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The Determinants and Forecasting of Coal Consumption in Pakistan

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Abstract
Pakistan faces severe energy crisis which has serious repercussion on different segments of the economy. Therefore it is important to identify the main determinants of energy consumption. Furthermore to accurately forecast the energy demand is crucial for policy origination and proper implementation to overcome ongoing energy crisis. This paper devoted to assess the determinants and forecasting of coal consumption in Pakistan using time series data from 1972 to 2014. For the analysis of data, ADF, Johansen co-integration test, ECM, multiple regression and ARIMA models were used. The empirical results of the study reveal the existence of long run relationship among variables of interest and ECM technique confirms stable long run equilibrium on the basis of short run dynamics for coal consumption. It is found from regression results that GDP, total energy import (coal) and cement production are statistically significant determinants of coal consumption. Further the forecasting results of ARIMA models predict increasing trend in coal demand from 2015 to 2025. Moreover, the study results suggest that coal consumption is inelastic to income and energy prices which mean there is need for economic deregulation and modification in energy market in the shape of privatization and liberalization. This study further suggests that government and private sectors should inject more funds to energy sector in favor of technology and to enhance energy supply to the meet increasing demands of energy.
Keywords: Energy Crisis, Coal consumption, ARIMA and Pakistan.

1. INTRODUCTION

Energy occupies a significant place in persistent growth and sustainable economic development of a country (Khan and Ahmad 2008). Although, Classical economists declared that labor and capital are main factors of production and neglected the most important role of energy in production and economic progress but neoclassical economists stressed on increase in amount of labor, capital and technology for increasing production (Stern, 2004), and modern research suggests that for economic progress of developing countries, energy plays greater role than other factors (IEA, 2005). However, the discovery and explorations of various energy deposits provide employment opportunities to a large numbers of persons of a country improve their economic conditions and fulfill the requirements of industrial, agricultural, transportation and commercial sectors in the economy. The availability of energy resources in the country reduces the imports bill of many items such as oil, electricity and chemicals etc. The energy sector thus makes a significant contribution to GDP (Odalaru, 2009). Starr and Field (1979) were of the view that the role of energy on economic progress appeared as an issue concern in USA in late 1960. While economical domestic supply of oil, coal and natural gas has decreased rapidly. The scarcity of domestic inexpensive energy resources were begun to hamper the future social and economic development. Efficient planning needed to increase energy supply to avoid energy deficiencies. They stated that energy supply has positive effect on economic growth and employment.

As energy is considered one of the most important factors of economic growth and social development therefore it is important to determine its consumption and production (demand and supply) and to elucidate different sources of energy. The decisions of consumer's both households and businesses sector about the consumption of energy have very important implications in economic actions. The nature of energy's demand and information about its determinants are of very much important for precise forecasting of its future needs. For this reason it is important to scrutinize the nature of the relationship between energy consumption, output and the prices. The analysis is also important for the assessment of expenditures on energy consumption, energy demand management and development of strategies for future energy requirements.

Alberinia et al (2011) disclosed the importance of gas and electricity by estimating demand models for U.S. They concluded that energy demand is elastic to energy prices in both short and long run. They further pointed out that price of energy is more important than income of household for gas and electricity. Therefore price of energy and income of household have vital role for policy makers in energy sector. On the other side Erdogdu (2010) observed an insignificant response from prices to gas consumption. Erdogdu (2007) and Khan and Ahmad (2008) provided the evidence that the demand for electricity is not depend on price and income the consumer (electricity demand is inelastic to price and income). The demand for energy is increased about 8% annually in Turkey, while the demand for natural gas is increased faster than others energy sources. They founded that the gas demand has highly inelastic to price and income, and also the estimated results were statistically insignificant. Price inelastic gas demand showed little response to change in price. The study proposed market deregulation needed in Turkey gas market. The present forecast was not over or under estimate natural gas consumption while

