pakistan, a nation of 175 million in the Indian subcontinent, is primarily driven by the inquisitiveness to examine the energy-growth nexus in light of the ongoing structural transformation. While we consider a set of relevant variables, research shows that the latter can be an important driver of economic growth. The paper contributes to the literature in several distinct ways. (a) Pakistan's economy is characterized by combination of a sizeable agricultural, and a modest manufacturing sector. The value added by agricultural and manufacturing sectors separately helps to capture elements of ongoing structural transformation in the Pakistan. This is the first comprehensive study that examines the dynamic interaction among: economic growth; financial development; energy consumption along with some measure of structural transformation. (b) From methodological perspective, we apply the ARDL approach which is well suited to small sample. We also apply a unit root test which is capable of detecting structural break in the series. (c) The inclusion of financial development in the model appears justified due to Pakistan's decision to liberalize the financial sector. d) The innovative accounting technique (IAA) used to examine the direction of causality has some advantages over the traditional Granger approach. The latter test does not determine the relative strength of the causality beyond the selected time span (Shan, 2005); nor does it show the extent of feedback from one variable to the other. The IAA avoids these shortcomings. The authors are not aware of a similar study for Pakistan which makes it a contribution to the literature. The findings should help to policy makers better understand the interaction among the series in crafting sustainable policy.

2. Literature Review

In this section, we review the extant literature along the three main strands: economic growth and energy consumption; economic growth and financial development; and financial development and energy consumption.

2.1 Economic Growth and Energy Consumption

The literature on energy-growth nexus is expansive. For example, Yu and Choi (1985), Stern (1993, 2000), Yang (2000), Alam and Butt (2002), Oh and Lee (2004a), Yoo (2006), Lee and Chang (2008), Beaudreau (2005, 2010), among others, find energy to be important for economic growth. Others consider energy consumption, gross domestic product and energy price as the variables of interest. Several studies have examined the nexus of energy consumption, energy prices and economic growth; and there are others that ignored the role of urbanization, trade, industrialization, and financial development, although they are relevant to energy demand (see, Mishra et al. (2009), Sadorsky (2011), Shahbaz and Lean (2012) and Shahbaz et al. (2013).

As for Pakistan, only a few studies have examined causality between energy consumption and economic growth. Aqeel and Butt (2001), Alam and Butt (2002), Siddiqui (2004), Khan and

Qayyum (2007), Qazi and Riaz (2008) and Shahbaz et al. (2012a) used different indicators of energy use to examine causality relationship between energy consumption and economic growth. The studies failed to find a consistent pattern on the direction of causality which might be due to the differences in methodology, use of indicators of energy consumption, and possibly the time span used. Also exclusion of some relevant variables might have led to model misspecification.

2.2 Financial Development and Economic Growth

The link between financial development and economic growth has gained prominence with globalization took the center stage. A developed financial system can help to achieve efficiency in the financial transactions; promote innovations, lower information cost, help adoption advanced technology; and insure efficient allocation of investment funds [Townsend (1979), Levine (1997), Bairer et al. (2004), Abu-Bader and Abu-Qarn (2008), Shahbaz et al. (2010a), Greenwood and Jovanovich, (1990) and Levine, (1997)]. Patrick, (1966) noted that 'demand-following' relationship implies that real economic activity Granger causes financial development through demand for financial services. This happens as an economy grows, need for financial sector development becomes intense. Robinson (1952); Lucas, (1988) and Stern (1989) suggest that financial development follows economic growth. The former promoted economic growth by raising savings, and enhancing capital. Broadly, financial markets help to raise internal and external resources and promote economic growth (Greenwood and Jovanovich, 1990 and Bencivenga and Smith, 1991).

Ibrahim (2007) found that financial development stimulates economic growth in Malaysia; so did Shahbaz (2009) for Pakistan. A sound financial market reduces financial instability[1] and thereby aids economic growth. Using investment as a variable, Odhiambo (2010) found that financial development promotes economic growth in South Africa where the former follows the latter and is closely related to foreign capital inflows. Financial development stimulates equity markets, allows easy access to financial capital, facilitates inflow of foreign direct investment (FDI), and lowers financial risk. Broadly, financial development improves monetary transmission mechanism, boosts savings and investment and promotes economic growth. Fung (2009) finds that the growth augmenting effect of financial development is facilitated by productivity boost [see Bekaert and Harvey (2000) and Bekaert et al. (2001, 2002, 2005)]. Shahbaz (2012) found that trade openness helps finance led growth in Pakistan.

2.3 Financial Development and Energy Consumption

The financial development affects energy consumption through consumption and production channels. Financial development can affect real variables i.e. investment and real interest rate (Zicchino, 2006). From production side, lowers borrowing cost enhances investment (local and foreign), boosts output, and generates employment. Low interest rate helps purchase of consumer durable (Sadorsky, 2010; Mankiw and Scarth, 2008). All these add to energy use. Karanfil (2009) argues that causality analysis between energy and economic growth needs to go beyond a simple bivariate framework. He recommends using stock market capitalization, liquid liabilities, and domestic credit to the private sector; as share of GDP as potential explanatory variables. He suggests that exchange rates and interest rates may influence energy demand through price channel.

Following suggestion by Karanfil (2009), Dan and Lijun (2009) examine the impact of financial development on primary energy consumption in Guangdong (China). They find causality from energy consumption to financial development. Sadorsky (2010) applied different indicators of financial development to 22 emerging economies (1990-2006)[2]. He found that the impact of financial development on energy demand is positive but small. Shahbaz and Lean (2012) found that financial development promotes economic growth and increases energy demand in Tunisia. They also report feedback effect between financial development and energy use. The same is true for industrialization and energy consumption. Chtioui, (2012) reported that the effect of financial development and economic growth on energy consumption is positive. Financial development Granger causes energy consumption; but feedback effect exists between economic growth and energy consumption. Xu, (2012) applied various indicators of financial development to Chinese provincial data from 1999 to 2009 and found a positive link between the two series. For Iran, Mehrara and Musai (2012) found that economic growth, financial development and energy consumption are cointegrated; and the impact of energy consumption on economic growth is negative, while the reverse is true of capital, oil revenues and financial development. Tang and Tan (2012) report the bidirectional causality between financial development and energy consumption in short and long runs. Islam et al. (2013) found that financial development, economic growth, and population led to the rise in energy demand in Malaysia. They found the feedback effect between financial development and energy consumption in the long run. Coban and Topeu, (2013) found positive and significant impact of financial development on energy consumption in 'old members of EU. However, for the new members the link between financial development and energy consumption is sensitive to the choice of an indicator. They found inverted-U relationship between the two series in the models that use stock market capitalization as the indicator of financial development.

