THE DETERMINANTS AND FORECASTING OF ENERGY CONSUMPTION AND SUPPLIES IN PAKISTAN FROM 1972 TO 2010

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Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Economics

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APPROVAL SHEET

Certified that the thesis entitled **"The Determinants and Forecasting of Energy consumption and supplies in Pakistan: 1972-2010"** Submitted by **Mr. Fazal e Wahid,** Ph.D. Research as partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy (Ph.D.) in Economics is hereby approved by the Supervisory Committee.

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This is to certify that this thesis prepared by Fazal e Wahid entitled as "Studies on The Determinants and Forecasting of Energy Consumption and Supplies in Pakistan from 1972 to 2010 is accepted in the present form by Department of Economics, University of Peshawar as fulfilling this part of requirements for the degree of Doctor of Philosophy in Economics.

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ACKNOWLEDGEMENT

First of all I would like to thank Almighty Allah, who gave me the ability and good health to accomplish this work in a proper manner. This thesis is a product of different brains. I would like to pay thanks to my teachers, colleagues, family members, and to all those thinkers, who directly or indirectly supported me to complete my research work.

I wish to express my heartiest gratitude to my respected supervisors Prof.Dr. Naeem Ur Rehman for his sincere cooperation and encouragement. It is their guidance, enthusiastic support and scholarly advice which enabled me to accomplish this task. I must pay a tribute to him, for his valuable advice, kind behavior, timely suggestions and constant encouragement at all time.

I am extremely thankful to Prof. Dr. Muhammad Naeem for his enormous support and worthy attitude.

I am thankful to all my friends particularly Dr. Anwar Hussain for his in time cooperation during my research.

I am forever grateful to my parents and brothers for their sincere cooperation and contribution in the completion of this research work. In last again I am very thankful to all those who guided me in this research work.

FAZAL E WAHID

LIST OF ACRONYMS/ABBREVIATIONS

ADF	:	Augmented Dickey-Fuller test
AEDB	:	Alternative energy development board
ANN	:	Artificial neural network
ARDL	:	Auto regressive distributed lags
ARIMA	:	Autoregressive integrated moving average
ARMA	:	Autoregressive moving average
Bcf	:	Billion cubic feet
Bn	:	Billion
BOP	:	Balance of payment
CPI	:	Consumer price index
CPROD	:	Cement production
DF	:	Dickey-Fuller test
DW	:	Durbin-Watson statistics
ECM	:	Error correction model
ECT	:	Error corrected term
EG	:	Economic growth
EMPLY	:	Employment
ETDL	:	Electricity transmission and distribution loss
FDI	:	Foreign direct investment
FGP	:	Final gas price
FOP	:	Final oil price
GA	:	Genetic algorithm
GDP	:	Gross domestic product
GFCF	:	Gross fixed capital formation
GWh	:	Giga watt hours
IEA	:	International Energy Agency
IMF	:	International monetary fund
IPP	:	Independent power producer
Ln	:	Natural algorithm

Mcf	:	Thousand cubic feet
Mm	:	Mille meter
Mmcft	:	Million cubic feet
Mn	:	Million
MNC	:	Multi-national Corporation
MTOE	:	Million tons oil equivalent
MW	:	Mega watts
NBP	:	National bank of Pakistan
NTDC	:	National transmission and Dispatch Company limited
OLS	:	Ordinary least square
Paisa	:	Unit of Rupee (currency unit of Pakistan)
PEPCO	:	Pakistan Electric Power Company
PLS	:	Partial least square
POP	:	Population
QIM	:	Quantum index of manufacturing industries
RF	:	Rainfall
RMSE	:	Root mean square error
Rs	:	Rupees (currency unit of Pakistan)
SARIMA	:	Seasonal Autoregressive integrated moving average
SBP	:	State bank of Pakistan
SESRIC	:	The Statistical, Economic and Social Research and Training center for Islamic Countries
SPC	:	Sale price of coal
SPE	:	Sale price of electricity
TCA	:	Total crop area
TCC	:	Total coal consumption
TCM	:	Total coal import
TCS	:	Total coal supply
TEC	:	Total electricity consumption
TEC	:	Total energy consumption
TED	:	Total external debt

TEMP	:	Temperature
TES	:	Total electricity supply
TGC	:	Total gas consumption
TGS	:	Total gas supply
TO	:	Trade openness
TPC	:	Total petroleum consumption
TPS	:	Total petroleum supply
TREND	:	Technology
TVR	:	Total vehicle registration
TWH	:	Tara watt hour
UPROD	:	Urea production
USA	:	United States of America
VECM	:	Vector error correction model
WAPDA	:	Water and Power Development Authority

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ABSTRACT

Pakistan faces severe energy crisis which has serious repercussion on different segments of economy. Proper identification of determinants of energy consumption and supply, and accurately forecasting of energy demand and supply is crucial for policy origination and proper implementation to overcome ongoing energy crisis. The present study focuses on to assess the determinants and forecasting of energy consumption and supply in Pakistan using time series data from 1972 to 2010. For the analysis of unit root in data ADF has been incorporated, Johansen co integration test, ECM are used to investigate the long and short run estimates of the required objectives, and ARIMA models were used to estimates the forecast their future values. 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 all components of energy consumption and supply. It is found from regression results that GDP, industrialization, total vehicle registration, price of petroleum, price of gas, total energy import (coal) and cement production are statistically significant determinants of components of energy consumption, and total petroleum import, price of petroleum, technology, gross fixed capital formation, total electricity consumption, foreign direct investment, total vehicle registration and employment are statistically significant determinants of components of energy supply. Further the results of the study revealed that total energy consumption has strong and significant effect on economic growth of Pakistan. The forecasting results of ARIMA models suggest increasing gap between energy demand and supply from 2011 to 2025. Moreover, the study results suggest that energy consumption and supply are inelastic to economic activity and energy prices

which mean there is need for economic deregulation and modification in energy market in the shape of privatization and liberalization. The finding of the study suggests that government and private sectors should inject more funds to energy sector in favor of technology and to enhance energy supply to meet increasing demands of energy.