past official forecast was over estimated. Halvorsen (1975) reported unitary and statistically significant price elasticity of demand for electricity however inelastic and statistically significant cross elasticity of electricity demand with respect to gas. Whereas income inelastic demand for electricity and it coefficient has statistically significant at 5 % level of significance. A twenty years forecast for residential demand of electricity has been computed and it is observed that, price of electricity has one of the important determinants of electricity consumption in future. Kankal et al (2011) incorporated different determinants of electricity consumption to determine their contribution in the electricity consumption like Population, GDP, imports; exports and employment. Population and GDP affect electricity consumption. Furtadoa and Suslickb (1993) and Geem (2011 were of the view that petroleum consumption depends on petroleum price (demand for petroleum is elastic to petroleum price), While indicated that petroleum consumption in is not depending on population growth and income of the country. On the other hand Kebede et al (2010) reported that there are negative but inelastic relationship exist between petroleum demand and petroleum prices while GDP, population and agriculture expansion have positive effect on petroleum consumption. Further price, GDP and agricultural expansion have statistically significant effect on petroleum consumption. The study indicated the regional differences in GDP growth rate, population growth and energy demand. At last study recommended that the countries should diversify and introduce modern technology in all sectors of energy in order to enhance GDP growth.

Yan (2008) has analyzed the share of change of coal consumption to total energy demand. The key coal consumption industries were iron- steel, power, construction material and chemical industries. Whereas it consume 85% of total coal consumption in 2005. This study forecasted coal demand for given industries from 2010 to 2020. The study considered factors such as future national economic growth rate and energy saving objective, along with co efficient of energy elasticity method used to forecasts energy demand. The study forecasted that there will be increasing tendency in coal consumption. While increase in demand for coal occur due to more coal consumption by power sector.

2. ENERGY SECTOR AND IMPORTANCE OF COAL IN PAKISTAN

In 1980s, the total energy demand in Pakistan was covered from domestic energy supply by 86 %, and remaining 14% of energy requirement was managed by imports, while this gap reached to about 47% at the end of 2000 (SBP, 2006). During 2009-10, the mismatch between energy demand and supply continued which severely affected various sectors of the economy. The shortage further widened the trade balance due to high prices of energy (specifically oil) in the international market. Due to the ongoing shortfall of electricity, there is persistent increase in load shedding in Pakistan for 8 to 10 hours in settled areas and 12 to 16 hours in villages (PEPCO, 2008-09 and Economic Survey of Pakistan, 2009-10). The existing shortage of energy not only increased import bills, but also affected macro economic variables like inflation, budget deficit, current account balance (BOP), foreign exchange reserves, exchange rate, employment level, GDP, and has also adversely affected the standard of living of poor. (Asif, 2011).

The total energy consumption in Pakistan is 63.1 MTOE[1] and supply of energy is 48.01 MTOE in 2009-10. During 2001-02 to 2009-10, the supply of coal, gas, electricity and petroleum products increased by 9.3, 6.3, 3.5 and 1.1 percent per annum respectively. Average total share of oil in total energy consumption is 27.9% in 2009-10. Due to oil price hike, the demand for oil decreased by 8.6% from 2004-05 to 2009-10, because the demand shifted from oil to other cheaper sources of energy. The electricity share in total energy mix during 2009-10 was 15.6% and its demand has increased up to 5.2% annually from 2001-02 to 2009-10. The share of gas in total energy consumption is 43.9% during 2009-10. Available natural gas reserve has been 26.62 trillion cubic feet. The transport and household showed increasing demand for gas by 14.3% and 0.75% respectively. Coal share in the energy mix is 11% during 2009-10. Pakistan has 185 billion tons coal reserves out of which only 175 billion tones are estimated in Thar. (Economic Survey of Pakistan, 2010-11).

Among different sources of energy coal has very important place. It uses in different sectors of the economy like power, cement and brick industries. It also uses at household level but in a negligible volume. In 1990s it was used about 99% in brick kiln industry while the remaining 1% was used in power sector. The structure of the consumption of coal changed over time its consumption increased in power and cement industries. In 2000 coal consumption increased in power and cement industry to about 14% and 28% respectively. This structure further changed over time due to energy crisis in Pakistan coal consumption increased in cement industry while more stagnant in brick industry. The use of coal in cement industry increases than in brick industry (Economic Survey of Pakistan).