3. Model Construction and Research Methods

The annual data from 1972-2011 relating to the variables is taken from the World Development Indicators (WDI-CD, 2012). Each series is measured in per capita terms. Energy consumption, denoted by E_t, is measured by energy consumed (kilowatt of oil equivalent). Financial development, denoted by F_t, is measured by the real stock market capitalization of the listed companies in the equity market[3]. Growth in real GDP, Y_t, measures economic growth. Value-added in the agriculture and modern sector (measures by value added of industrial and services sectors to GDP), denoted by A_t and M_t respectively. The following relation is posited. For estimations, the empirical model is specified in following equation.

$$E_t = f(F_t, Y_t, A_t, M_t) \qquad (1)$$

We specify the estimable equation[1] in log-linear form as follows:

$$\ln E_t = \delta_\circ + \delta_F \ln F_t + \delta_Y \ln Y_t + \delta_A \ln A_t + \delta_M \ln M_t + \mu_t \qquad (2)$$

A high value of stock market capitalization shows a developed and efficient equity market where funds are channeled to high return projects (*level effect*), and is pro-economic growth (Minier, 2009; Sadorsky, 2010). Developed financial markets enhance investor confidence, attract FDI,

[1] See for more details (Shahbaz, 2010)

and boost economic growth (Sadorsky, 2010). These are further pushed by the *efficiency effect* which ensures that stock market is channeling liquidity, diversifying assets, and securing finance for the projects; so $\delta_F > 0$. Growing economies consume more energy[2]; so $\delta_Y > 0$. Agriculture uses traditional technology so less efficient. So, we expect $\delta_A > 0$. Modern sector growth by contrast uses advanced and energy efficient technology, so that $\delta_M < 0$.

Ng-Perron (2001) developed a GLS based test statistics to test stationarity of a series. The critical values of the tests are based on Philip-Perron (1988) Z_α and Z_t statistics, Bhargava (1986) R_1 statistics, and Elliot et al. (1996) critical values. The following annotations are used:

$$k = \sum_{t=2}^{T} (y_{t-1}^d)^2 / T^2 \tag{3}$$

The de-trended GLS tailored statistics is given by:

$$MZ_a^d = (T^{-1}(y_T^d)^2 - f_\circ)/(2k)$$

$$MZ_t^d = MZ_a \times MSB$$

$$MSB^d = (k / f_\circ)^{1/2}$$

$$MP_T^d = (\delta^2 k - \delta T^{-1})(y^d T)^2 / f_\circ \text{ if } x_t = 1 \text{ and } MP^d T(\delta^2 k + (1-\delta)T^{-1}(y^d T)^2 / f_\circ \text{ if } x_t = (1,t)$$

where $\delta = -7$ if $x_t = 1$ and $\delta = -13.5$ if $x_t = (1,t)$ …(4)

As noted, we apply unit roots test, appropriate for structural break. Zivot-Andrews (ZA) (1992) and Perron and Volgelsang (1992) unit root tests are appropriate when the series contains one

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[2]See e.g., Aqeel and Butt (2001) for Pakistan, Ghosh (2002) and, Paul and Bhattacharya (2004) for India, Ang (2008) for Malaysia, Halicioglu (2009) for Turkey; Bowden and Payne (2009) for USA

structural break. ZA approach considers three possible alternatives: (i) a one-time change at the levels; (ii) a one-time change in the slope; and (iii) a one-time change both in intercept and trend. Each of the three scenarios can be modeled as follows:

$$\Delta x_t = a + ax_{t-1} + bt + cDU_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (5)$$

$$\Delta x_t = b + bx_{t-1} + ct + bDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (6)$$

$$\Delta x_t = c + cx_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (7)$$

Where the dummy variable is indicated by DU_t showing mean shift occurred at each point with time break while trend shift variables is show by DT_t. So,

$$DU_t = \begin{cases} 1 \ldots if \quad t > TB \\ 0 \ldots if \quad t < TB \end{cases} \text{ and } DU_t = \begin{cases} t - TB \ldots if \;\; t > TB \\ 0 \ldots if \;\; t < TB \end{cases}$$

The null hypothesis of unit roots break date is $c = 0$ which indicates that the series is not stationary with a drift not having information about structural break point while $c < 0$ hypothesis implies that the variable is found to be trend-stationary with one unknown time break. ZA unit root test considers all points as potential break points and estimates them successively and finally picks the break when $\hat{c}(= c - 1) = 1$ from a region where the end points of sample period are excluded.