Chapter 1

INTRODUCTION

1.1 Statement of the Problem

Energy occupies a significant place in persistent growth and sustainable economic development of a country. 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).

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 macroeconomic 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 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).

To stimulate economic growth, industrialization, agriculture productivity, growth in services and providing electricity to rural areas, it is important to seek additional sources of energy and further to utilize these resources efficiently. But unfortunately, in Pakistan the natural resources explorations combined with underutilization, mismanagement and poor-planning of energy are the key challenges. From the last two decades Pakistan is faced with severe energy crises. Increase in energy demand further manifolds these crises. In future, Pakistan will confront 31% shortage in energy, which will severely affect the different sectors of national economy like agriculture, industry, transport, services and commercial sector. The economic growth rate in 2009-10 was severely affected by shortage in energy availability (SBP, 2006 and Economic Survey of Pakistan 2009-10).

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 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 day by day. 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).

Pakistan faces a lot of challenges ranging from poverty, low economic growth, political instability and terrorism to energy crisis. The most important of all these challenges is the energy crisis as it is roots cause of many other problems like poverty, unemployment, slow economic growth and low living standard of the masses.

1.2 Universe and Scope of the Study

The consumer, producer and even the government decision relating to the use of energy have very crucial importance for economic growth both in the short run as well as in the long run. The present study will analyze the energy consumption and supply in Pakistan with special focus on its determinants and forecasting. More specifically, this study will focus on assessing the factors influencing energy consumption and supplies in Pakistan using time series data from 1972 to 2010. The energy components covered would be electricity, petroleum, natural gas and coal. This study will also forecast the energy consumption and supplies and their components up to 2025. It will provide a guideline for the consumers, producers, energy planners and government policy makers for managing demand for energy and to formulate appropriate policy for future to cope with the ongoing energy shortage (crisis) in the country both in present and in future.

1.3 Significance of the Study

Different studies have been conducted in split form on determinants of energy demand, electricity supply and relationship between economic growth and energy consumption, and forecasting of electricity demand. The empirical results of different studies are mixed. Pakistan case is also not a different one in this respect. Results of some of the studies show positive and significant relationships amongst determinants and demand for energy and supply of electricity, while other show negative and significant effect.

The present study is different in light of integrated study of the determinants and forecasting of energy demand and supply in Pakistan and also measure effect of energy consumption on economic growth of Pakistan. The study includes some determinants of energy demand and supply, which are used for the first time. Moreover integrated study such as Rainfall, electricity price and technology have positive effects on electricity supply in Pakistan.

- Prices of energy components and technology have positive effects on the total petroleum supply, natural gas and coal supply in Pakistan.
- Total energy consumption has positive and statistically significant effect on economic growth of Pakistan.
- There exists increasing trend in energy demand-supply gap in Pakistan both in present and in future.

1.7 Organization of the Study

This study is organized as follows:

Introduction of the study, covering objectives, and hypotheses are given in chapter one. The second chapter discussed the relevant literature. The data used and methodology developed for the study has given in chapter three. The fourth chapter has presented the results and discussion of energy consumption. The fifth chapter has presented results and discussion of energy supply. The last chapter has covered conclusion and recommendations based on the findings of the study.

on determinants of components of energy supply and forecasting of energy supply is being done for the first time.

1.4 Research Questions

This study answers the questions like; what are the influencing factors of the energy demand in Pakistan? What determines the supply of energy in Pakistan? Based on past trends, what would be the future of demand and supply of energy in Pakistan?

1.5 Objectives of the Study

Main objectives of the study are as under:-

- Highlight the recent trends (fluctuations) taking place in energy consumption and supplies in Pakistan.
- Asses the determinants of energy consumption and supply in Pakistan.
- Forecast the level of energy consumption and supply in Pakistan.
- Investigate the impact of energy consumption on economic growth of Pakistan.

1.6 Hypotheses to be Tested

The following hypotheses are tested in this study:

- Gross Domestic Product and population have positive effects, while prices of energy have negative effect on the total electricity, petroleum, gas and coal consumption in Pakistan.
- Higher electricity transmission and distribution loss and price of substitute (petroleum) have decreased the electricity supply. Moreover, major determinants

such as Rainfall, electricity price and technology have positive effects on electricity supply in Pakistan.

- Prices of energy components and technology have positive effects on the total petroleum supply, natural gas and coal supply in Pakistan.
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to inefficiency of policy makers to acknowledge the proper determinants of electricity supply for policy implementation.

This study used different econometrics method of co integration, stationary test and ordinary least square for analysis of time series data from 1970-2009. The regression model states that electricity supply is depended on government funding, price per Megawatt, rainfall, technology and quantity of power loss. The OLS results illustrated that power loss; government funding and technology were key and statistically significant determinants of electricity supply. While electricity price has positive but statistically insignificant effect on electricity supply at 5 % level of significance. The study suggests that the government should insert more funds to introduce modern technology to complete the existing projects and initiated new projects in order to increase electricity supply.

Alberinia et al (2011) estimated the static and dynamic gas and electricity demand models in U.S. They established greater response of energy demand to energy prices in both short and long term and the demand of electricity and gas were inelastic with respect to energy price. They found no proof in favor of difference in elasticity of gas and electricity for heating purpose. It further indicated that income elasticity of household for gas and electricity was less than price elasticity. The study recommended that price and income elasticity have immense importance for energy policy makers and for forecasting energy demand. Furthermore, the study suggested that policies should be more focused on energy prices.

