The Impact of Financial Development on Energy Consumption in Pakistan: Evidence from ARDL Bounds Testing Approach to Cointegration

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INTRODUCTION

- Energy economics has drawn quite a bit of attention from academicians and professionals in recent times. In particular, the relationship between energy consumption and economic growth has been under scrutiny; and for good reason.

- Energy drives the wheels of economic growth. A significant part of the spurt in the demand for energy has its roots both in the pursuit of economic growth by the developing, and the maintenance of the living standards by the developed nations.

INTRODUCTION

- Kraft and Kraft (1978), in a pioneering study found unidirectional causality running from GDP to energy consumption for the United States over the period 1947-74. The finding is intuitively appealing.
- Researchers have included several relevant variables to explore a long run relation between economic growth and energy demand; and the direction of causality.
- Energy use is highly dependent on the stage of economic growth.
- Rising population and increasing urbanization also play critical role in energy demand as does a host of other factors.

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- Apergis and Payne, (2009a, 2009b, 2010) and Wolde-Rufael, (2009a) argue that the spurt in energy demand in emerging economies is closely linked to rising income. Logically, efficient energy use should help sustained economic growth in the long run, although may not be true in the short run.

- Population growth tends to cause rapid urbanization due to pressure on rural resources and environmental degradation, which cause further rise in energy demand.

- Therefore, the interrelationship among capital stock, labor, and population in the energy-growth nexus should be carefully examined in the context of the contemporary world.

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- Financial development as part of financial liberalization activates equity market, introduces greater level of transparency in transactions, allows easy access to financial capital for investment across nations, facilitates inflow of foreign direct investment (FDI), and lowers financial risk and borrowing costs.

- An active financial sector increases consumption and business investment and affects energy demand. Financial development increases productivity and economic growth (Fung, 2009) and helps energy use. Broadly, financial development improves monetary transmission mechanism, boosts savings and investment and promotes economic growth which increases demand for energy.

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- Experience shows that liberalized financial market increases energy demand through economic growth-enhancing effect [Bekaert and Harvey, 2000; Bekaert et al., (2001, 2002, 2005)]. An alternative view suggests financial development follows economic growth (Lucas, 1988; Robinson, 1952; and Stern, 1989).

- According to this view energy demand is relatively non-responsive to financial development (Sadosky, 2009). The impact of financial development on energy use can work in different way.

INTRODUCTION

- The objective of this paper is to take a broader approach in examining a long run relationship; and the direction of causality among energy demand, financial development, economic growth, capital stock and population in Pakistan.

- Pakistan, a nation of 165 million is making major efforts to achieve sustained economic growth. This translates into higher energy use. Despite the importance of the topic for Pakistan, academic research to address this complex issue has been inadequate, at best.

Methodology

- We employ Auto Regressive Distributive Lag Model (ARDL) to investigate long run relationship using the bound testing approach and Error Correction Model (ECM) for short run association. The causality is examined using the innovation accounting approach.
- There are several advantages in using the ARDL bounds testing approach as given below:
- The first advantage is that it can be applied irrespective of whether underlying regressors are purely I(0), purely I(1) or mutually co-integrated (Pesaran and Pesaran, 1999).
- The second advantage of using the bounds testing is that it performs better than Engle and Granger (1987), Johansen (1990) and Philips and Hansen (1990) co-integration tests in small samples (see e.g. Haug, 2002).

Objectives of the Study

- The third advantage of this approach is that, the model takes sufficient number of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai, 2003).

Data Period

- Study utilizes annually time series data covering the period from 1971 to 2008. Data has been obtained from World Development Indicators (WDI, 2009) and Economic Survey (various issues).

