Financial Development and Energy Consumption: Empirical Evidence from Pakistan

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Abstract—**Even though a number of studies have attempted to determine the relationship between energy consumption and economic growth role of financial development has not been considered for efficient energy consumption. At present Pakistan is coping with a serious energy problem. This paper attempts to determine the nature of relationship between energy consumption, financial development and economic growth in Pakistan for the period 1980-2009 by employing co-integration and error correction techniques, finally Granger causality test is used to determine the direction of causality between financial development and energy consumption. The results indicate that financial development can be used as a useful measure to overcome energy problems by achieving efficiency in energy use.**

Index Terms—**Pakistan, energy consumption, economic growth, financial development, co-integration, error correction, granger causality.**

I. Introduction

Energy consumption plays a vital role in economic growth of any country. It improves the efficiency and productivity of the country and also has a very important role for individual and households. The role of energy in economic development is well recognized in the available literature of energy economics.

Kraft and Kraft, (1978), found the causal relationship between "Energy and GNP" for the period 1947-74. They indicate unidirectional causality between energy consumption and economic growth where direction of causality runs from GNP to energy consumption [1]. Hwang and Gum, (1992) analyze the energy and economic growth relationship for Taiwan, they indicates bidirectional causality between energy consumption and GNP [2]. In a cross country analysis, Erol and Yu (1987) using "Sims and Granger causality tests" establish mixed results for different countries [3]. They indicate unidirectional causality for West Germany and bi-directional causality for Italy, Japan, U.K, Canada, and France". Tyner (1978) indicates a significant relationship between energy consumption and economic growth for India [4]. Riaz, (1984) scrutinize the relationship between energy consumption and economic development for Pakistan by using simple log linear regression analysis. Surprisingly the result indicates no significant relationship between economic development and energy consumption [5]. Alam and Butt, (2002), concluded that energy consumption and economic growth do have co-integration and granger casualty indicate unidirectional casualty between the variables, and direction of causality runs from energy consumption to economic development [6].

Studies have shown that population growth and stages of economic development are most important forces behind increase in energy demand and consumption. Baltiwala and Reddy (1993) indicates that demand for energy depends upon energy consumption per person [7]. Al- Iriani (2006) found unidirectional causality from economic growth to energy consumption in six Gulf countries [8].

Recent research studies have established that financial development positively affect economic growth. Financial development assists trade growth increase demand and quality of infrastructure and thus effects energy consumption. Wietze and Montfort (2007) found co-integration between energy consumption and GDP in Turkey where the causality runs from GDP to energy consumption [9].

Tamazian, Chousa and Vadlamannati (2009) "observe the association between environmental quality and economic growth for 24 developing economies by Environmental Kuznets Curve. And found that the results favour Environmental Kuznets Curve hypothesis [10].

At present, Pakistan is facing a worse energy crisis of its history; Pakistan's energy requirements are expected to double in the next few years. Financial development can be a useful tool for obtaining efficiency in economic growth and reducing energy consumption. This study aims to determine the relationship between economic growth, energy consumption and financial development.

II. Data and Methodology

This study investigates the nature of relationship between energy consumption, financial development, and economic growth in context of the Pakistan for the period 1980-2009. The variables include "Real GDP, total Energy Consumption, indicators for financial development are proxy by Domestic Credit to Private Sector and Broad Money (M2). Data is taken from different sources that include IFS CD ROM, and statistical bulletin of Pakistan. To measure the long run relationship between the variables, it is necessary that the data should be integrated of same order. Augmented Dickey Fuller unit root test is used to check the order of integration. Johnson co-integration test and vector error correction model are used to determine the nature of relationship between variables and granger causality test is used to determine the

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direction of causality among the variables. Following log linear model is estimated.

$$LnY = \alpha + \beta_1(LnFD) + \beta_2(LnEC) + \varepsilon i$$

where:
Ln = Natural Logarithm
Y = Real GDP
EC = Total Energy Consumption
FD = Financial Development
ε = Error Term

III. Calculations and Results

This study intend to scrutinize the relationship between economic growth and total energy consumption in Pakistan from 1980-2009. Time series data usually have a tendency to be non-stationary, and the estimated regression results may indicate spurious results. To determine the order of integration between variables, test of unit root has been carried out, there are several unit root test available to solve the problem of stationerity, however, we have used Augmented Dickey Fuller test at level and at first difference. The results in table-1 indicate that the variables are non-stationery at level, thus carry unit root. When the unit root is tested at first difference, estimates show stationery properties, which mean the variables are integrated of order 1, I(1).

TABLE I: ADF Unit Root Test

Variables	Level	1st Difference	Result
LNTEC	-3.265393	-3.448434**	I(1)
LNY	-3.487657	-6.961929*	I(1)
LNM2	-0.477355	-4.027118*	I(1)
LNDC	-2.563586	-5.572793*	I(1)

NOTE: * and ** indicates stationerity of data at 5% and 10% significance level respectively.

TABLE II: Johansen Co-integration Test
(A): Trace Statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.869279	114.1692	55.24578	0.0000
At most 1 *	0.704514	61.26736	35.01090	0.0000
At most 2 *	0.594540	29.56985	18.39771	0.0009
At most 3 *	0.209088	6.098794	3.841466	0.0135
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Since the variables in the model are non-stationery and are integrated of same order we now apply the johansen co-integration test to determine the long term relationship between the variables. The "VAR" method is used to determine the optimal the lag length and stability condition. The "FPE, AIC AND SC" criteria determine the leg length and support the "lag 2" as the optimal choice. Johansen co-integration, in TABLE II (A) and TABLE II (B) presents both the trace and maximum eigenvalues. Trace statistics indicates 4 co-integrated equations and maximum eigenvalue also identify 4 co-integrating equations. Thus, we conclude that all the variables are co-integrated and have long-run relationship with each other.