Geem (2011) forecasted South Korea petroleum energy demand. The multiple regression models were fitted in which different variables were used such as GDP, number of users of energy, energy price and number of vehicles registration. In these models along with GDP, other variables were added and checked their R^2.The results showed that population has statistically insignificant effect on transport energy demand. Artificial Neural Network model was used to forecast energy demand that Korea will consume energy about 37 MTOE in 2025.

Kankal et al (2011) forecasted electricity consumption in Turkey. Different multiple regression models were estimated in which different socio economic variables were used i.e. population, GDP, export, import and employment. The results illustrated that imports, exports (due to world economic crises and fluctuation) and employment have statistically insignificant effect on electricity consumption. The Artificial Neural Network model was applied to forecast electricity consumption and their results were tally with official forecasts which were over estimated. The study concluded that correct forecasts will more important for efficiently execute energy polices to obtain maximum outcomes.

Shahbaz and Hooi (2011) estimated relationship between economic progress and electricity consumption in Pakistan. The results of the study showed that long-run relationship exists between economic progress and independent variables consist of electricity consumption, capital and labor. Along with capital and labor also electricity consumption has positive effect on economic growth and their coefficients were statistically significant at 5 percent level of significance. Two ways causal relation were found between electricity utilization and economic growth. Further the study recommended that instead of energy preservation polices, government should inject more fund to energy sector and explore alternative resources of energy along with adoption of suitable technology to enhance energy production to meet future demand of energy for persistent economic development.

Shuvra (2011) conducted study on electricity demand in Bangladesh and observed that for economic development of a country, sufficient availability of energy is necessary. He stressed to increase capacity of energy by effective investment. He assessed the impact of different socio-economic variables such as GDP, price of electricity, population and time trend as a proxy of technology on electricity demand. Auto regressive econometric technique was used to forecast electricity demand. The result of forecast showed that Bangladesh demand for electricity was increasing rapidly.

Bianco et al (2010) estimated and forecasted non housing electricity consumption of Romania. Price and GDP elasticity of non-residential demand for electricity were found inelastic in short-run and as well in long-run, further the coefficient of income and price were statistically insignificant. In the second part of the study non residential electricity demand forecasted up to 2020 by using the Trigonometric Grey and A Holt-Winter exponential smoothing models. Results of the both models almost gave equal results, with less than 5% mean deviation. This deviation was committed due to time horizon in the study.

Chaudhary (2010) estimated the demand for electricity in Pakistan. The price and income elasticity of electricity demand for the entire economy, across different firms, and for different sectors of the economy are calculated. Results indicated that income has significantly and positive effects on electricity demand while the coefficient of price has significantly and negatively related to demand for electricity.

Erdogdu (2010) has analyzed that the Turkey energy demand on average basis increased by 8% annually, while natural gas demand has increased faster than other energy components in Turkey. The study estimated the short run and long run price and income elasticity of gas consumption on sector basis. The gas consumption was forecasted by using ARIMA model. He found 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.

Kebede et al (2010) analyzed cross sectional time series data from twenty countries of Sub Saharan Africa. The results showed 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.

Lee et al (2010) estimated total energy demand function. The results revealed that the total energy demand were price and income less elastic. In short run energy consumption has statistically insignificant effect on economic expansion, however in the long run energy consumption has critical and statistically significant at 5 % level of significance effect on economic growth. The demand for total energy was motivated largely by economic growth in Asian countries and consumers were insensitive to change in price.

The study concluded that energy is the key part of production along with other factors of production. The study recommended long run stable policies to insure sufficient supply of energy to sustain economic growth in Asian economies.

Babatunde and Shuaibu (2009) used variables like population, average income of inhabitants, price of electricity and price of substitute were function to electricity demand. The study used ARDL approach to estimate the relationship among electricity demand and the explanatory variables. Results of the study showed that income, price of substitute and more especially population were dominant influencing factors of electricity demand. Further effect of price was positive, insignificant and against economic theory, while effect of price of substitute was significant but contradict with theory. Moreover the income and price have inelastic demand. Finally, the study concluded that residential demand for electricity was stable and useful for forecasting electricity demand and for policy matters.

Bianco et al (2009) estimated the electricity consumption and analyzed the influence of different economic variables on electricity demand. To investigate long run electricity consumption the multiple regression models were estimated. The study focused on the assessment of GDP, price and per capita income elasticity of domestic and imported electricity consumption. They found that short run price elasticity for domestic and imported electricity demand of both were inelastic. While long run elasticity of electricity demand were also inelastic. On the other side the estimated forecast of electricity consumption was higher compared with national forecasts.

Hsiao et al (2009) have showed the influence of preferred economic variables, such as the national income, number of users, GDP and CPI on the electricity consumption in

Taiwan. They used linear and non linear statistical models. Both methods concluded that electricity consumption was frequently influenced by population and national income, whereas GDP has least effect on electricity consumption. The ANN method was used for forecasting electricity consumption, it provide significant results and showed increasing trend in electricity consumption.

Naryan and Wong (2009) estimated relationship between oil consumption and independent variables like oil price and GDP per capita. According to Granger causality test the results showed that the study variables were co integrated. The study calculated long run price and income elasticity of oil demand. From results it has found that oil price has negative and statistically insignificant effect on oil consumption, while income has statistically significant and positive effect on oil consumption in Australia.

Odularu (2009) measured the link between economic performance of Nigeria and energy consumption. Crude oil, electricity and coal were taken as energy components. Co integration technique was applied and results derived that positive relationship exists between economic growth and energy consumption. All the three components of energy have positive effect on economic expansion, and negative relation existed between lagged value of energy consumption and economic expansion. The study recommended that more attention should be given to increase energy supply to promote economic growth.