The ARDL bounds testing approach is used to explore the long-run equilibrium relation in the presence of structural break among the series energy consumption (E_t), financial development (F_t), economic growth (Y_t), agriculture growth (A_t) and growth in modern sector (M_t). The bounds testing approach applies irrespective of the order of integration of the regressors, *I(0)* or *I(1)*although an I(2) can cause problem (Ouattra, 2004). A dynamic unrestricted error-correction model (UECM) is derived from the ARDL by using a simple linear transformation. The ECM combines short-run dynamics with long-run equilibrium without losing long-run information. The ARDL approach involves estimating the following unconditional error correction model (UECM):

$$\Delta y = \alpha_{\circ} + \lambda_D D + \lambda_2 y_{t-1} + \lambda_3 z_{t-1} + \lambda_4 x_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + \sum_{j=0}^{p} \alpha_i \Delta x_{t-j} + \sum_{s=0}^{p} w_s \Delta z_{t-s} + \varepsilon_i \qquad (8)$$

where, $\alpha_{\circ}$ is a drift component and ε_i a white noise process. The ARDL approach estimates $(p+1)^k$ number of regressions to obtain optimal lag length for each series. Here '*p'* is the maximum number of lags used and '*k*' the number of variables in equation-8. The optimal lag structure of the first difference regression is selected by using both the Akaike (AIC) and the Schwarz (SBC) criteria. The lagged terms help to induce white noise property to the error term. Pesaran et al. (2001) suggest that we use the bounds test for a long-run relationship; and the *F-test* for joint significance of the coefficients of the lagged variables in equation-8. The long run relation holds if the null hypothesis of no cointegration $H_{\circ} : \lambda_2 = \lambda_3 = \lambda_4 = 0$ is rejected in favor of the alternate $H_a : \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$. Two asymptotic critical bounds are used when the independent variables are *I(d)* $(0 \leq d \leq 1)$.

If the F-statistic exceeds the UCB, we conclude in favor of a long run relationship, regardless of the order of integration; but if it is below the (LCB, the null hypothesis of no cointegration is sustained. The test is inconclusive if the *F-statistic* lies between the two bounds. When the order of integration for the explanatory variables is *I(1)* the decision is made based on the UCB; and if they are *I(0)*, the decision is based on the LCB. If cointegration exists, the conditional long run model is derived from the reduced form equation-8 when the series in first difference are jointly equal to zero, i.e. $\Delta x = \Delta y = \Delta z = 0$. Thus**,**

$$y_t = \partial_\circ + \partial_2 x_t + \partial_3 z_t + \mu_i \tag{9}$$

where, $\partial_\circ = -\lambda_1 / \lambda_2 ; \partial_2 = -\lambda_3 / \lambda_2 ; \partial_3 = -\lambda_4 / \lambda_2$, and v_t is a random error. The long-run coefficients are estimated using OLS from equation-9. If long run relation is found, an error correction representation exists which is estimated from the following reduced form equation:

$$\Delta y_t = \sum_{i=1}^{p} \lambda_i \Delta y_{t-1} + \sum_{j=1}^{m} \beta_i \Delta x_{t-j} + \sum_{k=1}^{n} \beta_k \Delta z_{t-k} + \eta ECM_{t-1} + \varepsilon_i \tag{10}$$

To assess goodness of fit of the ARDL model, we apply the diagnostic and the stability tests. The former is used to check for serial correlation, functional form, heteroskedasticity, and normality of the error terms. The stability test employs the CUSUM and the CUSUMsq.

The IAA involves two steps: (a) decomposes forecast error variance; and (b) generates impulse response function (IRF). The decomposition process splits the proportion of variation in a series into those caused by its own shocks; and those coming from others (Enders, 1995) are used to show the strength of the impact. In practice, a system of equation is used to examine the impact of one standard deviation shock to the variable on others and also on the future values of the series sustaining the shock (Shan, 2005). The IRF on the other hand traces out the time path of the impacts of a series.

For instance, if shock to financial development affects energy consumption significantly but a shock on the latter affects the former minimally, then, we have unidirectional causality from the former to the latter. If the energy consumption explains more of forecast error variance of financial development, then energy consumption causes financial development in the Granger sense. The bidirectional causality exists if shocks affect each strongly; while minimal impact implies absence of causality between them. As noted, the IRF helps us to trace out the time path of the impacts of shock on variables in the VAR. For example, financial development is said to cause energy consumption if the IRF triggers strong response of the latter to shocks in the former compared to other series. A VAR system takes the following form:

$$V_t = \sum_{i=1}^{k} \delta_i V_{t-1} + \eta_t$$

where, $V_t = (E_t, F_t, \mathrm{Y}_t, A_t, M_t)$

$$\eta_t = (\eta_E, \eta_F, \eta_\mathrm{Y}, \eta_A, \eta_M)$$

$\delta_1 - \delta_k$ are four by four matrices of coefficients, and η is a vector of error terms.

4. Results and Discussion

Table-1 reports the descriptive statistics and the correlation matrix. The Jarque-Bera test confirms normality of each series. The correlation between each pair of variables is positive.

[Insert Table-1 here]

Given that the standard unit root tests may produce unreliable results in the presence of structural break in the series (Baum, 2004), we complement the Ng-Perron unit root with the Zivot-Andrews (ZA) (1992) unit root test. The Ng-Perron test results, reported in Table-2, show that all the series are I(1) with intercept and trend. The ZA test results reported in Table-3 also confirms the order of integration as I(1).

[Insert Table-2 here]

[Insert Table-3 here]

We apply the Akaike information criteria (AIC) to choose an appropriate lag length because of its better power properties compared to others (Shahbaz and Rahman, 2012). The ARDL F-statistic is sensitive to the lag order. The lag length of the series is given in column-2 of Table-4. Our results of the ARDL bounds testing are also reported in Table-4**.**

[Insert Table-4 here]

To test cointegration, we take the critical bounds from Narayan (2005) rather than Pesaran et al. (2001). The letter are suitable in large samples (T = 500 or higher) and can produce downward bias (Narayan and Narayan, 2004) in small samples. The Narayan's (2005) is more appropriate for sample ranging from T = 30 - 80. We find the computed F-statistic to exceed the UCB at the 1% and 5% when energy consumption, agriculture and modern sector are the predicted variables.

The series energy consumption, agricultural growth and growth in modern sector show structural breaks occurring in 1987, 1995 and 1993 respectively. The severe drought in Pakistan in 1987 may have caused the structural break in energy consumption series. The agriculture growth series was impacted by the rise in cotton prices in 1995. The government policy to promote industrial and services sectors was captured in 1993. The results confirm cointegration among the series from 1972 to 2011 for Pakistan.

