Linkages between Foreign Capital Inflows and Energy Consumption: Fresh Evidence from Pakistan

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Introduction

- Foreign capital inflows (foreign remittances, foreign direct investment and foreign portfolio investment) have increased over the selected period of time, i.e., 1972-2014.

- Real foreign remittance per capita growth is 3,756%, real FDI per capita growth is 1395% and real foreign portfolio investment per capita growth is 1496%.

- A large portion of the foreign capital inflows in Pakistan comes from foreign remittances; therefore, neglecting its impact on energy demand will result in imprecise conclusions.

- Real exports per capita growth is 71%, real effective exchange rate (devaluation) decline is 52%, real GDP per capita growth is 154%, and energy use per capita growth is 68%.

Theoretical Linkages

- How foreign capital inflows (FCI) impact energy demand is a popular research topic yielding mixed empirical findings. Developing countries provide incentives to attract FCI to reap positive externalities that may in turn affect income per capita.

- These positive externalities include inter-alia productive efficiency, advancements in technology, human and managerial skillfulness, learning by doing, new methods of production and access to international markets. These externalities may affect energy consumption via different channels.

- For instance, FCI stimulates economic activity in the host country, which in turn impacts energy consumption. This is the so-called *scale effect*. Therefore, FCI has an indirect but positive impact on energy demand.

Theoretical Linkages

- The structural changes in an economy may change the production patterns of energy intensive goods. During the early stages of economic development, economies transition from agricultural to industrial sectors, and this shift results in higher energy demand. This is the positive *composite effect*.

- When the economy achieves a matured level of economic development, it shifts from industrial to service sectors (light industry), and the latter is less energy intensive compared to the former. This is the negative *composite effect*.

- The effect of adopting advanced technologies for energy consumption is termed the *technique effect*. The *technique effect* suggests that the advancements in technology results in enhanced output as well as less energy consumption than in the case of traditional technologies.

Theoretical Linkages

- Furthermore, FCI lowers energy consumption via the adoption of energy efficient technology and increases market competition.

- FCI may increase energy demand by boosting economic activity, encouraging industrialization and creating cheap business opportunities via the *scale*, *composition* and *technique effects* in developing economies.

- Further, FCI enhances the export potential of an economy and raises stock market capitalization in the host country.

Empirical Model

$$\ln EC_t = \delta_0 + \underbrace{\delta_1 \ln FCI_t}_{Foreign\ capital\ \inf lows\ effect} + \underbrace{\delta_3 \ln Y_t}_{Economic\ growth\ effect} + \underbrace{\delta_4 \ln EX_t}_{Exports\ effect} + \underbrace{\delta_5 \ln DEV_t}_{Devaluation\ effect} + \underbrace{\varepsilon_t}_{\text{Re}sidual\ effect}$$

- EC is energy use measure for Energy Consumption.
- FCI Foreign capital inflows.
- Y is real GDP per capita
- EX is real exports per capita
- DEV is real effective exchange rate (measure for real devaluation)

Contribution of the Study

- The current study may have four contributions to existing literature:

I. The relationship between foreign capital inflows and energy consumption is investigated by adding economic growth, exports and currency devaluation as factors of GDP growth and energy demand.

II. The structural break unit tests are employed to test the stationarity properties of variables.

III. The cointegration relationship between the variables is examined by applying ARDL bounds testing in the presence of structural breaks.

IV. The direction of causality is investigated between foreign capital inflows and energy demand by applying the VECM causality test.

The Data

- The data of real GDP, real exports, energy consumption, real foreign direct investment, real portfolio investment and real foreign remittances are sourced through the World Development Indicators of World Bank (CD-ROM, 2015).

- The data for real effective exchange rate to proxy currency devaluation are obtained from International Financial Statistics (CD-ROM, 2015).

- Foreign capital inflows (generated by authors)

- Quarterization of data by Quadratic Match-sum method.