Pao (2009) showed the causality between electricity utilization and GDP. The study illustrated that real GDP and electricity consumption were co integrated. There was unidirectional causality from economic growth to electricity consumption in both short and long run as well, but not vice versa. Different models were used to forecast electricity consumption in Taiwan; amongst these methods the SARIMA model was best to forecast electricity consumption in short period.

Swan (2009) the effort is going on to reduces emission of greenhouse gas by decreasing energy consumption all over the world economies. In every country the residential sector is one of the important consumers of energy. Appropriate models are required to analyze the techno economic effect of renewable energy. Suitable efficient technologies have required meeting residential energy consumption.

The regression analysis technique was used for residential energy consumption modeling. The energy consumption was regress by macroeconomic variables such as GDP, inflation, energy price, and temperature. All variables have greater impact on residential energy consumption.

Jian et al (2008) Path analysis was used to analyze the effects of different economic factors on China's energy demands. The study concluded that the economic growth, total population and primary energy structure were major influencing factors of the China's energy demand. GDP was main determinant of energy demand and structure of energy was limiting factor of China energy demand. Due to consideration of multicollinearity, they used sum of a partial least-square (PLS) and trend extrapolation forecasting model. At last used Bayesian statistic theory to find the probability distribution of the error term and also obtained the combining forecasting results and confidence interval. Due to the use of Bayesian error correction model the result would be more efficient and precise of combining forecasting model.

Khan et al (2008) analyzed the demand for energy in Pakistan. The results showed that the coal and electricity have elastic demand to income and inelastic demand to price. In short run the gas demand responded negatively to price and positively to real income, furthermore prices have insignificant effect on coal and electricity demand in the long run. Moreover, the absolute elasticity of real income and prices for gas demand are greater than coal and electricity demand in the short run. Different components of energy have different elasticity, which have crucial for policy makers to boost revenue generation.

Okafar (2008) studied that the power crisis has vast effect on industrial infrastructure of Nigeria. Technological infrastructure has important for industrialization, economic growth and technological progress. Technological infrastructure consists of energy, power supply, transport and communication etc but this study relay mainly on power supply. Further this study examined that the government allocate massive fund to power sector in 1999 to 2007 was produce almost 3000 MW electricity despite the requirement of 10000 MW. This scarcity of electricity supply has severely affect industrial sector of Nigeria. The study recommended that on urgent basis renovate the overall power sector of Nigeria to insure the industrial and economic development in the country.

Sambo (2008) has examined and counterpart energy supply with demand in Nigeria. The expected electricity demand was calculated. The key determinants of energy demand were economic growth, population and technology. Out of which GDP and structure of economy were dominant factors. The electricity supply stratagem depends on the expected electricity demand as a factor. The projected 484.62 b dollars of total investment required to meet the energy demand for buoyant growth. The government might not afford that much height of funding separately, along with Govt, private sectors and foreign direct investment have to engage. Further the domestic resources of energy should be utilized in order to equate energy supply with demand on retinue basis in the country.

Subair (2008) assessed the importance of electricity for infrastructure, socio economic conditions, transport, communication, construction, standard of living and ultimate economic growth and development. Results of the study showed that there was no co integration found amongst variables, consequently short run dynamic model has used as suitable model. The electricity consumption depends on electricity production, Per Capita Income and price. All variables in line with theory but income have statistically insignificant effect on electricity consumption; further income and price have inelastic demand. Due to privatization and commercialization and no intervention of government to regulate prices the consumption of electricity will reduce mostly. At last the study suggested that more licenses should be provided to private sectors in order to increase supply of electricity from available resources.

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.

Erdogdu (2007) evaluated that in early 2000s Turkey commenced a lot of modification in the form of privatization and liberalization in the electricity market. The rationale behind this reform was rapidly increasing electricity demand and eventually energy crises. This paper estimated and forecast electricity demand by using regression and ARIMA models. The results of the study indicated that income and price elasticity were inelastic require economic regulation in the electricity market, moreover the official forecast projected high demand of electricity then estimated forecast obtain from ARIMA model.

Zhao and Wu (2007) used co integration and VECM techniques. The study evaluated that China energy imports promote due to persistent economic growth. China has inelastic import of oil irrespective of world oil price because of scarce domestic energy resources and high domestic production cost of oil. The China internal oil production has least substitution effect on import due to industry and automotive sectors growth.

Vita et al (2006) estimated energy demand in Namibia and long run elasticity of different types of energy demand. The obtain results showed that there is positive relationship between energy consumption and GDP, whereas negative relationship exist between energy consumption with prices and temperature. Further the results of the study indicated that electricity demand has low GDP elastic then diesel but price has statistically insignificant effect on diesel demand. The price elasticity of petrol has more than electricity, while temperature has statistically insignificant effect on petrol demand. Different price elasticity of different components of energy has indicated implication of different ratio of energy tax for policy makers regarding energy sector in Namibia.

Mohamed et al (2005) used Harvey and logistic models to forecast electricity consumption. The Harvey model forecasted high electricity consumption then the Logistic model, while Harvey Logistic model provided forecasts in between the other two models. The Harvey model was best to forecast domestic sector electricity consumption, while Logistic model gave best results to forecast non domestic electricity consumption. But overall the Harvey model was best to forecast the total electricity consumption. The forecast obtained from all three models were found more accurate then national forecast. At last the study concluded that in New Zealand the total electricity consumption including domestic and non-domestic sectors will increasing more in future.

Fillippini and Pachauri (2004) estimated residential demand of electricity for urban areas in India using primary data. The study used electricity price, price of substitute, income, population and geographical effect as determinants of electricity demand. Three electricity demand functions had been estimated for summer, monsoon and winter seasons. The results confirmed that electricity demand have inelastic to price and income in all seasons while in summer comparatively the demand for electricity has more price inelastic. Further population and geographical variables have statistically significant effect on electricity demand.