Model Specification

Following theoretical framework as discussed above, the basic specification for the empirical model is as below

$$ENC = f(FD, GDP, POP, PCS)$$

Empirical model for long run relationship among the variables is given below:

$$LENC = \delta_{\circ} + \delta_{FD} LFD + \delta_{GDP} LGDP + \delta_{POP} LPOP + \delta_{PCS} LPCS + \mu_t$$

Given below model is for short run relationships for said running actors in the study:

$$\Delta LENC = \beta_{\circ} + \beta_{FD} \Delta LFD + \beta_{GDP} \Delta LGDP + \beta_{POP} \Delta LPOP + \beta_{PCS} \Delta LPCS + \eta ECM_{t-1} + \mu_t$$

Definitions of Variables

- Energy consumption (ENC) is measured by total energy consumption (kt of oil equivalent).
- Growth in real GDP is used to measure economic growth (GDP).
- Capital stock is measured by real gross fixed capital formation (PCS).
- POP refers to population.
- FD is measured by the real stock market capitalization of the listed companies in equity markets is used to measure of financial development.

Results Interpreting Style

Now I am going to present the results from:

(a) Ng-Perron (2001)unit root test.

(b) ARDL based long run results, and the short run dynamic behavior of running actors.

(c) Direction of causality between the series using innovation approach and

(d) sensitivity analysis and stability test.

Descriptive Statistics and Correlation Matrix

Table-1: Descriptive Statistics and Correlation Matrix

Variables	LENC	LFD	LGDP	LPOP	LPCS
Mean	10.68661	7.59708	10.05611	18.52390	9.66786
Median	10.74041	7.62073	10.13379	18.53532	9.70194
Maximum	11.40364	10.3576	10.50474	18.94629	9.95702
Minimum	9.89409	5.57150	9.58838	18.04691	9.24956
Std. Dev.	0.46578	1.48835	0.26462	0.26944	0.19087
Skewness	-0.20413	0.28130	-0.33384	-0.11674	-0.63653
Kurtosis	1.77717	1.93210	2.06984	1.83103	2.41585
Jarque-Bera	2.49298	2.18540	1.96650	2.13151	2.94293
Probability	0.28751	0.33531	0.37409	0.34446	0.22958
LENC	1.00000				
LFD	0.21104	1.00000			
LGDP	0.42842	0.30134	1.00000		
LPOP	0.13689	-0.18731	-0.00738	1.00000	
LPCS	0.11105	-0.02667	0.33067	0.00972	1.00000

Unit Root Estimation

Table-2: Unit Root Test

Ng-Perron Test at Level				
Variables	MZa	MZt	MSB	MPT
LENC	-3.1045	-1.1242	0.3621	26.5248
LFD	-8.3435	-1.9820	0.2375	11.1069
LGDP	-3.9775	-1.3994	0.3518	22.7751
LPCS	-4.4692	-1.4780	0.3307	20.2497
LPOP	-30.6880[a]	-3.7986	0.1237	3.6343
Ng-Perron Test at 1st Difference				
ΔLENC	-18.1834[b]	-3.0134	0.16573	5.0221
ΔLFD	-38.3289[a]	-4.3690	0.11399	2.4236
ΔLGDP	-27.2043[a]	-3.6881	0.13557	3.3496
ΔLPCS	-98.6871[a]	-7.0235	0.07117	0.9270
ΔLPOP	-43.3696[a]	-4.6430	0.10706	2.1712

Note: a. b indicate the significance at the 1%. 5% levels.

Lag Length Criteria

Table-3: Lag Length Criteria

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	174.8929	NA	3.14e-11	-9.99370	-9.76923	-9.91715
1	473.5318	491.8758*	3.27e-18*	-26.0901*	-24.74332*	-25.63081*
2	497.5150	32.44781	3.85e-18	-26.03029	-23.56118	-25.18825

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Results of ARDL Cointegration Test

Table-4 The Results of ARDL Cointegration Test

Panel I: Bounds testing to cointegration		
Estimated Equation	$LENC = f(LMC, LLGDP, LPOP, LPCS)$	
Optimal lag structure	(1)	
F-statistics	21.67606***	
Significant level	Critical values $(T = 37)^{\#}$	
	Lower bounds, $I(0)$	Upper bounds, $I(1)$
1 per cent	7.763	8.922
5 per cent	5.264	6.198
10 per cent	4.214	5.039
Panel II: Diagnostic tests	Statistics	
F-statistics (Prob-value)	2228.155 (0.00000)	
J-B Normality test	3.01713 (0.22122)	
Breusch-Godfrey LM test	1.12148 (0.35101)	
ARCH LM test	1.39397 (0.26422)	
White Heteroskedasticity Test	0.50227 (0.87772)	
Ramsey RESET	0.39952 (0.53574)	
CUSUM	Stable	
CUSUMsq	Stable	

Note: The asterisks *** denote the significant at 10 per cent level. The optimal lag structure is determined by AIC. The probability values are given in parenthesis. # Critical values bounds computed by surface response procedure (Turner, 2006).