FCI Index Generation

Table 1: Correlations Matrix

Variables	FDI_t	REM_t	FPI_t
FDI_t	1.0000		
REM_t	0.7575	1.0000	
FPI_t	0.6344	0.6167	1.000

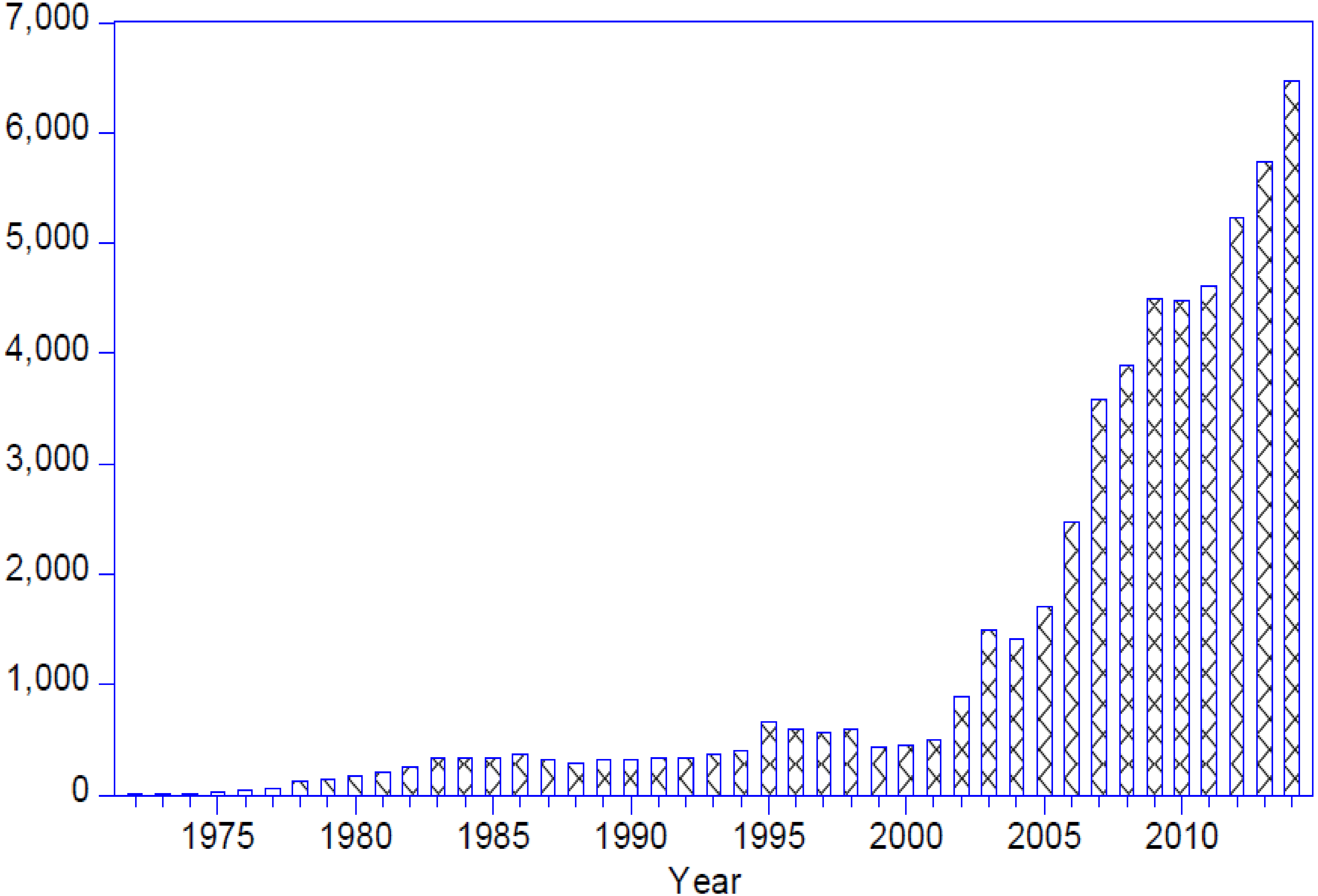
FCI Index Generation

Table 2: Principle Component Analysis

	PAC 1	PAC 2	PAC 3
Eigen value	2.3411	0.4169	0.2418
Variance Prop.	**0.7804**	0.1390	0.0806
Cumulative Prop.	0.7804	0.9191	1.0000
Eigenvectors			
Variable	Vector 1	Vector 2	Vector 3
FDI_t	0.5879	-0.4309	0.6845
REM_t	0.5925	-0.3466	-0.7271
FPI_t	0.5506	0.8331	0.0515

Note: FDI_t is the real foreign direct investment per capita, REM_t indicates real foreign remittances per capita, and FPI_t shows the real foreign portfolio investment per capita.