Table-5 presents long run elasticity of energy consumption with respect to independent variables. Financial development and energy consumption are positively related; and significant at 10% level. A 10% increase in financial development (stock market capitalization) is expected to raise energy demand by 1.486%, ceteris paribus. High stock market capitalization enhances investors' confidence, stimulates economic growth and thus boosts energy use. Also credit availability makes it easier for consumers to purchase big ticket durable items, which adds to energy demand. Our findings lend support to those by Sadorsky (2010), Shahbaz and Lean (2012), and Islam et al. (2013). These authors find a higher elasticity than ours which may be due the difference in measuring financial development.

[Insert Table-5 here]

Results suggest that the effect of economic growth on energy consumption is sizeable. A 1% rise in economic growth increases energy demand by about 0.8769%. (All elasticity measures reported here are on 'an average' and 'ceteris paribus'). The results are consistent with those found by Aqeel and Butt (2001) and Qazi and Riaz (2009) for Pakistan; Bowden and Payne (2009) for USA; Halicioglu (2009) for Turkey; Odhiambo (2009) for Tanzania; Shahbaz and Lean (2012) for Tunisia and Islam et al. (2013) for Malaysia. The impact of agriculture growth is positive and statistically significant at the 1% level. A rise by 0.2113% in energy demand is linked to a 1% increase in agriculture growth. These finding are consistent with Mushtaq et al. (2007) who noted that an increase in agricultural value-added raises energy demand. The relation between the growth in modern sector and energy consumption is negative and statistically significant at the 5% level. It may be noted that modern sector uses energy efficient technology. A 1% rise in modern sector growth is linked with 0.1216% decline in energy demand. Yildirim et al. (2012) found negative relationship between industrial production and energy consumption in the United States.

The short run results can be seen in the lower segment of Table-5. The coefficient of financial development shows positive and significant effect on energy consumption. However, short run coefficient is smaller than long run. Energy consumption increases by 0.014% in response to a 1% rise in the stock market capitalization. A 1% increase in economic growth raises energy consumption by 0.389%. The impacts of agricultural sector growth and modern sector growth are positive and negative respectively but not significant in the short run. This is not unreasonable. By nature of the sector usually takes somewhat longer time to respond.

The error-correction term among a set of cointegrated series implies that changes in the response variable is a function of both the levels of disequilibrium in the cointegrating relationship (represented by the ECM) and the changes in other explanatory variables. The ECM_{t-1} tells us about the speed of adjustment from short to the long run. Bannerjee et al. (1998) noted that a significant lagged error term with negative sign (we have -0.5022) indicates stable long run relationship. The estimated coefficient suggests that energy demand is corrected by 50.22%

annually from short to the long runs equilibrium. The short run tests pass the sensitivity analysis against serial correlation and ARCH. The errors are normally distributed and homoscedastic. The Ramsey Reset test confirms a well specified model.

4.1 Stability Tests

The cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) tests are used to examine the stability of the long-and short-term parameters. If the plots of the graph for both the tests lie within 5% critical bounds, we accept the hypothesis that "the regression equation is correctly specified" (Bahmani-Oskooee and Nasir, 2004: 485). Our results are within the critical bounds (Figure-1 and Figure-2). Thus the model is stable and correctly specified.

[Insert Figure-1 and 2 here]

4.2 Generalized Variance Decomposition

By implementing the IAA, we find that 25.91% energy consumption is explained by its own innovative shocks, 0.13% by financial development, and 38.07% by economic growth. Financial development explains very small part of energy consumption through the innovative shocks. The contribution of agriculture growth and growth in modern sector to energy consumption is 12.97% and 22.90% respectively.

[Insert Table-6.1 here]

This implies that, next to economic growth and growth in modern sector are the major drivers of energy consumption. The share of energy consumption to explain financial development is 29.85% but 17.89% portion of financial development is contributed by its own innovative shocks. One innovative shock in economic growth explains financial development by 25.50%. Agriculture growth and growth in modern sector contribute to financial development by 9.79% and 16.94% respectively, through their innovative shocks.

We found that energy consumption causes financial development in the Granger sense. This is consistent with Dan and Lijun (2009) who found the unidirectional causality from energy consumption to financial development; but Shahbaz and Lean (2012); and Islam et al. (2013) reported the feedback effect between the two series for Tunisia and Malaysia, respectively. One standard deviation shock to energy consumption explains 18.98% of economic growth, but a shock to financial development on economic growth is negligible. Growth in agriculture and modern sectors significantly add in economic growth i.e. 27.24% and 12.54% respectively.

We find bidirectional causality between energy consumption and economic growth but strong causality running from economic growth to energy consumption. This finding is consistent with Alam and Butt, (2002); Shahbaz and Lean, (2012b) and Shahbaz et al. (2012). The finding that economic growth causes financial development lends support to the demand-side hypothesis, something reported by Shahbaz, (2012) for Pakistan.

[Insert Table-6.2 here]

A look at Table-6.2 shows impact of shock. Energy consumption explains 30% of agriculture growth from its own innovative shocks, while financial development explains agriculture growth some 5.41%. Innovative shocks to economic growth explain 26.92% of agriculture growth. Growth in modern sector adds in agriculture growth by 12.33% and 25.76% is explained by innovative shocks to agriculture growth itself. We find unidirectional causality from energy consumption to agriculture growth. This finding is consistent with Mushtaq et al. (2007). They report that electricity consumption in agricultural sector plays a critical to boosting the productivity of agriculture sector. Sebri and Abid, (2012) find energy consumption Granger causes agricultural growth in Tunisia. Faridi (2012) reported unidirectional causality from agriculture growth to economic growth. The author argues that agricultural productivity helps to promote rural economic activity and contributes to economic growth.

Table 6.2 shows that a sizeable part of the growth in modern sector is explained by the innovative shocks of energy consumption, but financial development contributes minimally to it. A 37.90% growth in modern sector is explained by innovative shocks to economic growth while 11.09% and 28.25% are explained by the innovative shocks in agriculture growth and growth in modern sector, respectively. The contribution of financial development and agriculture growth is dismal. We find bidirectional link between energy consumption and growth in modern sector and same is true for economic growth and growth and modern sector.