(B): Maximum Egien Values

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.869279	52.90185	30.81507	0.0000
At most 1 *	0.704514	31.69750	24.25202	0.0043
At most 2 *	0.594540	23.47106	17.14769	0.0053
At most 3 *	0.209088	6.098794	3.841466	0.0135
Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

TABLE III: Vector Error Correction Model

Error Correction:	D(LNEC)	D(LNGDPGR)	D(LNM2)	D(LNDC)
CointEq1	0.020050	-14.25880	-10965.96	5.367316
	(0.13459)	(3.61522)	(122399.)	(10.9118)
	[0.14897]	[-3.94410]	[-0.08959]	[0.49188]
D(LNEC(-1))	0.099535	13.82142	25383.43	6.374869
	(0.40857)	(10.9741)	(371545.)	(33.1229)
	[0.24362]	[1.25946]	[0.06832]	[0.19246]
D(LNEC(-2))	-0.389600	-7.521816	-309373.7	-69.68546
	(0.25636)	(6.88585)	(233132.)	(20.7835)
	[-1.51973]	[-1.09236]	[-1.32703]	[-3.35292]
D(LNGDPGR(-1))	-0.003196	1.050432	-3862.390	-0.093016
	(0.01410)	(0.37867)	(12820.3)	(1.14292)
	[-0.22668]	[2.77404]	[-0.30127]	[-0.08138]
D(LNGDPGR(-2))	0.004138	0.509580	929.3716	0.199493
	(0.01045)	(0.28058)	(9499.66)	(0.84689)
	[0.39613]	[1.81613]	[0.09783]	[0.23556]
D(LNM2(-1))	-7.96E-08	-1.67E-06	0.618236	-5.04E-05
	(3.2E-07)	(8.7E-06)	(0.29363)	(2.6E-05)
	[-0.24665]	[-0.19225]	[2.10550]	[-1.92424]
D(LNM2(-2))	2.05E-07	1.85E-05	0.711808	4.48E-05
	(4.1E-07)	(1.1E-05)	(0.36904)	(3.3E-05)
	[0.50603]	[1.69746]	[1.92883]	[1.36193]
D(LNDC(-1))	0.007277	-0.314334	2549.299	0.302418
	(0.00716)	(0.19245)	(6515.67)	(0.58087)
	[1.01566]	[-1.63334]	[0.39126]	[0.52063]
D(LNDC(-2))	0.010516	0.037031	-12486.02	0.015035
	(0.00802)	(0.21549)	(7295.87)	(0.65042)
	[1.31072]	[0.17184]	[-1.71138]	[0.02312]
C	0.067414	-2.524814	11829.14	5.252917
	(0.04098)	(1.10078)	(37268.6)	(3.32247)
	[1.64497]	[-2.29367]	[0.31740]	[1.58103]

The presence of co-integration show long-run relationship between the variables. This indicates that there exists an error correction model, which combines the short run effects with the long run and indicates how much of previous disequilibrium is removed in the current year. Results of Vector error correction model given in table-3 indicate that financial development and energy consumption does not have a significant short run relationship. It indicates that, in the long-run financial development, economic growth and energy consumption are correlated but in the short-run there exist no significant relationship between financial development, energy consumption and economic growth.

Granger causality test is used to indicate the direction of relationship between the variables. Table-4 indicates that unidirectional causality exists between Economic growth and total energy consumption, and direction of causality runs from energy consumption to economic growth, unidirectional causality exist between financial development and energy consumption, the direction of causality runs from money supply to energy consumption, it means money supply cause energy consumption. And direction of causality between domestic credit and energy consumption runs from energy consumption to domestic credit, it means energy consumption increase growth process and output, thus cause credit transfer in the economy.

TABLE IV: GRANGER CAUSALITY TEST

Null Hypothesis:	Obs	F-Statistic	Probability
LNGDPGR does not Granger Cause LNEC	28	0.52214	0.60042
LNEC does not Granger Cause LNGDPGR		1.86499	0.17857
LNM2 does not Granger Cause LNEC	28	2.00784	0.15815
LNEC does not Granger Cause LNM2		0.88323	0.42760
LNDC does not Granger Cause LNEC	28	1.25750	0.30402
LNEC does not Granger Cause LNDC		3.30245	0.05569

IV. CONCLUSION

This paper examines the relationship between energy consumption, financial development and economic growth in Pakistan for the period 1980-2009; by using Johansen Co-integration and Vector Error Correction model.

The results indicate that financial development affect energy consumption in the long-run but remain insignificant in the short-run period. Granger causality test indicates that financial development does effect the energy consumption; the results of Granger causality test indict unidirectional causality between money supply and energy consumption and bidirectional causality between domestic credit and energy consumption. it indicates that energy consumption is essential for economic growth and any energy shock may affect the long-run economic development of Pakistan, and financial development measures such as strengthening financial institutions controlling money supply efficient allocation of financial resources can be used to promote efficient energy use in the long-run.

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