Figure 1: Foreign Capital Inflows per Capita (PKR)



Empirical Results

Table 3: Descriptive Statistics and Correlation Matrix

Variables	$\ln EC_t$	$\ln FCI_t$	$\ln Y_t$	$\ln EXP_t$	$\ln DEV_t$
Mean	4.5701	-1.1740	5.9342	8.0323	4.7469
Median	4.5977	-1.1716	5.8611	8.0784	4.5940
Maximum	4.8846	-0.9879	8.4365	8.7037	5.2868
Minimum	4.2376	-1.3736	2.7934	7.2173	4.3277
Std. Dev.	0.1967	0.1091	1.5065	0.4680	0.3415
Skewness	-0.1045	-0.0494	-0.3366	-0.1878	0.3286
Kurtosis	1.7101	2.0072	2.9023	1.7669	1.4526
Jarque-Bera	2.9236	1.6589	0.7716	2.7693	2.7105
Probability	0.2218	0.4362	0.6798	0.2504	0.2648
$\ln EC_t$	1.0000				
$\ln FCI_t$	-0.1889	1.0000			
$\ln Y_t$	0.1645	0.1309	1.0000		
$\ln EXP_t$	0.0967	0.2009	0.3669	1.0000	
$\ln DEV_t$	-0.2188	0.210	-0.0354	-0.3100	1.0000

Unit Root Analysis

Table 4: Unit Root Tests without Structural Breaks

Variables	Augmented Dickey-Fuller Test		Philips-Perron Test	
	T-statistics	Prob. Values	T-statistics	Prob. Values
$\ln EC_t$	-2.6542(9)	0.2573	-2.3110 [3]	0.3252
$\ln FCI_t$	-2.0658 (4)	0.5603	-1.8349 [9]	0.6831
$\ln Y_t$	-2.1212 (9)	0.5593	-2.7789 [3]	0.2073
$\ln EXP_t$	-2.4031 (9)	0.3764	-2.3986 [3]	0.3796
$\ln DEV_t$	-2.0844 (4)	0.5500	-2.5171 [6]	0.3196
$\Delta \ln EC_t$	-3.7551 (8)**	0.0216	-6.7525 [6]***	0.0000
$\Delta \ln FCI_t$	-3.5111 (6)**	0.0417	-5.3424 [12]***	0.0001
$\Delta \ln Y_t$	-4.8647 (7)***	0.0006	-6.7551 [6]***	0.0000
$\Delta \ln EXP_t$	-4.7997 (6)***	0.0007	-6.6276 [6]***	0.0000
$\Delta \ln DEV_t$	-3.8081 (4) **	0.0186	-5.7611 [3]***	0.0000

Note: *** and ** indicate significance at 1 percent and 5 percent levels, respectively. () and [] indicate lag order and bandwidth based on AIC for ADF and PP unit root tests, respectively.

Unit Root Analysis

Table 5: Unit Root Tests with Structural Breaks

Clemente-Montanes-Reyes Detrended Structural Break Unit Root Test						
Variable	Innovative Outliers			Additive Outliers		
	T-statistic	TB1	TB2	T-statistic	TB1	TB2
$\ln EC_t$	-2.013 (6)	1984Q2	….	-5.559 (3)***	1985Q2	….
	-3.801 (6)	1985Q3	2001Q2	-5.377 (5)**	1986Q3	2001Q2
$\ln FCI_t$	-4.100 (6)	2001Q4	….	-4.699 (5)**	1988Q1	….
	-4.221 (5)	1995Q1	2001Q2	-6.245 (6)***	1985Q3	1987Q2
$\ln Y_t$	-1.880 (6)	2003Q1	….	-6.890 (3)***	1980Q2	….
	-4.863 (2)	1979Q1	2003Q1	-8.610 (3)***	1992Q2	2001Q3
$\ln EXP_t$	-2.629 (4)	1985Q2	….	-5.587 (5)**	1977Q1	….
	-3.701 (5)	1985Q2	2004Q4	-5.905 (5)***	1977Q3	2001Q1
$\ln DEV_t$	-3.753 (2)	1985Q1	….	-4.769 (6)**	1982Q3	….
	-3.803 (3)	1985Q1	1998Q1	-6.244 (5)*	1985Q2	1987Q1

Note: *** and ** show significance at 1 per cent and 5 per cent levels, respectively. () indicates lag length to be used.