Ozturk et al (2004) the purpose of the study was to estimate models for residential-commercial sectors energy consumption and forecast energy demand by using Genetic Algorithm (GA) approach. The variables used in GA approach and future energy demand depend on the economic growth, number of energy users, export, import, infrastructure, cement production and basic house appliances consumption. In the study three types of models were used for forecasting. The GA approach was easy and preferred on other techniques of forecasting energy inputs in Turkey. The results of GA approach shows that there were increasing trend in energy inputs demand in future. The study results provide guideline for engineers and policies makers in implementation of different planning and the study suggests that policies measure required for increasing production of energy sector.

Sari and Soytos (2004) have examined that how much variation occurs in GDP growth explained by change in energy consumption and employment level in Turkey. The 21% forecast variation of GDP will explain by total energy consumption and energy consumption has also positive effect on employment in Turkey. The study urged that the policy makers have taken keen interest to allocate handsome amount for investment in energy sector in budget.

Verbruggen 2003 has estimated price inelastic demand of electricity, counter claim that lesser price generate lesser revenue. Furthermore the result shows that well organized and improve electricity sector was better than the high price policy. Industrial countries with high tax the lesser will be the share of electricity bills in GDP. The study suggested that decrease demand for electricity is more resourceful and useful than supply expansion for meeting the energy requirements.

Faris (2002) was used co integration techniques to show effect of economic variables on electricity consumption. The co integration and error correction methods were used due to existence of unit root. Both income and price have significant effect on electricity consumption and policies concerning price and income could be useful in the electricity demand management.

Adjaye (2000) measured the dependency of energy consumption on income and price. The results of the study indicate that energy consumption and income were not of the fence of each other, however in the case of India and Indonesia where energy consumption and income were neutral of each other in short run. Whereas income has significant and price has statistically insignificant effect on energy consumption in long run.

Cleveland et al (2000) analyzed the effect of energy utilization on economic performance of a country. Results of the study confirmed that the energy surplus was increasing due to energy (petroleum) extraction, which brought change in GDP, it further forced to vary in energy consumption and overall GDP growth had occurred due to aggregate increase in energy consumption.

Nasra et al (2000) estimated influencing determinants of electricity consumption in of Lebanon. In different period of time, the study investigated the impact of GDP, total imports and degree of temperature on electricity consumption. The GDP have positive and statistically significant impact on electricity consumption, while temperature and total imports have negative effect on electricity consumption. All determinants of electricity consumption were significant at 5% level of significance. Co-integration technique showed the existence of long run relationship between variables of the study. Finally ECM was developed for short run dynamics.

Siddiqui (1999) investigated the economic factors that determine energy demand in Pakistan and tries to explain the effect of change in price on revenue generation from the energy sector. Income and price are one of the important determinants of household, commercial, and industrial demand for energy. Change in price of energy affects revenue generating potential of electricity, natural gas, and petroleum products directly as well as through other factors like inflation and income distribution.

Sailor (1998) had estimated models for natural gas consumption and climate change for different sectors of the U.S. The forecasted effect of temperature on natural gas consumption, other things remaining same as 1 degree centigrade monthly temperature increase the residential natural gas consumption and commercial gas consumption decreased by 8.1% and 5.9% respectively. Over the period of 1984-1993, moreover the net natural gas consumption of residential sector decreased by 111.8 TWH (Tara watt hour) and commercial sector by 47.0 TWH. The largest change occurred in the month of January when both sectors gas consumption has decreased.

Lledare (1995) has developed and calculate supply model of natural gas in West Virginia using data on 18000 new drilled wells from 1997 to 1987. The study found that sensitivity of gross reserve and drilling attempt with in same individual geological series to the expected per well head price, exhaustion of resource, taxes and costs. The study suggests effective policies in shape of incentives and relaxation to increase supply of natural gas.

Bentzen and Engsted (1993) analyzed data from 1948-1990 and find that energy consumption, real GDP, real price point out to be non-stationary variables, therefore co integration and Errors Correction Method were applied. As clear from the value of parameters that energy demand has not much affected by increase in real energy prices but energy has elastic income demand since 1973-1974.

Furtadoa and Suslickb (1993) forecasted petroleum demand in Brazil. Results of the study showed that GDP was key determinant of petroleum consumption and petroleum price have insignificant effect on petroleum consumption. The study assessed that forecasting models showed accurate results and use of petroleum share in energy mix has increased since 1973. The study suggests that in future petroleum consumption have important role in GDP growth of Brazil.

Ibrahim and Hurst (1990) estimated oil and energy demand function for developing countries in 1970s and 1980s. The study formulated energy demand for oil exporting and importing countries. The results of the study indicated that energy consumption has positive impact on economic progress. However price and income elasticity of energy demands were inelastic, while domestic price has insignificant but international price of oil has statistically significant effect on oil demand, though domestic energy production could affect energy demand. The study has not properly forecast oil demand but extrapolate future oil demand which indicate increasing trend in oil demand. At last the study suggested that the developing countries should explore domestic alternative resources to oil and inject more funds by attracting investment in energy sector in order to fulfill future energy demand.

Greene et al (1986) analyzed that in most developing nations road transport is the main petroleum consumption sector. Amount and effectiveness of vehicle stock are more important part of energy planning for transport sector. Size and further new registration and fuel replacement have effect on planning and development. Due to fuel substitution automobile fuel gain obtained by US economy since 1975. Existing amount of saving due to fuel switching is about 92 billion $ in 1984.

Riaz (1984) estimated that economic growth of Pakistan and energy consumption has significant relationship. This paper also developed the energy sector optimization model for the economy of Pakistan, which consists of different energy components, such as oil, electricity, gas, coal and non-commercial fuel. The model has used to forecast energy balances.