Long-run OLS Results

Table-5: Long Run Elasticities

Dependent Variable = LENC				
Variable	Coefficient	Std. Error	T-Statistic	Probability
Constant	-18.1728	1.2266	-14.815	0.0000
LFD	0.0169	0.0075	2.2469	0.0334
LGDP	0.2707	0.0999	2.7095	0.0118
LPOP	0.1354	0.0094	14.293	0.0000
LPCS	0.0952	0.0466	2.0408	0.0515

R-Squared = 0.9984
Adjusted R-Squared = 0.9981
S.E. of Regression = 0.0178
Akaike info Criterion = -5.0672
Schwarz Criterion =-4.8359
F-Statistic = 4010.5640
Prob(F-Statistic) = 0.0000

Sensitivity Analysis

Serial Correlation LM = 2.1225 (0.1250)
ARCH Test = 0.2757 (0.6036)
Normality Test = 1.7646 (0.4138)
Heteroscedisticity Test = 0.6551 (0.7066)

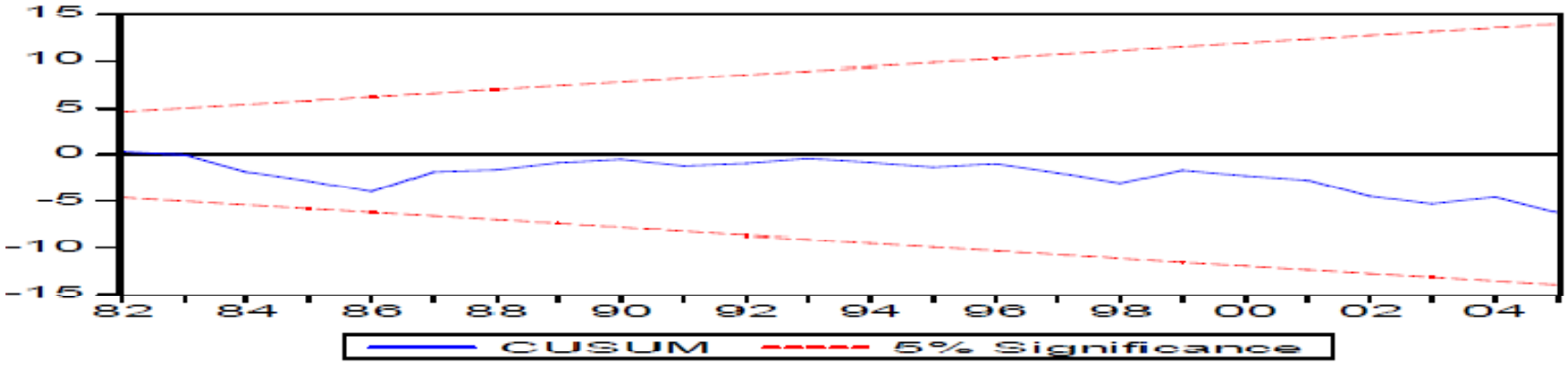
Short-run Dynamic Behavior

Table-6: Short Run Elasticities

Dependent Variable = ΔLENC				
Variable	Coefficient	Std. Error	T-Statistic	Probability
Constant	0.0281	0.0152	1.8440	0.0776
ΔLFD	0.0072	0.0028	2.5066	0.0194
ΔLGDP	0.1793	0.0888	2.0196	0.0547
ΔLPOP	0.3701	0.5788	0.6393	0.5286
ΔLPCS	0.0480	0.0369	1.2997	0.2060
ECM_{t-1}	-0.6516	0.1270	-5.1277	0.0000
R-Squared = 0.5936 Adjusted R-Squared = 0.5089 S.E. of Regression = 0.0123 Akaike info Criterion = -5.7764 Schwarz Criterion = -5.4961 F-Statistic = 7.0121 Prob(F-Statistic) = 0.0004 Durbin-Watson = 1.8674				
Sensitivity Analysis Serial Correlation LM = 0.02610 (0.97426) ARCH Test = 0.40444 (0.53015) Normality Test = 0.53056 (0.76698) Heteroscedisticity Test = 1.66725 (0.16203) Ramsey Reset Test = 0.0043 (0.94814)				