Cointegration Analysis

Table 7: Results of Cointegration Tests

Bounds Testing to Cointegration			Diagnostic Tests		
Estimated Models	F-statistics	Structural Break	$\chi^2 NORMAL$	$\chi^2 SERIAL$	$\chi^2 REMSAY$
$F_{EC}(EC/FCI, Y, EXP, DEV)$	4.925 ***	1984Q2	0.2991	[1]: 1.2606	[1]: 2.8014
$F_{FCI}(FCI/EC, Y, EXP, DEV)$	4.434	2001Q4	0.1967	[2]: 0.3291	[1]: 0.0108
$F_{Y}(Y/EC, FCI, EXP, DEV)$	3.690 *	2003Q1	0.1424	[2]: 2.6901	[1]: 2.4718
$F_{EXP}(EXP/EC, FCI, Y, DEV)$	4.609 **	1985Q2	0.6203	[2]: 0.9052	[1]: 0.3008
$F_{DEV}(RER/EC, FCI, Y, EXP)$	2.611	1985Q1	0.1308	[2]: 0.1705	[3]: 0.8714
Significance level	Critical values (T = 172)				
	Lower bounds $I(0)$	Upper bounds $I(1)$			
1 percent level	3.60	4.90			
5 percent level	2.87	4.00			
10 percent level	2.53	3.59			

Note: ***, ** and * show significance at 1 percent, 5 percent and 10 percent levels, respectively. The optimal lag is determined by AIC. Upper and lower critical bounds are obtained from Pesaran et al. (2001).

Long-Run Results

Table 8: Long Run Results

Dependent Variable = $\ln EC_t$				
Variable	Coefficient	Std. Error	t-Statistic	Prob. values
Constant	-1.5069***	0.3600	-4.1857	0.0000
$\ln FCI_t$	-0.0151***	0.0041	-3.6800	0.0003
$\ln Y_t$	0.7925***	0.0396	20.0006	0.0000
$\ln EXP_t$	0.0435***	0.0115	3.7619	0.0002
$\ln DEV_t$	-0.1210***	0.0162	-7.4594	0.0000
D_{1984}	-0.0330***	0.0046	-7.0427	0.0000
R-squared		0.8417		
Adj. R-squared		0.6415		
F-statistic		62.4766***		
Durbin-Watson Test		2.1665		
Note: *** shows significance at the 1 percent level.				