The consumption of coal is almost doubled during the last two decades (1990s and 2000s), while it's domestic supply remain more static. There is a divergence between domestic demand and supply which make the situation worse. Forecasting of energy demand and supply is very crucial for the future growth and development of a country. While correct energy demand and supply forecasting are made by the researchers, planners and

[1] Million Ton Oil Equivalent

government, it will help to handle energy crises effectively. Particularly for country like Pakistan, accurate forecasting is very essential because in Pakistan the gap between energy demand and supply is widening with the passage of time. According to official forecasting made by National Transmission and Dispatch Company Limited (NTDC) from 2009-10 to 2019-20, the total electricity consumption in 2019-20 will be 35048 MW as compared to 17847 MW in 2009-10 respectively (NTDC, 2009-10). The cause of high demand for electricity consumption is due to rapid increase in consumers of electricity. In 2010 the total domestic consumers were 0.172 billion, whereas in 2020 it will be 0.209 billion (NTDC, 2008). The gap between total demand and supply of electricity will be -13651 MW in 2020, while it was -3338 MW in 2008 (IPP, 2008). Like other energy sources coal demand and supply mast also forecasts in order to know about the future consumption and production.

Therefore it is important to forecast the future value of consumption (Demand) to provide suitable policy tool to equate demand and supply in order to avoid any distortion in the economy. This paper is devoted to investigate the future value of coal consumption in Pakistan.

3. METHODOLOGY AND DATA SOURCE

Energy demand is derived demand; based on the requirements of economic activities as factor input. Thus economic agents use energy consumption as factor input in the production process as its supplement in household utility and cost of production of firms. Energy consumption required to meet certain human needs to obtain utility, such as heat, lighting, transport, power, business, industrialization and public services etc. Energy demand shows how much quantity of energy purchased at specified price within constrained of income and how effected demand by change in price and income, which is unsatisfied side of demand. Where energy consumption takes place after decision is complete to buy, as it express the measured satisfied demand, nevertheless the demand and consumption of energy are used alternatively.

3.1. Data Sources

In this study, times series secondary annual data on different variables in favor of empirical analysis for the period ranging from 1972 to 2014 has been used. The data required for the study is obtained from various sources. The data for total coal consumption, coal import, maximum temperature and cement production taken from Economic Survey of Pakistan various issues. Data of GDP is source from The Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC). The numerical data of sale price of coal per ton are taken from Pakistan Energy Year Book (2013-14).

3.2 Econometric Modeling for Coal Consumption

In light of the above arguments the multiple regression models is estimated to assess the determinants of components of coal consumption in Pakistan. For econometric modeling of energy demand the following studies provide base i.e. Al- Faris (2002), Filippini and Pachauri (2004), Geem (2011), Kankal et al (2011), Khan and Qayyum (2008), Naryan et al (2007), Sailar (1998), Shurva (2011) and others. They expressed energy especially electricity demand as double and single log linear function of explanatory variables.

$$LnTCC = \beta 0 + \beta 1 LnGDP + \beta 2 LnTCM + \beta 3 CPRO + \beta 4 LnSPC + \beta 5 LnTEMP + \mu t \quad (3.4)$$

Where in the above model the TCC represent total coal consumption which depends on GDP (income), TCM (energy imports), CPRO (manufacturing production), SPC (price) and TEM (temperature).

4. ECONOMETRIC ANALYSIS

Before the estimation of the models, the data must be checked for the order of integration because the nature of the data is time series. Therefore, before proceeding the empirical analysis of time series data, the ADF test will be used to check the data is stationary or non stationary at level.

4.1. UNIT ROOT TEST

The following table 1 report results of Augmented Dickey Fuller test. The ADF statistics for all variables (LGDP LTEMP LTCC LTCM CPROD LSPC) are statistically insignificant at 5% level. It means that null hypothesis does not rejected at level, it is found that given variables are non stationary. At first difference null hypothesis are rejected. Thus all variables are becoming statistically significant at 5% level of significance, which implies that variables are stationarity at first difference. Hence the above variables are integrated of order 1(1).