Liu (1983) estimated the price and cross price elasticity for natural gas demand in different sectors of different regions of U.S.A. The price and cross price elasticity of gas demand was estimated by reduced form of simultaneous equations from 1967 to 1978, but the oil price hike in 1973 was used separately as a dummy variable. The price elasticity of natural gas demand was more elastic in long-run than short-run and inelastic demand was recorded for industrial sector. However there was a difference found among interregional price and cross price elasticity of gas demand, which have significant implication for energy policy makers.

Starr and Field (1979) Focused on 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 defficiencies. The study found that energy supply has positive effect on economic growth and employment.

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.

2.3 Summary

Different studies have been conducted by different researchers on determinants of electricity, petroleum, gas and coal consumption and supply of electricity along with forecasting of given energy components consumption in separate form, alongside the determination of the relationship among energy consumption and economic growth in both developed as well as developing countries. The empirical results of some of these studies show positive and statistically significant relationships among energy consumption and economic growth. As the relevant studies showed impact of GDP, price of energy and price of substitutes, population, number of vehicles registration, import, climate and industrial production on energy consumption. The results of given various studies demonstrated effect of GDP, price of energy, rainfall, government funding and technology on electricity supply. Different studies used Artificial Neural Network Model, Holt-Winter forecasting model, Exponential Smoothing Model and ARIMA model for forecasting of electricity and coal consumption. Some of the studies used Dickey Fuller (DF), Phillip Piron and Augmented Dickey Fuller test (ADF) for checking stationarity in the time series data, due to existence of unit root problem the co-integration and error correction methods were used to check co-integration amongst variables of interest and stability of long run relationship. Most of the studies used single equation model and some of the studies used simultaneous equations model for determining the relationship among the energy consumption and interested independent variables. Contrarily to other studies, this study investigates both short and long run relationship among the variables of interest.

2.4 Contribution of Present Research

Present study is different in light of integrated study of the determinants and forecasting of energy consumption and supply in Pakistan and also shows impact of energy consumption on economic growth of Pakistan. The study includes some of the determinants of energy demand and supply, which are used for the first time. Moreover this is the first comprehensive study regarding energy especially on supply of different energy sources with additional and important variables ignored by the past studies.

Chapter 3

THEORETICAL FRAMEWORK AND METHODOLOGY

3.1 Introduction

Various techniques are used in this chapter in the light of objectives and to test the hypothesis. It highlights the scope of the study, identifies variables, data collection and its limitation and explains econometric models.

3.2 Theoretical Framework for Energy Consumption

To evaluate the determinants of different components of energy consumption, the theoretically frame work for models are consumption function and Fisher and Kaysen (1962) model, which indicates that in long run consumption depend on income as well as prices, weather and population etc.

Energy demand is derived demand; transpire from the requirement of economic activities as factor input. Thus economic agents use energy consumption as factor input in the production process as it 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 take place after decision is complete to buy, as it express the measured satisfied demand, nevertheless the demand and consumption of energy are used as swapping.

In this study the energy components (electricity, petroleum, natural gas and coal) consumption depends on income, price, demographical factors, price of substitutes, temperature, energy imports and manufacturing production.

3.2.1 Theoretical Framework for Energy Supply

For analysis the determinants of supply of different energy components, the basic theory of supply is in support of theoretical background of the present study. Here supply of energy means output offered for sale at given price. It is obvious that the suppliers offer more for sale at higher price and low at lower price and other determinants like cost of production, price of substitute, technology, weather condition and stock of capital etc have effect on energy supply. Due to unusualness in energy market in Pakistan the stated law of supply may not inevitably hold in true sense, because usually components of energy supplied by government and enjoy monopoly power.

3.2.2 Theoretical Framework for Energy and Economic Growth

Classical economists, neo classical growth theory, Harrod-Domar growth model and Solow-Swan growth model were not considered energy as factor of production. Hitherto, energy economists declared that energy is important factor of production and also considered as key input in production process. Neo-classical economists stressed on increase in technology along with other factors to increase production, in this outlook energy has key use in real capital and economic activities. Hence dropping energy input from production function will be the indication of deficiency in judgment. Energy required for greater output, labor productivity and capital accumulation. Alam (2006) in his work on 'economic growth with energy' attained energy is important factor of production, further energy impel the work that exchange raw materials into final goods in the production process and also enhance economic growth of a country.

The central theme of Solow growth model is that long run growth elucidates by the pace of technological advancement, which appear exogenously. The new growth theory has developed against of neo-classical exogenous growth model. Romar endogenous growth model was first developed in 1986 which indicated advance technology are necessary for long run economic growth, hence technology and capital operate due to use of energy. In nutshell the energy and economic growth relationships vary considerably beside the different phases of growth and development.

The study used comprehensive model which shows along with physical capital, trade openness, external debt and total cropped area an increase in availability of energy have significant effect on economic growth.

3.3 Data Collection and Sources

In this study, times series secondary annual data on different variables in favor of empirical analysis for the period ranging from 1970 to 2010 has been used. The data required for the study is obtained from various sources. The data for total electricity, oil and petroleum, gas, coal consumption, total electricity, petroleum, gas and domestic coal supply, total petroleum and coal import, population, maximum temperature, rain fall, total vehicles registration, quantum of manufacturing, cement and urea production, total external debt, employment and total cultivated area taken from Economic Survey of Pakistan various issues. Data of GDP, GFCF and FDI are sources from The Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC). The numerical data of price per unit of electricity and sale price of coal per ton are taken from

WAPDA and Pakistan Energy Year Book (2010) respectively. Electricity transmission and distribution loss data is obtained from IMF (2011- 12). The electricity supply variable is computed by subtracting total electricity transmission and distribution loss from total electricity generation and technology variable is taken as proxy by time trended. The data on final oil price and final gas price as an index is constructed separately for oil and gas. As for as the prices of these components (oil and gas) are concerned; they defer from sector to sector and component to component. For instance, the oil has different components like motor spirit, high speed diesel, light speed diesel, kerosene, and furnace oil with their respective prices. Similarly, the prices vary across sectors and across consumers. For instance, the gas prices are different for different consumers. Energy year books report all this prices data in quite details. To construct aggregate price indexes for oil and gas we used the tool of weighted average index approach. The weights could be constructed by using the relative consumption share and the time base. Time weight means that if a price is effective for thirty days, for example, it will get twice as much weight as compared to price which is effective for fifteen days. Data on trade openness is calculated by adding export and import and obtained sum divide by GDP.