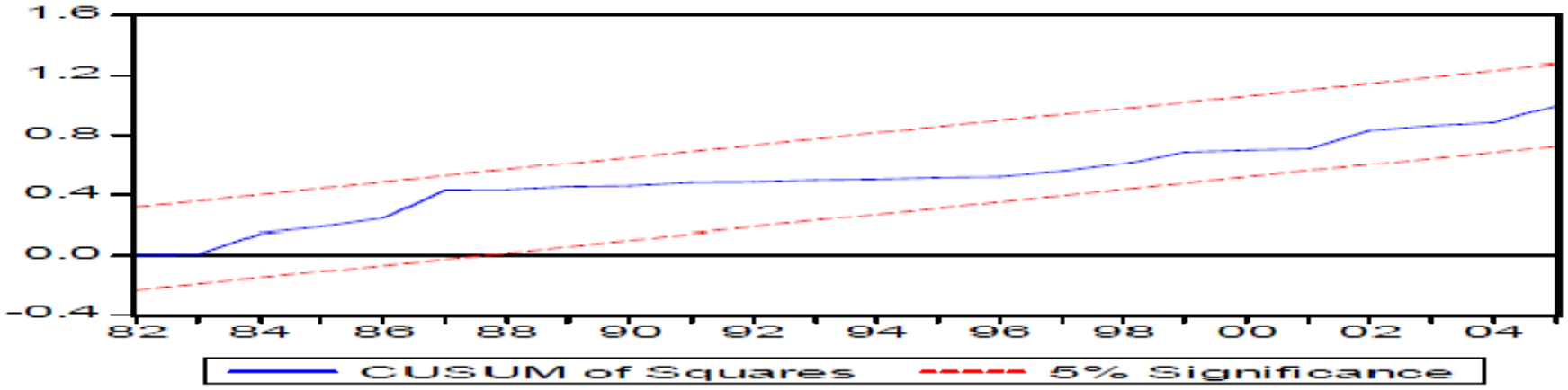
Stability Analysis

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.

Direction of Causality by Innovative Accounting Approach

Table-7.1: Variance Decomposition Approach

Variance Decomposition of LENC						
Period	S.E.	LENC	LFD	LGDP	LPOP	LPCS
1	0.0160	100.0000	0.0000	0.0000	0.0000	0.0000
3	0.0244	94.6275	2.9703	1.5294	0.4881	0.3844
5	0.0303	71.9125	20.8062	5.2286	1.7617	0.2907
7	0.0396	45.0791	39.7967	12.3750	2.5376	0.2113
9	0.0483	32.8402	47.7755	15.9867	3.2519	0.1455
11	0.0552	27.5713	51.1091	17.1117	4.0815	0.1262
13	0.0610	25.4458	51.9632	17.4955	4.9453	0.1501
15	0.0658	25.5030	51.1132	17.2790	5.9164	0.1881
Variance Decomposition of LFD						
Period	S.E.	LENC	LFD	LGDP	LPOP	LPCS
1	0.3158	18.9941	81.0058	0.0000	0.0000	0.0000
3	0.6154	16.3591	73.2579	9.5828	0.2860	0.5139
5	0.8056	18.8373	69.9751	10.5654	0.2202	0.4018
7	0.9254	21.2383	68.6861	9.5510	0.1794	0.3449
9	1.0292	23.0268	67.4763	9.0655	0.1457	0.2854
11	1.1233	24.7915	66.0858	8.7471	0.1238	0.2516
13	1.2074	25.7909	65.4073	8.4573	0.1103	0.2340
15	1.2882	26.1318	65.2149	8.3305	0.1041	0.2184
Variance Decomposition of LGDP						
Period	S.E.	LENC	LFD	LGDP	LPOP	LPCS
1	0.0176	5.1255	28.1937	66.6806	0.0000	0.0000
3	0.0326	4.3120	39.6976	51.4534	0.7809	3.7559
5	0.0533	5.8233	52.9503	37.9057	1.3088	2.0116
7	0.0791	6.1017	56.4449	35.2057	1.2609	0.9866
9	0.0994	5.4776	57.6459	34.6932	1.4061	0.7770
11	0.1153	5.2975	58.3840	34.0501	1.6068	0.6613
13	0.1287	5.0202	58.7014	33.9095	1.8016	0.5671
15	0.1395	4.6663	58.8307	33.9514	2.0385	0.5129