Table 1: ADF Test for Unit Root:

Variables	Level		First difference		Conclusion
	Statistic value	Critical value at 5%	Statistic value	Critical at 5%	
LGDP	-0.869	-2.943	-3.398*	-2.943	1(1)
LTEMP	-2.472	-2.954	-3.807*	-2.957	1(1)
LTCC	0.174	-2.943	-3.420*	-2.945	1(1)
LTCM	1.529	-2.943	-3.792*	-2.945	1(1)
CPROD	1.274	-2.957	-4.672*	-2.957	1(1)
LSPC	-1.249	-2.943	-5.081*	-2.945	1(1)

***Denotes rejection of null hypothesis at 5% level of significance**

4.2 JOHANSEN CO INTEGRATION TEST

After checking unit root problem the Johansen co-integration test is used to test out co-integration amongst variables of interest. The necessary condition for Johansen co-integration test has satisfied that all variables are stationary at first difference or integrated of orders one. Johansen (1998) and Johansen and Juselius (1990) co integration test have been used to check co integration among the variables of interest, which is crucial for acquiring meaningful results from the models.

The results of Johansen co-integration test for TCC are given in Table 2. The alternative hypothesis presence of co-integration is accepted because trace statistics values are greater than critical values at 5 percent level of significance. The trace statistics and the maximum Eigen justify 2 and 1 co-integrating vectors value respectively at 5 percent level of significance. Thus the results prove the presence of long run relationship between interested variables.

Table 2: Johansen Co Integration Test Results:

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max- Eigen Statistics	5 % Critical Value
$R = 0$	$R \geq 1$	136.7627*	117.7082	44.08286	42.49720*
$R \leq 1$	$R \geq 2$	92.67981*	88.80380	31.95415	38.33101
$R \leq 2$	$R \geq 3$	60.72566	63.87610	21.65852	32.11832
$R \leq 3$	$R \geq 4$	39.06714	42.91525	19.42633	25.82321
$R \leq 4$	$R \geq 5$	19.64081	25.87211	12.33095	19.38704
$R \leq 5$	$R \geq 6$	7.309866	12.51798	7.309866	12.51798

Usually time series data have non stationarity problem, in such case using OLS models on non stationary data gives spurious or not reliable results (Granger and Newbold, 1974). If variables of the study are stationary and co integrated after applying suitable tests, then results obtained from OLS are not spurious. Therefore the results obtained from OLS are consistent.

4.3. Estimation of Determinants of Total Coal Consumption

Table 3 demonstrates the numerical estimates of regression indicate that all variables have positive effect on total coal consumption apart from TEMP and the relationship among variables are in sustain with economic theory. Only SPC and TEMP are statistically insignificant the rest of the variables are statistical significant at 5 percent level. It indicates that coal price and temperature are not key determinants in the long run; the effect of coal price is insignificant due to the reasons that energy is supplied under government owned companies and profit making is not primary objective. Moreover there is no close and cheap substitutes of coal at large scale are available to cement and brick kilns industries. Also price of coal is not determined by market forces. Hence consumers are coercing to consume it irrespective of their price. Therefore price is not dominant factor of coal consumption in Pakistan. Further consumption of coal is not effected to a great extent from temperature because productions of cement and brick kilns are almost unwavering. However the coefficients show that on average 1 unit increase in GDP, TCM and CPROD lead to 0.0059, 0.092651 and 3.732305 units increase in total coal consumption respectively. While 1 unit increase in TEMP and SPC is brought -1.225543 and -0.101028 units decrease in total coal consumption. The given estimated sign of coefficients agree with Adjaye (2000) and Khan and Ahmad (2008).

The values of adjusted R^2, F-statistic and D-W statistic are 0.965540, 213.9463 and 1.585992 respectively, which show the fitted overall model is good.

