The Forecasting of Coal Consumption in Pakistan (1972-2015)

Fazale Wahid
University of Peshawar
Sher Ali
Islamia College Peshawar
Naeem ur Rahman
Sarhad University of Peshawar

Pakistan's economy faces severe energy shortfall since the decades of 1990s, and it has severe impacts on various sectors of the country. The shortfall is the difference between supply and consumption. To keep out the economy from any sort of disequilibrium, it is essential to pinpoint the key determinants of energy consumption. In this connection, the accurate forecast of energy consumption is important for policy initiation and suitable execution to deal with energy needs of the day. The main objective of this study is to measure the factors affecting coal to provide a suitable forecast of coal consumption in Pakistan. For this purpose annual time series from 1972 to 2015 are put into investigation through Auto Regressive Distributive Lags (ARDL) and ARIMA techniques are to identify the factors affecting coal consumption and to forecast about future value. The outcome of the co-integration confirms the appearance of long-run association. The results of Error Correction Model confirm stable long run equilibrium. The main determinants of coal consumption are per capita national income measured by Per Capita GDP, total import of coal and production of Cement. Furthermore the results of Auto regressive integrated moving averages (ARIMA) forecast increasing trend in Coal consumption during the period of 2016-2030. The responsiveness of Coal consumption is inelastic to income and prices which indicates that there is need for economic deregulation and alteration in energy market like privatization and to subsidize the energy sector. This study also suggests that more funds should be injected from both public and private sector in favor of technology to satisfy increase in coal consumption .

***Keywords*:** coal consumption, determinants, forecasting, ARDL and ARIMA.

Last two and a half decades witnessed a significant increase in the use of energy for production purpose in different sectors of the economy. Therefore, a continuous increase is experienced in energy prices. This also reflects shrinking in existing energy resources. The rise in demand intensifies the need for search of alternative sources of energy and energy conservation. Energy has become a necessity of the contemporary world. Its availability in proper magnitude need to enhance growth and its lack may hamper the process of growth. Alternative uses of Energy reduce

Correspondence concerning this article should be addressed to Mr. Fazal e Wahid, Department of Economics, University of Peshawar Pakistan, Email: drali@icp.edu.pk
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space and time, enlightening the human lives save and clear environment for future, make sure information sharing and make delivery easy of social services in the modern globalized world. It also helps in best utilization of modern health services. Therefore, it can be claimed that energy and its availability to the mass, have important implications for growth and employment and also in poverty reduction Siddiqui (2004). Energy plays an important role in the determination of industrial output. In case of small scale industry, particularly in rural area; depends on electricity provision. It may affect the length of working duration and productivity. Furthermore, energy itself is an important source of employment generation. Consequently, the use of energy as an input have impacts on both directly and indirectly, which further leads to reduce poverty and quality of life through the employment generation.

The direction of causality between economic growth and the demand for energy extensively have been discussed a lot but there is no clear consensus about it. Adjaye (2000) examined the bi-directional causal relationship between energy consumption, energy prices, and economic growth for selected developing countries. It is found from the study that uni-directional casualty exist, which runs from energy to growth for India and Indonesia, in case of Philippines and Thailand there exist bi-directional causality runs from energy consumption and economic growth. Uni-directional found in case of Pakistan, runs from consumption of electricity to economic growth, and reported bi-directional causality petroleum consumption and economic growth. There is no causal association between consumption of natural gas and growth Aqeel and Butt (2001). Mahmud (2000) reported positive association between energy use and growth of manufacturing sector in Pakistan at sectoral level.

Siddique (1999) reported a positive association between Energy consumption and economic growth, particularly in households sector. The demand is price elastic in case of energy consumption, which is negative and parallel with the theory. The responsiveness of substituted goods is elastic like electricity and petroleum products; and natural gas and petroleum products.

Energy has captured a significant place in the determination of high and persistent growth of a country (Khan & Ahmad,2008). Although, conventional Classical theorists have only defined the role and importance of conventional inputs like labor and capital in economic growth. They have ignored the role and important of some other important factor which explained the variation in economic growth. The theories of 1960's to 1970's didn't say anything about the use energy, they emphasized on the devotion of labor, capital and technology for increasing output (Stern, 2004 & Odalaru, 2009). Starr and Field (1979) highlighted for the first time in the history of USA the importance of energy in economic progress in late 1960.Modern literature highlights the role of energy in economic progress more than other factors for the developing countries International Energy Association (2005). New and differentiated energy's deposits explorations change the nature and composition of the world economy, and provide employment opportunities on large scale. Furthermore, it facilitates different sectors i.e. agricultural, industrial, transportation and communication and commercial sectors to satisfy the needs of the society. The reduction in supply of energy resources will begin to hamper the future social and economic welfare. Effective and suitable planning needed to energy conservation to avoid any risk of energy deficiencies.