Short-Run Results

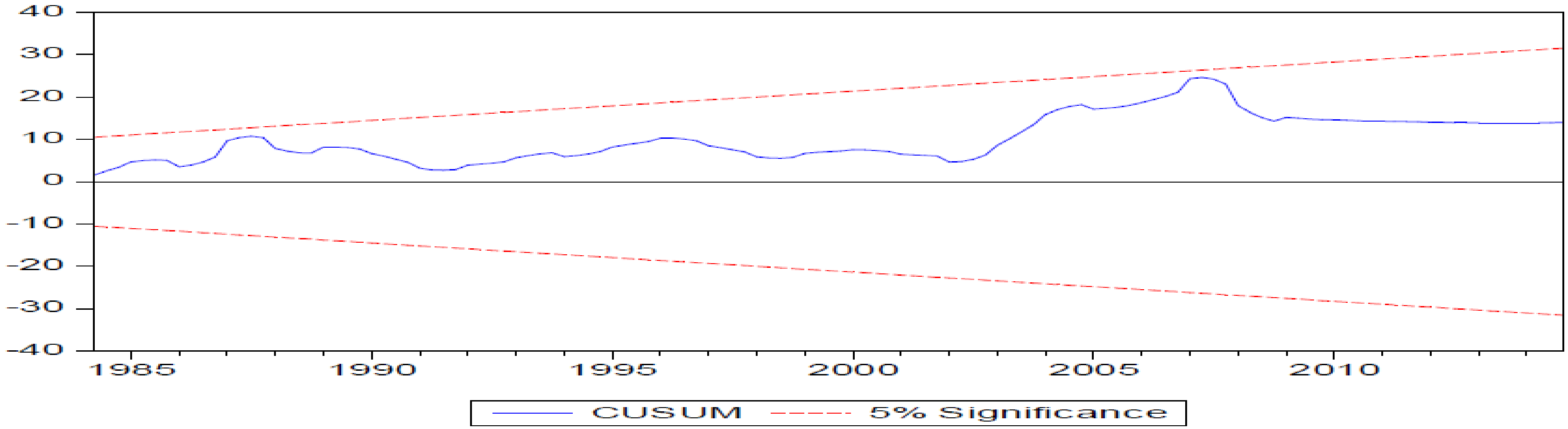
Table 9: Short Run Results

Dependent Variable = $\Delta \ln EC_t$				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
Constant	0.0021**	0.0009	2.1691	0.0315
$\Delta \ln FCI_t$	-0.0074	0.0070	-1.0609	0.2903
$\Delta \ln Y_t$	0.3891***	0.0748	5.1968	0.0000
$\Delta \ln EXP_t$	0.0355***	0.0121	2.9250	0.0039
$\Delta \ln DEV_t$	-0.0809***	0.0250	-3.2303	0.0015
D_{1984}	-0.0005	0.0009	-0.2680	0.7890
ECM_{t-1}	-0.0795***	0.0278	-2.8556	0.0049
R-squared		0.2250		
Adj. R-squared		0.1966		
F-statistic		8.9361***		
Durbin-Watson Test		2.0431		
Diagnostic Tests		F-statistic	Prob. Value	
$\chi^2 NORMAL$		0.2800	0.7499	
$\chi^2 SERIAL$		0.3200	0.6500	
$\chi^2 ARCH$		0.2316	0.6606	
$\chi^2 WHITE$		2.3960	0.1199	
$\chi^2 RAMSEY$		0.1579	0.6970	

Note: *** and ** shows significance at 1 percent and 5 percent levels, respectively. Normality of the error term, serial correlation, autoregressive conditional heteroskedasticity, White heteroskedasticity and functional form of short run model is indicated by $\chi^2 NORMAL$, $\chi^2 SERIA$, $\chi^2 ARCH$, $\chi^2 WHITE$ and $\chi^2 RAMSEY$, respectively.