4.3 Generalized Impulse Response Function

The generalized impulse response function shows responsiveness of the regressands to shocks to each series within the vector autoregressive (VAR) model. The plots in IRF (Figure-3) indicate that the response of energy consumption to a unit standard deviation shock in financial development is weak; but strong in the reverse direction– case of unidirectional causality. The response of energy consumption from shocks in economic growth and growth in modern sector is very strong and positive. Energy consumption and growth in modern sector contribute to economic growth positively and strongly. This confirmed our established bidirectional causality between energy consumption and economic growth and, energy consumption and growth in modern sector. Feedback effect exists between economic growth and modern sector growth. The response in energy consumption from one standard shock to agriculture growth is depleting while financial development responds positively and strongly to standard shocks in energy consumption. This establishes a causal link between energy consumption and financial development. The response in energy consumption, financial development and economic growth due standard shocks stemming in agriculture growth is undetermined.

Agriculture growth responds positively from a unit standard error random shock to financial development, but it is significant. Energy consumption, economic growth and growth in modern sector add in agriculture growth positively. Finally, modern sector growth strongly responds to unit standard error random shocks in energy consumption, financial development and economic growth but is weakly due shock occurs in agriculture growth. The results of impulse response function are very similar to those found from variance decomposition methods.

[Insert Figure-3 here]

6. Conclusion and Policy Implications

The paper finds a long-run equilibrium relationship among energy consumption, financial development, economic growth, growth in agriculture and modern sectors in Pakistan from 1972 to 2011. Ng-Perron tests show that all the series are I(1). The Zivot-Andrews test identifies structural break in the series. The ARDL bounds testing approach has been used for a long run relation and the IAA for the direction of causality. Evidence points to a significant positive impact of financial development on energy consumption; and economic growth also adds further to it. Agriculture growth increases demand for energy but growth in modern sector does the opposite. IAA shows unidirectional causality from energy consumption to financial development and bidirectional causality between economic growth and energy consumption. Financial development is Granger caused by economic growth. Energy consumption and economic growth Granger cause agriculture growth. The feedback effect exists between energy consumption and growth in modern sector and same is true of growth in modern sector and economic growth.

Contemporary research suggests that financial development is a major driver of economic growth in emerging nations, and has significant impact on energy consumption. The literature on financial development and economic growth points to the role of finance in economic activity. The energy literature points to the link between energy and economic growth. In a free market economy, entrepreneurial talents are translated to action through access to finance. A financially developed system facilitates resources availability for viable investment projects. The latter stimulates economic growth which in turn raises demand for energy. While intuitively appealing, the paper finds empirical support to this idea.

The findings of the study can help to formulate appropriate policy and promote economic growth in Pakistan. A developed financial system attracts investors, boosts stock market, and channels funds to the sectors that are more efficient. Modernizing capital equipment will lower energy use and help to achieve productive efficiency. The long run coefficients are larger than (still small) those for the short run which appears to be more of a structural issue and should be addressed based on further research.

In Pakistan, poorly designed ad-hoc macroeconomic policies relating to stock markets and deteriorating law and order situation have been a recipe for a corrosive chemistry. These factors are contributing to the poor economic performance. The stock market is in need of overhaul to create a pro-business atmosphere that will help confidence building at home and abroad. Without suggesting too much regulation in financial sector of Pakistan, one can still introduce sensible albeit, comprehensive financial reforms to strengthen the sector and achieve efficiency. Government should introduce broad incentives to local and foreign investors. The commercial banking sector should extend more support for importers of modern technology for industrial sector. Energy efficient technology should be given serious consideration which can save energy and lower energy intensity.

Resources should be allocated to research & development for exploring new sources of energy for sustainable economic development. Modern sector should focus green energy to address environmental concerns. Modernization of the technology will boost agricultural growth and should be encouraged and supported. Training at rural areas to train farmers in this regard would be helpful. Opening more agricultural development should be considered.

For the future, direction of research should explore the relationship between economic growth, financial development and energy consumption from the perspective of sectors. In this case it would be necessary to use sectoral data which may help policymakers to design comprehensive economic, financial and energy policy for sustained growth by sector. This would allow a macro approach from micro level. The relationship among these series should also be examined using panel methodology for more reliable estimates. Shahbaz, (2012) points out that for optimal fruits of financial liberalization or financial development, sensible and yet careful trade openness must be on the menu. However, a word of admonition from Bhagwati (2002, p.180) is in order here. "While freer trade, or "openness" in trade, is now widely regarded as economically benign, in the sense that it increases the size of the pie, the recent anti-globalization critics have suggested that it is socially malign on several dimensions, among them the question of poverty. Their contention is that trade accentuates not ameliorates, deepens not diminishes, poverty in both the rich and the poor countries. The theoretical and empirical analysis of the impact of freer trade on poverty in the rich and in the poor countries is not symmetric, of course."

Footnotes

1. Shahbaz and Malik (2011) reported that financial instability weakens finance-growth nexus in case of Pakistan.
2. FDI, bank deposits as share of GDP, stock market capitalization as share of GDP, stock market turnover ratio and total stock market value traded over GDP.
3. Several researchers have used liquid liabilities (LLY) as share of GDP to proxy financial development (McKinnon, 1973; King and Levine, 1993). The measure does not present true picture of financial development as it shows the volume of financial sector but not financial development. Increase in liquid liabilities does not show mobilization of savings. This is why some countries are high in this indicator, but has underdeveloped financial markets. Other proxy measures for financial development are domestic credit issued to private sector as share of GDP; the ratio between commercial bank assets to the sum of commercial bank and

central bank assets. The most common proxy is domestic credit to private sector as share of GDP.