Erdogdu (2007) analyzed energy demand functions. He founded that there is no responsiveness from price and income to energy demand. Therefore, he suggested market deregulation needed in domestic economy. Furtadoa and Suslickb (1993), Kebede et al (2010) and

Kankal et al (2011) examined the determinants of different types of energy consumption i.e.income, trade, Population and employment. Income and Population affect electricity consumption. They were also of the view that petroleum demand for petroleum is price elastic, while independent of income and population growth. Kebede et al (2010) founded negative and inelastic association between petroleum price and petroleum consumption. Other variables i.e. income, agriculture and population growth have positive association with petroleum consumption. They concluded that the countries should introduce new technology and diversify energy sector in order to boost output growth.

Yan (2008) examined the difference in used of different sources of energy consumption in particular coal consumption to total use of energy consumption. Coal consumption is mostly directed to construction, chemical, iron, power and steel industries. The share of coal consumption is about 85% of total coal consumption in 2005. He forecasted coal consumption for the industries in consideration for the period of 2010-2020. Various factors like future national growth and energy conservation goals, besides energy elasticity method used to forecasts energy consumption. Increasing tendency was forecasted in coal consumption due the increasing use in power sector.

Pakistan's Energy Status

According to the Stat Bank Report (2006), in the first four decades, Pakistan's energy need was satisfied from domestic resources. About 85% of energy was carried out from the utilization of local energy resources. Only 15% energy was brought through external energy inputs. With the passage of time this distortion was widened and reached to about 50% at the end of the 20th century. During 2007-10,divergence between consumption and production continued, and reached to a very severe stage. Severe shortfall in energy sector affected local economy different sectors of the economy. Beside local sectors, external sector was also badly affected and experienced huge increased in import bill. These deteriorating effects ultimately strike the living standard country (Asif, 2011).

In 2009-10, Energy demand in Pakistan was about 64.05 MTOE[1]and domestic sources were mobilized and generate about 50 MTOE. Various sources of energy were mobilized to satisfy domestic needs during 2002-10 at a rate of 9.3, 6.3, 3.5 and 1.1 Gas, petroleum, electricity, and coal consumption respectively per annum respectively. There is a change observed in the pattern of consumption of different sources of energy. The average share of petroleum to total energy consumption was change due to hike in petroleum prices. Petroleum was substituted by other cheap sources of energy. In 2010 the used of petroleum was observed about 29 percent which decreased from 2005 by about 9 percent. Conversely, the other sources of energy were observed in increasing trend; electricity demand increased to about 16 percent in 2010with the annual increase of about 5 percent, gas consumption increased to about 44 percent in 2010, coal consumption is 11percent in 2010.The consumption of coal increased in different sectors was observed about 3.359 M in 2013 and 4.8691M in 2014.

According to an estimate Pakistan has a very large coal reserves about 185 billion tons (Economic Survey, 2010-11). Pakistan has the potential to get benefited from the huge reserves of coal. Coal can be used to different sectors of the country to contribute growth. It contributed to household sector and Brick industry but in a negligible amount in household sector. In 1990s about 99 percent of the coal was contributed to brick industry and only 1percent to power sector. With the

[1] Million Ton Oil Equivalent

passage of time this structure changed, coal consumption increased by 28 percent and 14 percent in cement and power sector respectively during 2000's.The consumption of coal pattern changed further with the shortfall in energy sector. It uses in cement industry magnified, remains stagnant in brick industry (Economic Survey 2014-15).

Through the world coal is the cheapest source of electricity generation. Several developed countries generate electricity by using the coal. They substituted the expansive resources oil and gas by cheaper resource like coal and reduce their dependency on the oil or gas only. Some of the developed and developing economies that are using coal comprehensively for electricity generation are Poland 96%, South Africa 88%, China 78%, India 78%, Australia 77%, Germany 72%, USA 52% and UK 37%etc.Nadeem and Hafeez (2013). Pakistan should follow coal utilizing economies and adopt the ways to generate electricity from coal reserves and also utilized in other sectors to get benefit from large coal reserves.

Therefore, it is important to identify the key determinants of Coal consumption. These determinants will provide suitable estimates coal consumption and to formulate suitable policy to avoid any distortion in energy sector of the economy. Therefore this study aimed to find out factors affecting coal consumption and forecast future values of coal consumption in Pakistan.

Method

Energy demand is derived demand, which derived from productive economic activities. It is an important need to both household and firms' determine the satisfaction. While in production process it is the basic need to every sector of the economy like agricultural, industrial and services sectors. Energy consumption depends on various factors, whether to use it or not. These factors are price of energy, population size, substitute energy source, import of energy etc.