3.4 Selection of the Variables

- **Consumption and Supply of Energy Components:** Total consumption of different components of energy in all sectors of Pakistan is taken as dependent variables. The energy demand is derived from the demand of the overall production capacity (GDP) of a country which depends on energy consumption as factors input. In this study total consumption of electricity, petroleum, natural gas and coal are denoted by "TEC", "TPC", "TGC" and "TCC" respectively. Also total supply of electricity, petroleum, gas and coal are represented by "TES", "TPS", "TGS" and "TCS" respectively.

- **Gross Domestic Product (GDP):** It is the sum of sale value of all final commodities produced inside the geographical boundary of our country in one year. It is used in this study as proxy of income of the nation. According to economic theory other things remaining same an increase in income leads to higher demand and vice versa. As for increase in GDP concerned which in turn uplifts the standard of living of the masses, it ultimate increase consumption of the overall energy.

- **Prices of Energy Components:** Price and price of substitutes are important determinants of energy demand and supply. Usually demand and price have negative relationship i.e. other things remaining same, any decrease in price will lead to increase in energy consumption. Other things remaining same, supply and price have positive relationship as an increase in price occur increase in supply of energy and vice versa. In Pakistan prices of energy set administratively, that ultimately help in enhancing revenue generation, it further invests in energy oriented technology sectors which will increase energy supply. Price of substitute goods has considerable effect on energy demand and supply. Prices of electricity, petroleum, gas and coal are represented by "SPE", "FOP", "FGP" and "SPC" respectively

- **Population:** It is important demographic factor which effect energy demand positively. With growing the total population the energy requirement in different forms will increase in all sectors of economy. It is denoted by "POP" in this study.

- **Weather Factors:** Energy demand and supply depend on seasonal variation. In winter for heating purposes the demand for energy is high, while in summer the demand of energy (electricity and oil) is also high. With rainfall the supply of electricity from hydro power stations will increase. Moreover in cold temperature the supply of electricity from hydro sector is low due to less reserve of water and gas supply also remains low. In hot weather the supply of energy especially electricity and coal are low. Temperature is denoted by "TEMP" and rainfall represent by "RF".

- **Quantum Index of Manufacturing Industries:** It presents the overall production index of manufacturing industries in Pakistan. Demand of energy components are increasing along with increase in manufacturing units, moreover cement, bricks kilns and fertilizer industries shift almost to coal and gas respectively, it further drive up the demand of coal and gas. Quantum index of manufacturing industries represent by "QIM".
- **Gross Fixed Capital Formation:** It measures the sum of net additions to fixed investment/ investment. GFCF includes the total value of fixed valuable by household, firms and government. Gross fixed capital formation has positive impact on energy supply and economic growth of Pakistan. It is presented by "GFCF".
- **Number of Vehicles Registration:** The total motor vehicles registration in Pakistan consists of motor cars, jeeps, station wagons, buses, trucks and motorcycles two and three wheels. The numbers of registered motor vehicles raise the consumption of energy especially petroleum, diesel and CNG are amplify. Further supply of petroleum and gas also responds positively because demand for energy has increases due to addition in the number of motor vehicles. It denoted by "TVR".
- **Energy Imports:** Imports of oil and coal have positive effect on energy consumption and supply. The production of electricity raises especially from thermal power stations with import of petroleum, moreover the consumption of oil/ petroleum

180.71, 59.33 and 55.80 million respectively of Pakistan in 2012. In general production respond positively to employment ratio, in a nutshell the supply of energy will be enhanced. Employment represent by "EMP".

- **Total External Debt:** Pakistan faced stern deficit in the balance of payment till from independence, indeed to fill the gap through external debt. It stood at 58.49 US billion dollars in 2012. GDP responded positively to foreign debt but not effectively in case of Pakistan due to misuse of it on non-development side. It express in "TEDEBT".

- **Trade Openness:** Unrestricted trade brings specialization, competition and utilization of key domestic resources and eventually contributes to economic growth of a country. In this study trade openness denoted by "TO".

- **Total Cropped Area:** The total non-cultivated area was 79.61 million hectares and total cultivated was 22.75 million hectares of Pakistan in 2012. Still agriculture secured dominant share in GDP of Pakistan, any change in extensive cultivation of land will augment GDP because Pakistan is agrarian economy. It denoted by "TCA" in the study.

3.5 Econometric Modeling for Energy Consumption

In light of the above arguments the multiple regression models are estimated to assess the determinants of components of energy consumption in Pakistan.