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Table-1: Descriptive Statistics and Correlation Matrix

Variables	$\ln E_t$	$\ln F_t$	$\ln Y_t$	$\ln A_t$	$\ln M_t$
Mean	5.9618	6.7889	10.0488	8.6491	17.3308
Median	6.0090	6.9723	10.1337	8.6361	17.4730
Maximum	6.2553	10.1057	10.4710	8.8600	18.4874
Minimum	5.6023	3.9422	9.5491	8.4552	15.9997
Std. Dev.	0.2172	2.0633	0.2845	0.1417	0.7556
Skewness	-0.299355	0.1365	-0.3442	0.0615	-0.2023
Kurtosis	1.6475	1.6408	1.8966	1.5143	1.9485
Jarque-Bera	3.6458	3.2033	2.8192	3.7039	2.1153
Probability	0.1615	0.2015	0.2442	0.1569	0.3472
$\ln E_t$	1.0000				
$\ln F_t$	0.3160	1.0000			
$\ln Y_t$	0.4913	0.3618	1.0000		
$\ln A_t$	0.2310	0.1668	0.4841	1.0000	
$\ln M_t$	0.3286	0.3054	0.6246	0.0748	1.0000

Source: Prepared by the author

Table-2: Unit Root Test

Ng-Perron Test at Level				
Variables	Mza	MZt	MSB	MPT
$\ln E_t$	-8.6405(2)	-1.9688	0.2278	10.9152
$\ln F_t$	-9.9813(1)	-2.2206	0.2224	9.1893
$\ln Y_t$	-4.1032(1)	-1.3765	0.3354	21.5912
$\ln A_t$	-8.5005(1)	-2.0616	0.2425	10.7199
$\ln M_t$	-12.4070(1)	-2.4334	0.1961	7.6534
Ng-Perron Test at 1st Difference				
$\Delta \ln E_t$	-19.0795(2)**	-3.0867	0.1617	4.7873
$\Delta \ln F_t$	-19.3433(3)**	-3.0891	0.1597	4.8365
$\Delta \ln Y_t$	-18.3730(1)**	-3.0309	0.1649	4.9597
$\Delta \ln A_t$	-22.3856(1)*	-3.3403	0.1492	4.1020
$\Delta \ln M_t$	-35.6680(3)*	-4.2085	0.1179	2.6343
Note: * and ** indicate the significance at the 1% and 5% levels. Lag order is shown in parentheses.				

Source: Prepared by the author

Table-3: Zivot-Andrews Structural Break Unit Root Test

Variable	At Level		At 1st Difference	
	T-statistic	Time Break	T-statistic	Time Break
$\ln E_t$	-4.027(0)	1987	-6.957(3)*	1979
$\ln F_t$	-3.438 (2)	1992	-6.865(1)*	2003
$\ln Y_t$	-3.405 (1)	1993	-5.752 (2)*	1993
$\ln A_t$	-4.144 (0)	1995	-8.151 (0)*	1997
$\ln M_t$	-3.654 (1)	1993	-5.091 (1)**	1987
Note: * and ** represent significant at 1%, 5% and 10% level of significance. Lag order is shown in parenthesis.				

Source: Prepared by the author

Table 4: The Results of ARDL Cointegration Test

Bounds Testing to Cointegration				Diagnostic tests		
Estimated Models	Optimal lag length	F-statistics	Structural Break	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}
$F_E(E/Y,F,A,M)$	2, 1, 2, 2, 2	8.113*	1987	1.0810	[1]: 0.0134	[1]: 2.2426
$F_Y(Y/E,F,A,M)$	2, 2, 2, 2, 1	2.881	1992	0.0736	[2]: 1.1174	[1]: 0.6200
$F_F(F/E,Y,A,M)$	2, 2, 2, 1, 2	1.192	1993	1.8050	[2]: 0.9063	[1]: 1.0193
$F_A(A/E,Y,F,M)$	2, 2, 2, 2, 2	9.897*	1995	0.1819	[1]: 0.4543	[1]: 0.0392
$F_M(M/E,Y,F,A)$	2, 2, 2, 1, 1	6.174**	1993	0.7932	[1]: 1.7448	[1]: 0.2294
Significant level	Critical values (T= 41)					
	Lower bounds $I(0)$	Upper bounds $I(1)$				
1 per cent level	5.893	7.337				
5 per cent level	4.133	5.260				
10 per cent level	3.373	4.377				

Note: The asterisks * and ** denote the significant at 1 and 5 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).

Source: Prepared by the author

Table-5: Long-and-Short Run Analysis

Dependent Variable: $\ln E_t$			
Long Run Results			
Variable	Coefficient	Std. Error	t-Statistic
Constant	-2.6705*	0.7212	-3.7025
$\ln F_t$	0.1486***	0.0781	1.9017
$\ln Y_t$	0.8769*	0.1520	5.7669
$\ln A_t$	0.2113**	0.0794	2.6599
$\ln M_t$	-0.1216**	0.0594	-2.0475
Short Run Results			
Variable	Coefficient	Std. Error	t-Statistic
Constant	0.0057	0.0038	1.4706
$\Delta \ln F_t$	0.0148***	0.0082	1.7948
$\Delta \ln Y_t$	0.3893**	0.1906	2.0421
$\Delta \ln A_t$	0.0542	0.0808	0.6710
$\Delta \ln M_t$	-0.0059	0.0597	-0.1003
ECM_{t-1}	-0.5022*	0.1321	-3.8011
R^2	0.4878		
$Adj-R^2$	0.4102		
F-statistic	6.2860*		
D. W Test	2.1403		

Diagnostic Test	F-statistic	Prob. value	
$\chi^2 NORMAL$	2.5809	0.2751	
$\chi^2 SERIAL$	0.7374	0.3968	
$\chi^2 ARCH$	0.7807	0.3827	
$\chi^2 WHITE$	0.3588	0.9543	
$\chi^2 RAMSEY$	0.8058	0.3760	
Note: *, ** and *** denote the significant at 1%, 5% and 10% levels respectively. $\chi^2 NORM$ is for normality test, $\chi^2 SERIAL$ for LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Ramsey Reset test.			