3.1 Data Sources

The present deals with time series data. Data are used from 1972 to 2015.The data on coal consumption, import of coal and cement production taken from Pakistan Economic Survey. Data on coal price are per ton are taken from Energy Year Book (various issues).

3.2Econometric Modeling

The model of the present study based on some of the past studies like Al- Faris (2002), Kankal et al (2011), Khan and Qayyum (2008) and Shurva (2011); to assess the factors affecting coal consumption in case of Pakistan. The final model of the study is as:

$$\mathrm{LCC} = \beta 0 + \beta 1\mathrm{LGDP} + \beta 2\mathrm{LEM} + \beta 3\mathrm{LCP} + \beta 4\mathrm{LPC} + \mu t$$

(3.4)

Where

CC = Coal Consumption
GDP= Per Capita Income
EM= Energy Imports
CP=Cement Production
CP= coal Price and
U_t = Error Term

Results

As the present study deals in time series data, therefore needed to be tested against unit root tests. For this purpose the ADF test is used in this study.

4.1 Augmented Dickey Fuller (ADF)

The results of ADF-test are given in table-1. It is clear from the given results values all the variables are become stationary after first order. Therefore, all the selected variables for the model are stationary of order 1(1).

Table 1

ADF Test

Variables	Level		First difference		Conclusion
	A	B	C	D	
LGDP	-0.909	-3.021	-3.401*	-3.013	1(1)
LCC	0.174	-3.013	-3.420*	-2.945	1(1)
LCM	1.529	-3.001	-3.792*	-3.104	1(1)
LCP	1.274	-2.957	-4.672*	-2.957	1(1)
LPC	-1.249	-2.943	-5.081*	-2.945	1(1)

Where A=Statistic value, B=Critical value at 5% at level and C=Statistic value and D=Critical at 5% At first difference; *****represents the rejection of Ho at 5% significance level

The next step is the investigation of the existence of the long run relationship to confirm that that selected variables affect coal consumption in the long run or not.

Testing of long Run Relationship

In Table-2 the output of the Wald test is reported. It is clear from reported values of the Wald Test that the value of F-Calculated is greater than the F-Tabulated, which confirms the existence of the long run. After confirmation of co-integration the next step is the estimation of both long run and short run parameters estimates.

Table 2

Wald Test Results

Equation	**A**	B	**C**
FY(CC/GDP,CM,CP)	9.56(0.013)**	(4.1)---------(5.29)	CO-INTEGRATION

A = F-Calculated, B=Critical values at 5% level ^ B and C=decision about co-integration existence

^ CRITICAL VALUES ARE TAKEN FROM PESARAN ET. AL.(2001) TABLE CI(III), CASE III

Long run estimates are estimated with the help of bound testing technique. The required estimates are given in table-3.The results of ECM are given in table-4.

Table3

Estimates of the Long Run

Dependent Variable= Coal consumption			
Var	Coeff	T-Values	P-values
Constant	22.10	2.99	0.009
LGDP	0.0901	3.901	0.008

LCM	0.0651	3.201	0.010
LPC	-0.1282	-1.3862	0.310
LCP	3.0513	7.4735	0.000

Long run estimates are presented in Table-3, variables LGDP LCM and LCP positively affect Coal Consumption, while the variable SPC has negatively affect Coal consumption. The relationship among variables is in consistent with theory. The only variables i.e. LPC is insignificant, while all other factors affecting Coal consumption at 5 percent level. It indicates that coal price is not the key variable in the determination of coal consumption in the long run. Coal price is insignificant because of no close availability cheap substitutes than of coal to bricks and cement industries. Also price of coal is not determined by market forces. Thus price of coal is not the key determining factor of coal consumption in Pakistan. The impact of Cement production CP, income and import of energy have positive association with coal consumption. Though, the parameters express on average that 1percent increase in GDP, CM and CP lead to 0.091, 0.0651 and 3.051percent upsurge in consumption of coal in turn. As income of the country increases consumption of the country also increases is consistent with the economic theory (consumption function). Income of the country increases construction and electricity demand increases over time which leads to increase coal consumption. While a unit increase in SPC is brought -0.1282 percent decrease in consumption of coal. The result of the present study is parallel with the past literature i.e. Adjaye (2000) and Khan and Ahmad (2008).

ERROR CORRECTION MODEL ESTIMATES

Table-4 demonstrates estimates of Short-run. The impact of all explanatory variables on total coal consumption is positive except GDP in the short run. The impact of PC and CM are positive and significant. The results are also parallel with the economic theory existed in the literature except CM. The estimate of the ECM is negative and significant confirms the existence of co-integration. Moreover, the value of estimate demonstrates that any disequilibrium in the long run will be converged to equilibrium at rate of about 60 percent in one year.