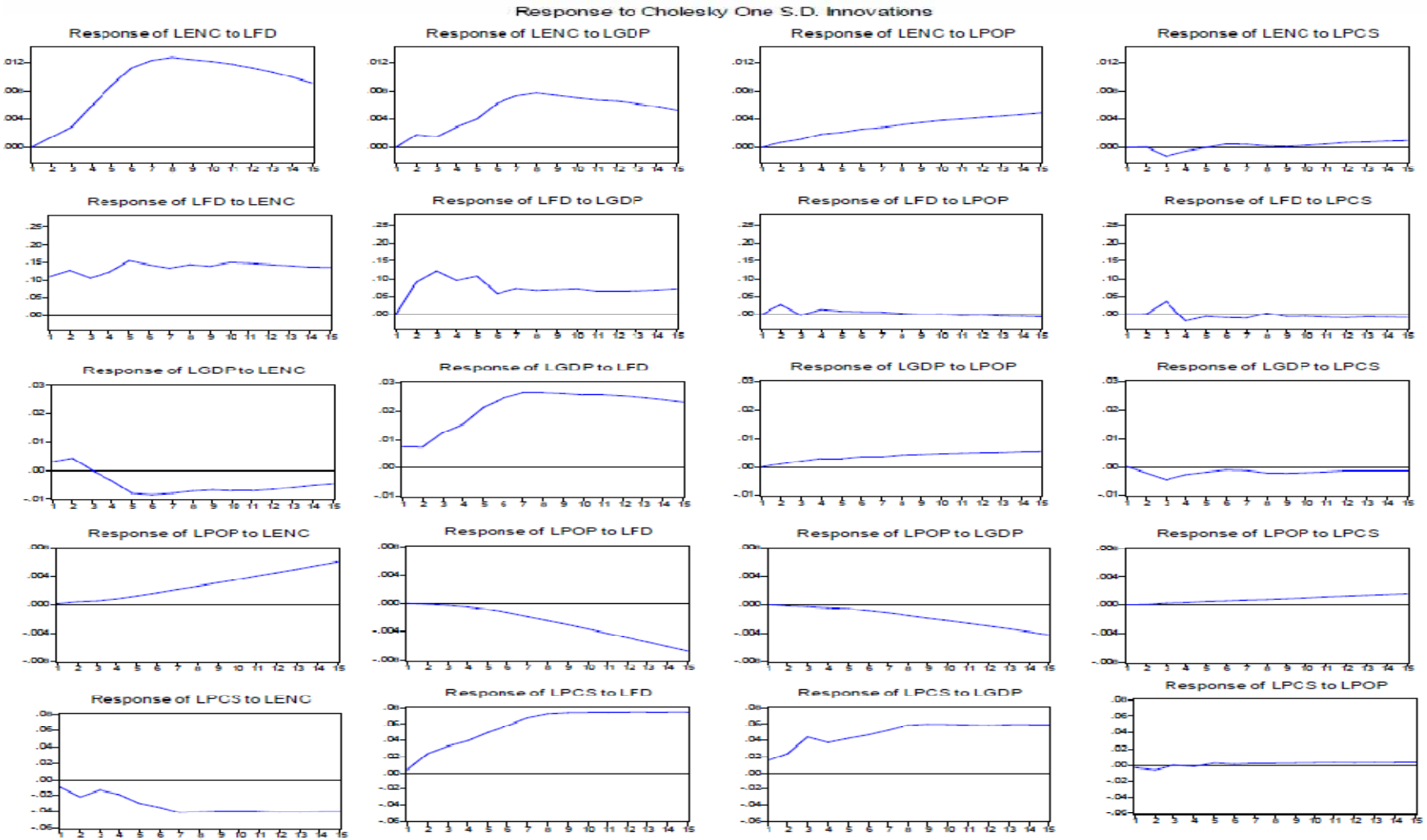
Direction of Causality by Innovative Accounting Approach