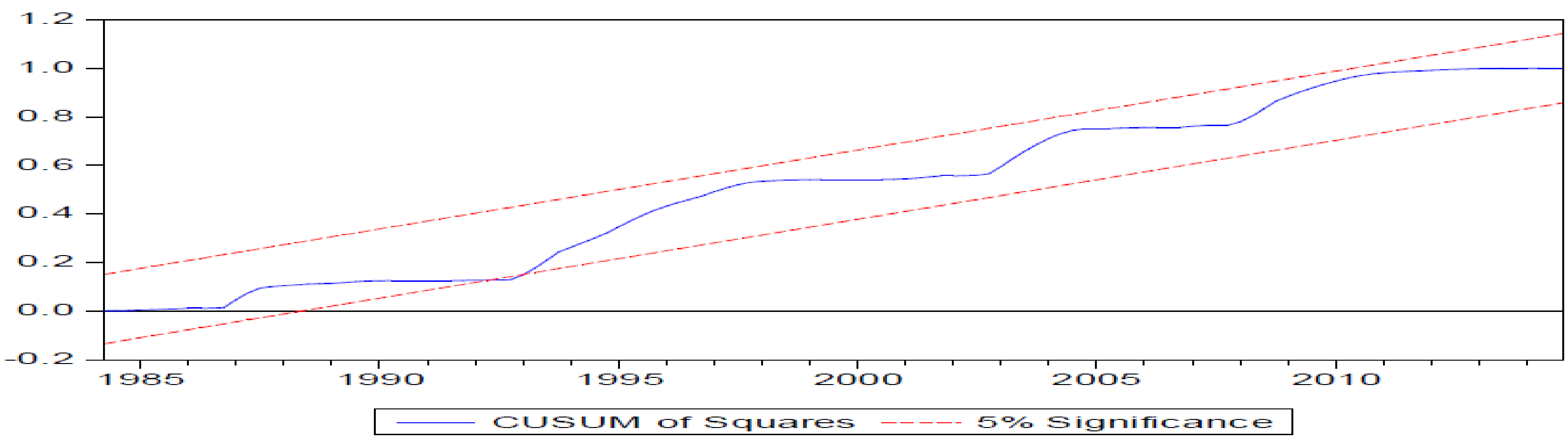
Stability Tests

Figure 2: Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

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



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

Causality Analysis

Table 11: Long-and Short Run Causality

Dependent Variable	Direction of Causality						
	Short Run						Long Run
	$\Delta \ln EC_{t-1}$	$\Delta \ln FCI_{t-1}$	$\Delta \ln Y_{t-1}$	$\Delta \ln EXP_{t-1}$	$\Delta \ln DEV_{t-1}$	Break Year	ECM_{t-1}
$\Delta \ln EC_t$	....	0.4500 [0.6368]	6.0847*** [0.0024]	5.8640*** [0.0065]	3.9808** [0.0209]	1984Q2	-0.0894*** [-3.6930]
$\Delta \ln FCI_t$	0.5239 [0.5933]	....	3.6451** [0.0285]	9.8690*** [0.0001]	6.3933*** [0.0022]	2001Q4	-0.0306*** [-2.6455]
$\Delta \ln Y_t$	5.5055*** [0.0050]	2.7777*** [0.0700]	....	7.2107*** [0.0008]	0.5797 [0.5620]	2003Q1	-0.0776*** [-3.9292]
$\Delta \ln EXP_t$	3.8969** [0.0345]	9.5389*** [0.0000]	7.7789*** [0.0004]	....	8.6996*** [0.0002]	1985Q2	-0.1202*** [-4.3860]
$\Delta \ln DEV_t$	4.9498** [0.0134]	6.0098** [0.0024]	2.0294 [0.2212]	10.2650*** [0.0000]	....	1985Q1	....

Note: ***, ** and * show significance at 1 percent, 5 percent and 10 percent levels, respectively.

- The causality analysis reveals feedback effects between foreign capital inflows and energy consumption, economic growth and energy consumption, and foreign capital inflows and economic growth.

- The relationships between exports and energy consumption, economic growth and exports, and foreign capital inflows and exports are also bidirectional.

- Currency devaluation causes Granger energy consumption, foreign capital inflows, economic growth and exports in Pakistan.

Policy Recommendations

- Although we find a negative relationship between foreign capital inflows and energy consumption, the impact is minimal. Foreign capital inflows need to be directed towards the energy sector for a consistent supply of energy.

- The government should encourage foreign investors to adopt innovative technologies with better management to enhance the efficiency of the energy sector.

- Research and development expenditures should be increased to develop energy efficient and environment friendly technologies, which will help in saving energy resources for maintaining economic development in the long run.

Policy Recommendations

- The existence of a feedback effect between economic growth and energy consumption suggests that energy sources should be utilized efficiently for long run economic development.

- A technology fund can be introduced by the Pakistan government to encourage energy efficient-projects to enhance domestic production and thus exports.

- This would help them earn foreign exchange via boosting exports. Exports should be utilized as sources for importing advanced technology.

Future Directions

- We have discussed possible channels of FCI affecting energy demand in Pakistan but not covered all in empirical analysis. Scale, composition and technique effects are measureable following Ling et al. (2015) and can be examined their effect on energy demand.

- Existing literature is full symmetrical empirical analysis but ignores the role of potential asymmetries in time series data. To cover this issue, we should move to Non-linear ARDL developed by Shin et al. (2014) for empirical analysis.

- You can read a paper published in Energy Policy on "**Financial development and environmental quality: The way forward**" for your under how NARDL is important and how it works?

Thanks so much for *Your* kind ***attention and patient***