Table 4

ECMEstimates

Dependent Variable= Coal Consumption			
Var	Coeff	T-Value	P-value
Constant	0.05	0.805	0.401
DLGDP	-0.301	-0.701	0.501
DLCM	0.010	0.12	0.90
DLPC	0.20	2.30	0.030
DLCP	0.01	2.60	0.012
ECM(-1)	-0.60	-3.20	0.003

4.4 RESULTS OF DIAGNOSTIC TESTS

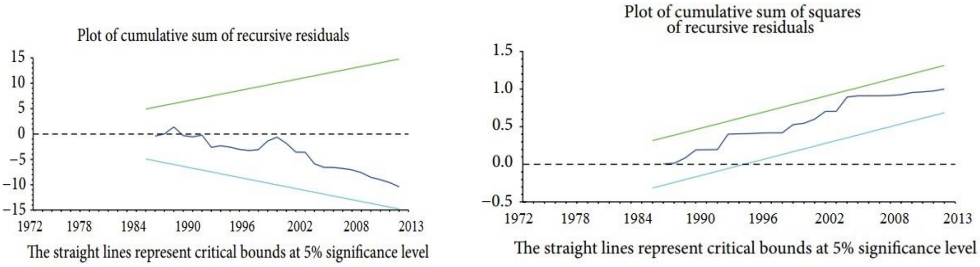
In this section different tests are given to test the specifications errors: Lagrange multiplier (LM) Ramsey's RESET, Jarque–Bera test and White test are used for testing of Serial Correlation, specification of the model, normality and Heteroscedasticity respectively. The plot of cumulative sum or recursive residuals (CUSUM) and cumulative sum of square recursive residual (CUSUMQ) confirms no evidence of mis-specification and structural instability for the estimation period of the model. Results of the above mentioned tests are given in table-5. Plotted residuals are given in figure-1.

Table 5

Diagnostics for the Estimated Model

Test Statistics	LM Version (CHSQ)	Probability
Lagrange multiplier test for serial correlation	0.034	[0.901]
Ramsey's RESET for functional form	3.40	[0.021]
Jarque–Bera test for normality	1.40	[0.501]
White test for heteroscedasticity	0.50	[0.450]

Figure-1



Autoregressive Integrated Moving Average(ARIMA)

ARIMA forecasting technique is used to estimate the forecast values of coal consumption. The forecasted figures are given in Table-5for the period of 2016-2030. Forecasting technique estimated forecasted values for the forecasted values of total coal consumption for 2016 to 2030will be6946.6 and 7710.2thousand metric tons respectively. The forecasted results reported an increasing trend in coal consumption of Pakistan which beneficial and desirable.

Table 5

Forecasting of Coal Consumption from 2016-2030

Projected Years	Forecasted Coal Consumption (000 tons)	Lower 99% confidence interval	Upper 99% confidence interval
2016	6205.0	3812.4	8597.7
2017	6296.1	2683.6	9308.7
2018	6399.2	2228.6	9969.9
2019	6506.9	1426.8	10587.0
2020	6616.2	965.3	11167.1
2021	6726.2	464.1	11716.5
2022	6836.4	67.4	12240.1
2023	6946.6	-848.8	12742.0
2024	7056.9	-2111.3	13225.1
2025	7167.2	-2357.6	13692.0
2026	7277.4	-3030.8	14184.5
2027	7387.6	-3676.3	14739.0
2028	7491.6	-4336.2	15284.5
2029	7605.8	-4999.1	15847.9
2030	7710.2	-5666.2	16373.2

Conclusion and Recommendations

The outcome of the present study reveals that only national income, energy import in the form of coal and cement production are the key factors affecting coal consumption, while price of coal is not the key factor determining coal consumption. In the prevalent energy shortfall economic reform and deregulation in energy sector must be done in the shape of privatization. Coal consumption is determined by economic growth and manufacturing output. Income leads to increase new construction (increase in bricks industry demand) and the need of other energy which production needs coal consumption like electricity. If we want to get from coal consumption we should increase the manufacturing production. ARIMA reported an increasing trend in trend Coal consumption, which is desirable and need of the day.

Pakistan is rich country with natural resources like natural gas, coal, oil and extended water resources. But, still Pakistan hasn't achieved to fulfill its energy needs from domestic resources. With the availability of huge energy resources Pakistan faced severe shortfall since 2000. The issue here with the country in consideration is not of resources availability, the problem herewith mismanagement, exploitation resources, insecurity and lake of planning to attract FDI.

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