Table-7.2: Variance Decomposition Approach

Variance Decomposition of LPOP						
Period	S.E.	LENC	LFD	LGDP	LPOP	LPCS
1	0.0005	7.2887	0.9407	0.1490	91.6215	0.0000
3	0.0017	21.6061	6.3174	6.7714	61.9015	3.4034
5	0.0036	28.6560	13.9908	7.8219	44.4312	5.0999
7	0.0066	33.5146	23.0312	9.8172	29.5815	4.0553
9	0.0108	33.9204	29.4601	12.0327	21.2709	3.3156
11	0.0158	33.5766	33.4406	13.3358	16.6977	2.9491
13	0.0216	33.2240	36.0461	14.1416	13.9043	2.6838
15	0.0282	32.8289	37.8505	14.7348	12.0883	2.4973
Variance Decomposition of LPCS						
Period	S.E.	LENC	LFD	LGDP	LPOP	LPCS
1	0.0432	7.9981	1.3093	19.2179	0.6493	70.8251
3	0.1019	11.5296	25.6878	41.4630	0.5589	20.7605
5	0.1553	13.1630	37.2792	38.6701	0.3048	10.5826
7	0.2229	15.9332	43.0507	34.2994	0.1697	6.5468
9	0.2886	15.6633	45.7323	33.7647	0.1228	4.7167
11	0.3421	15.4793	47.1828	33.4293	0.1128	3.7956
13	0.3890	15.5697	47.9830	33.0232	0.1079	3.3160
15	0.4310	15.5088	48.4687	32.8965	0.1042	3.0216

Direction of Causality by Innovative Accounting Approach

Figure-3: Generalized Impulse Response Function



Conclusions

- Variables are cointegrated suggesting the existence of a long run relationships among the series.
- Financial development is positively related to energy consumption and significant at the 5 percent level both in long as well as in short span of time.
- Economic growth has positive and significant impact on energy consumption at the 5 percent level in long run, and 10 percent for short run respectively.
- Growth of population and capital stock also leads to an increase in energy demand at the 1 and 10 percent levels respectively in long run and in short runs. Impact of capital stock is positive both in the long and short run. While the impact of PCS is significant at the 10% level in the long run, it is insignificant in the short run.

Conclusions

- Innovative accounting approach detects the direction of causality among the variables. Results show unidirectional causal relation from financial development and economic growth to energy consumption.

- Bidirectional causality is found between financial development and energy consumption. The link is strong from financial development to energy consumption.

- Economic growth is caused by financial development. The causality is also runs from energy consumption and financial development to population.

- Finally, financial development and economic growth cause capital stock.

Policy Implications

- Findings of the study can be helpful for those in charge of to the energy sector of Pakistan. While promoting economic growth is a primary goal of economic policy, in theory use of modern capital equipment can reduce energy consumption and raise productive efficiency. Appropriate policy formulation might help Pakistan modernize capital.

- A developed financial system can attract investors, boost stock market, make funds available and bring efficiency to an economy from many dimensions including the energy sector.

Policy Implications

- Ad hoc macroeconomic policies with respect to stock markets combined with deteriorating law and order situation in many nations, including Pakistan, reflects on the relatively poor performance of financial development on energy consumption. The stock market needs some overhaul in the direction to creating a more friendly atmosphere through confidence building.

- Without suggesting too much regulation in the financial sector of Pakistan, one can still introduce sensible and comprehensive financial reforms to strengthen the sector. Attracting FDI and superior technology in the area of capital machinery can improve energy use. Also needed are energy conservation policies.

Thanks!

Questions?