Table 3: Regression Results:

Dependent variable LTCC			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	10.43040	2.942633	0.0059
LGDP	0.0059	3.686653	0.0008
LTCM	0.092651	3.461892	0.0015
LTEMP	-1.225543	-1.197832	0.2395
LSPC	-0.101028	-1.030862	0.3101
CPROD	3.732305	7.432575	0.0000
R^2= 0.9701 F-Stat = 213.9463 Durbin-Watson = 1.859		AdjR^2= 0.9655 Prob(F-stat)= (0.000)	

4.4. Short Run Dynamics ECM

The ECM is use to show short run relationship between variables, after existence of co integration among variables.

The ECM results are specified in Table 4. All variables have positive effect except GDP has negative effect on TCC. Only SPC and CPROD variables are statistically significant at 5% level. Excluding TCM and CPROD the rest of the variables are against the economic theory, which indicates no stable relation among variables in short-run. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms stable long run equilibrium among variables, with pace of 37 percent to restore equilibrium in case of any shock.

Table 4: ECM results for Total Coal Consumption

Dependent variable D(LTCC)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.048158	0.832562	0.4115
D(LGDP)	-0.286270	-0.724245	0.4743
D(LTCM)	0.005645	0.139079	0.8903
D(LTEMP)	0.351364	0.499567	0.6209
D(LSPC)	0.194891	2.270761	0.0303
D(CPROD)	3.27E-05	2.643122	0.0128
ECT04(-1)	-0.567982	-3.189770	0.0033
R^2= 0.504231 F-Stat = 5.254849 Durbin-Watson = 1.910232		AdjR^2= 0.408275 Prob(F-stat)= 0.000782	

4.5. Autoregressive Integrated Moving Average Model (ARIMA)

The ARIMA model permits every variable to explain by its lagged or previous values and error term. For application of ARIMA model it is necessary that time series must have stationary at level or becomes to stationary at first or more differencing order. Annual time series data from 1972 to 2014 is used and data is not change to logarithms form.

Table 5 is demonstrates forecast results of total coal consumption for the year 2015 to 2025.The results ARIMA model show on average the forecasted values of total coal consumption for the year 2015 to 2020 and 2020 to 2025 will be 6404.68 and 6946.66 thousand metric tons respectively and as whole average total coal consumption in Pakistan from 2015 to 2025 will be 666.58 thousand metric tons. The result illustrates that in future there will be increasing trend in total coal consumption and turn out to be 7167.2 thousand metric tons in 2025.

Table 5: Forecasting of Coal Consumption from 2011-2025

Projected Years	**Forecasted coal consumption (000 tons)**	**Lower 95% confidence interval**	**Upper 95% confidence interval**
2015	6144.6	2448.9	9840.4
2016	6205.0	1812.4	10597.7
2017	6296.1	1283.6	11308.7
2018	6399.2	828.6	11969.9
2019	6506.9	426.8	12587.0
2020	6616.2	65.3	13167.1
2021	6726.2	-264.1	13716.5
2022	6836.4	-567.4	14240.1
2023	6946.6	-848.8	14742.0
2024	7056.9	-1111.3	15225.1
2025	7167.2	-1357.6	15692.0

5. CONCLUSION AND POLICY RECOMMENDATIONS

The results of the study express that price and income elasticity of coal consumption are inelastic also rapid increasing demand of energy and prevailing energy crises require economic deregulation and modification in the energy market in the form of privatization and liberalization. Due to entrance of private sector along with public ownership strong competition will create and will diminish shortage and ultimate insure economic growth.

The forecasted results shows that there is an increasing trend in components of energy (Coal) consumption; furthermore, growth rate of energy consumption is faster than energy (Coal) supply in Pakistan and will carry on in future.

This fact cannot be ignored that Pakistan is rich in various natural resources such as the passageways of natural gas, coal, oil and extended water resources. But, in Pakistan resources availability is not an issue. The more important issue is under utilization and exploitation of available resources, insecurity, mismanagement, ill-planning and no inducement to attract FDI and MNCS to energy sector of Pakistan. For the last two decades Pakistan faces severe energy crises. Increase in energy demand further manifold the crises. The main factors responsible for the increase in crises is economic growth, industrialization, increased per capita energy consumption, enhance agriculture productivity, growth in services, urbanization, modernization, increased per capita income, and providing electricity to Rural areas (NBP, 2008)

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