Source: Prepared by the author

Table-6.1: Variance Decomposition Approach

Variance Decomposition of $\ln E_t$					
Period	$\ln E_t$	$\ln F_t$	$\ln Y_t$	$\ln A_t$	$\ln M_t$
19	26.8961	0.1339	37.8059	13.1439	22.0200
20	25.9128	0.1335	**38.0781**	12.9720	**22.9034**
Variance Decomposition of $\ln F_t$					
19	30.7913	18.9122	24.5365	9.6933	16.0665
20	**29.8534**	17.8924	**25.5065**	9.7975	16.9498
Variance Decomposition of $\ln Y_t$					
19	19.3091	0.1801	41.0544	12.6790	26.7771
20	**18.9815**	0.1840	41.0409	12.5456	**27.2478**
Variance Decomposition of $\ln A_t$					
19	30.6839	5.7835	25.8030	26.7005	11.0289
20	**29.5597**	5.4133	**26.9220**	25.7685	12.3363
Variance Decomposition of $\ln M_t$					
19	22.2586	0.9444	37.7437	11.1210	27.9321
20	**21.8392**	0.9080	**37.9052**	11.0951	28.2523

Source: Prepared by the author

Table-6.2: Variance Decomposition Approach

Variance Decomposition of $\ln A_t$					
Period	$\ln E_t$	$\ln F_t$	$\ln Y_t$	$\ln A_t$	$\ln M_t$
1	6.6057	0.1129	13.1645	80.1166	0.0000
2	9.2050	4.2687	14.1642	72.3535	0.0084
3	19.6619	7.3192	12.4901	60.4870	0.0422
4	24.6398	11.3347	10.9318	52.9898	0.1037
5	30.2862	12.7219	9.76694	47.0948	0.1300
6	34.4551	12.9375	9.1805	43.2462	0.1806
7	37.3312	12.5638	9.1184	40.7314	0.2551
8	39.2398	11.9964	9.4606	38.9347	0.3683
9	40.2761	11.3678	10.2033	37.5866	0.5659
10	40.6202	10.7280	11.2931	36.4641	0.8945
11	40.3938	10.0949	12.6853	35.4224	1.4033
12	39.7123	9.4715	14.3146	34.3786	2.1226
13	38.6920	8.8605	16.0941	33.2970	3.0561
14	37.4429	8.2665	17.9337	32.1754	4.1813
15	36.0660	7.6964	19.7509	31.0307	5.4557
16	34.6462	7.1577	21.4810	29.8880	6.8270
17	33.2484	6.6567	23.0799	28.7723	8.2424
18	31.9183	6.1980	24.5233	27.7048	9.6554
19	30.6839	5.7835	25.8030	26.7005	11.0289

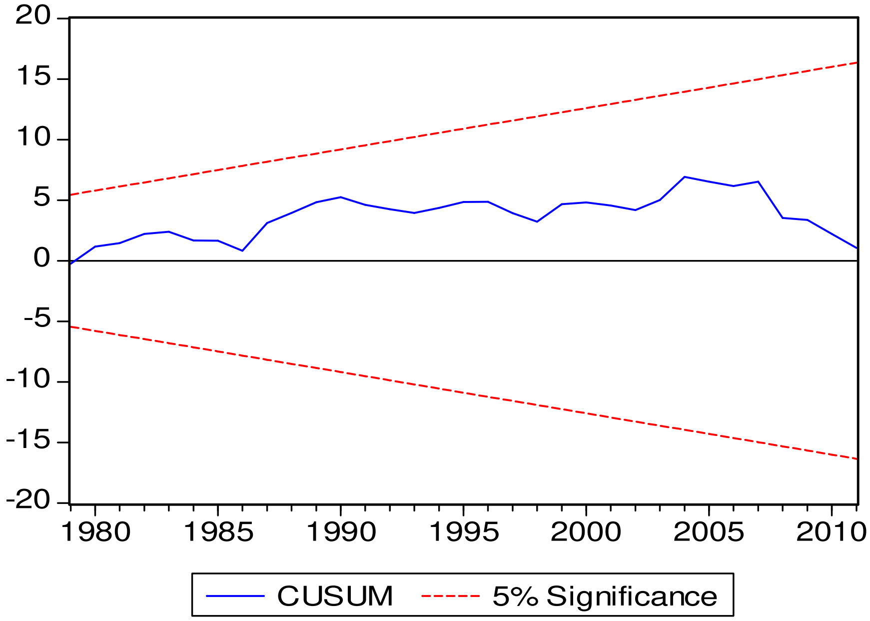
20	29.5597	5.4133	26.9220	25.7685	12.3363

Variance Decomposition of $\ln M_t$					
Period	$\ln E_t$	$\ln F_t$	$\ln Y_t$	$\ln A_t$	$\ln M_t$
1	13.5970	3.3669	33.5980	4.3612	45.0768
2	28.3096	3.6989	31.2900	5.6410	31.0603
3	31.7590	3.5608	31.0216	6.0269	27.6315
4	32.8176	3.2727	30.8897	7.0302	25.9895
5	32.9959	3.0417	30.9471	7.9108	25.1043
6	32.5513	2.7657	31.3870	8.6334	24.6624
7	31.8244	2.4812	31.9970	9.2339	24.4633
8	30.9253	2.2183	32.6899	9.7211	24.4451
9	29.9414	1.9873	33.4025	10.1146	24.5540
10	28.9343	1.7898	34.0929	10.4256	24.7572
11	27.9434	1.6224	34.7380	10.6653	25.0307
12	26.9959	1.4809	35.3239	10.8445	25.3546
13	26.1083	1.3613	35.8451	10.9729	25.7122
14	25.2898	1.2599	36.3009	11.0597	26.0894
15	24.5443	1.1740	36.6941	11.1130	26.4744
16	23.8718	1.1013	37.0290	11.1401	26.8576
17	23.2696	1.0398	37.3116	11.1472	27.2316
18	22.7335	0.9879	37.5477	11.1395	27.5911
19	22.2586	0.9444	37.7437	11.1210	27.9321

20	21.8392	0.9080	37.9052	11.0951	28.2523

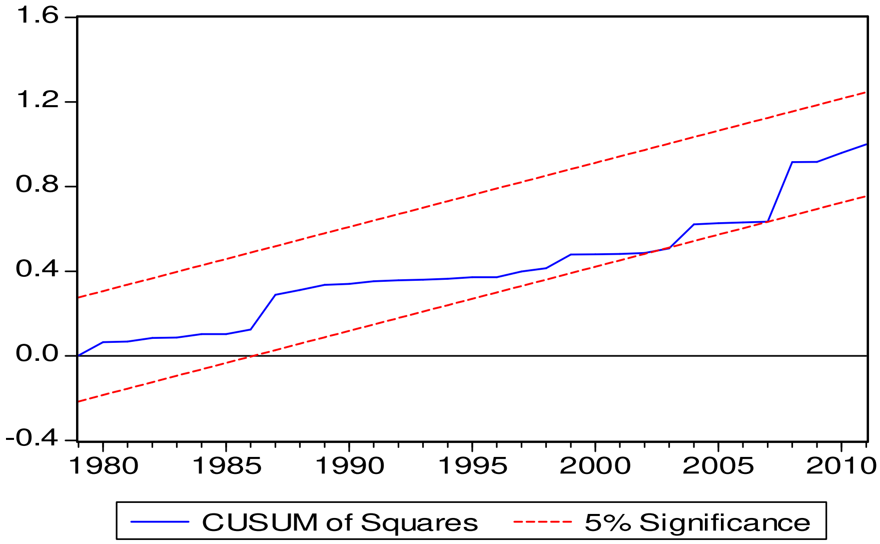
Source: Prepared by the author

Figure-1: Plot of Cumulative Sum of Recursive Residuals



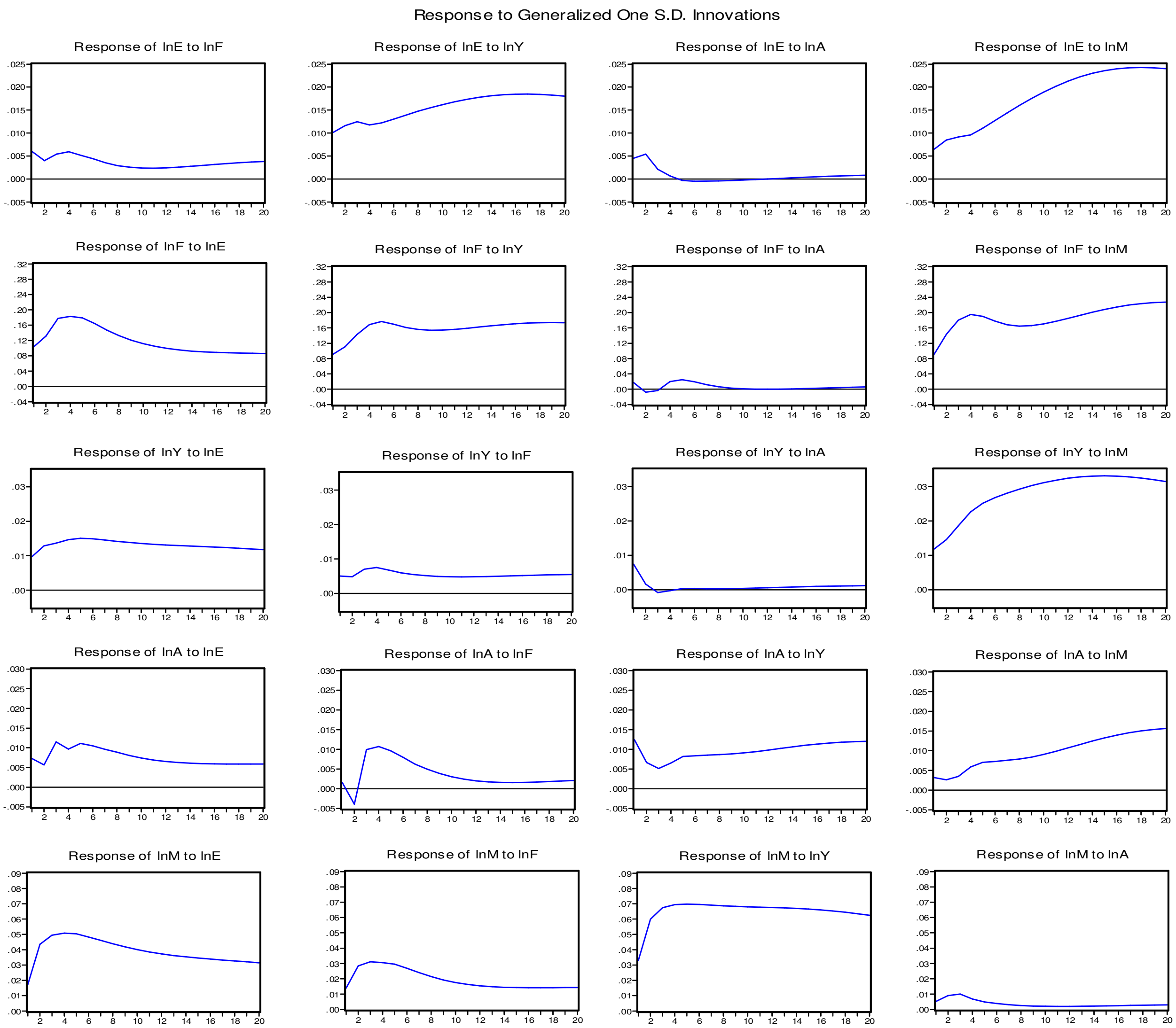
The straight lines represent critical bounds at 5% significance level.

Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level.

Figure-3: Generalized Impulse Response Function



Source: Prepared by the author