For econometric modeling of energy demand the following studies provide base i.e. Al-Faris (2002), Erkan (2007), 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.

$$LnTEC = b_0 + b_1\,LnGDP + b_2\,LnPOP + b_3\,LnSPE + b_4\,LnTEMP + b_5\,LnQIM + U_t \quad (3.1)$$

$$LnTPC = b_0 + b_1\,LnGDP + b_2\,LnPOP + b_3\,LnTEMP + b_4\,LnTVR + b_5\,LnFOP + b_6\,LnFGP + U_t \quad (3.2)$$

$$LnTGC = b_0 + b_1\,LnGDP + b_2\,LnPOP + b_3\,LnTVR + b_4\,LnFGP + b_5\,LnFOP + b_6\,LnUPROD + U_t \quad (3.3)$$

$$LnTCC = b_0 + b_1\,LnGDP + b_2\,LnTCM + b_3\,LnTEMP + b_4\,LnCPROD + b_5\,LnSPC + U_t \quad (3.4)$$

3.5.1 Econometric Modeling for Energy Supply

To assess the determinants of different components energy supplies in Pakistan, the following models have estimated:

The designs of the models of energy supply for the study are consistent with the literature of Isola (2007), IEA (2002), Lledare (1995), Lwayemi (2008), Ubi (2012). It provides foundation for identification of the determinants of supply of energy components of Pakistan.

$$LnTES = b_0 + b_1\,LnRF + b_2\,LnTPM + b_3\,LnETDL + b_4\,LnSPE + b_5\,LnFOP + b_6\,Ln@TREND + Ut \quad (3.5)$$

$$LnTPS = b_0 + b_1\,lnGFCF + b_2\,LnFDI + b_3\,LnFOP + b_4\,Ln@TREND + Ut \quad (3.6)$$

$$LnTGS = b_0 + b_1 LnFDI + b_2 LnTPM + b_3 LnFGP + b_4 LnFOP + b_5 Ln@TREND + U_t \quad (3.7)$$

$$LnTCS = b_0 + b_1 LnGFCF + b_2 LnEMPLY + b_3 LnTEMP + b_4 LnSPC + b_5 Ln@TREND + U_t \quad (3.8)$$

Where

TEC = Total Electricity Energy Consumptions (Ghw)	GDP = Gross Domestic Product (Rs.bn)
POP = Population (in billions)	FDI = Foreign Direct Investment (Rs.bn)
FDI = Foreign Direct Investment (Rs.bn)	EMPLY = Employment (billions)
GFCF = Gross Fixed Capital Formation (Rs.bn)	TEMP = Temperature in Degree Celsius
TVR = Total no of Vehicles Registration (billions)	TPC = Total Petroleum Consumptions (Tons)
TGC = Total Natural Gas Consumptions (Mmcft)	TCC = Total Coal Consumptions (000 metric tons)
TCM = Total Coal Import (000 tons)	TES = Total Electricity Supply (Gwh)
RF = Rain Fall (mm)	TPS = Total Petroleum Oil Supply (000 tons)
@ TREND = Technology	TGS = Total Natural Gas Supply (Mcf)
TCS = Total Coal Supply (000 tons)	UPROD = Urea Production (000 tons)
CPROD = Cement Production (000 tons)	QIM = Quantum of Manufacturing Index (100 nu)
SPE = Average Sale of Electricity (Paisa)	FOP = Final Oil Price
FGP = Final Gas Price	ETDL = Electricity Transmission and Distribution Loss (Gwh)
SPC = Average Sale Price of Coal (Rs ton)	

Also b_0 is the intercept and b_i coefficients while U_t is Error term which includes the effect of all those variables which are not included in the model.

3.5.2 Econometric Modeling for Economic Growth and Energy Consumption

To show the effect of total energy consumption and other determinants on economic growth, the below model has been estimated.

The following studies of Lee et al (2010), Odularo (2009), Pao (2009), Paul and Bhattacharya (2004), Riaz (1984), Sari and Soyatos (2004) and Toman and Jemelkova (2002) have focused the same econometric models as given below on the relationship of economic growth and energy consumption.

$$LnEG = b_0 + b_1 LnTEC + b_2 lnGFCF + b_3 LnTED + b_4 LnTO + b_5 LnEMPLY + b_6 LnTCA + U_t \quad (3.9)$$

Where

EG = Economic Growth (GDP) (Rs bn)	TEC = Total Energy Consumption (MTOE)
TO = Trade Openness (Rs bn)	GFCF = Gross Fixed Investment (Rs.bn)
TED = Total External Debt (bn $)	EMPLY = Employment (in billions)
TCA = Total Crop Area (Million hector)	

3.6 Estimation Techniques

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.

3.6.1 Unit Root Test

The problem of the stationarity is mostly concerned with time series data. The well-known Augmented Dickey-Fuller test was presented by Dickey and Fuller (1979 and 1981) is the most important test for checking stationarity in the data. ADF test depends on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypothesis of no unit root (the series are stationary).

The stationarity of the data is checked out by using the ADF test relying on the following structure:

$$\Delta X_t = b_0 + b_1 t + b_2 x_{t-1} + \sum_{i=1}^{k} b_3 \Delta X_{t-1} + \varepsilon_t \quad (3.10)$$

Where X is the variable we check for stationarity, Δ is the first difference operator, t shows time trend, εt is the usual random term in time period t and the maximum lag length is k and its optimal lag length is identified. It is clarified that the error term is white noise. After the identification the next step is the estimation of parameters i.e. b_0, b_1, b_2 and b_3.

If we accept the null hypothesis $b_2 = 0$, then we conclude that the series under consideration is non-stationary and having a unit root.

3.6.2 Co Integration Test

The basic idea behind co-integration is that if, in the long run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989). The Johansen co-integration test has used for checking the long-term relationship among the variables of the estimated equations, because same order of differencing is evident. The general form of equation is as follow.

$$Xt = b0 + b1Xt\text{-}1 + \ldots\ldots + bk\text{-}1Xt\text{-}k + Vt \qquad (3.11)$$

Where Xt is an n×1 column vector of variables, which are integrated of order 1(1), bi are n×n parameters and Vt is an independently and normally distributed error term.

If the variables are non-stationary and no co-integration exist between variables, then estimates obtained from OLS technique will give up spurious results (Chan and Lee 1997). In such case the co-integration technique presents solution to the prevailing problem. Philips (1986), Bentzen and Engsted (1993) has pointed that OLS analysis provide consistent and reliable results if variables used in equation are co integrated.

3.6.3 Error Correction Model

Further, if evidence were found about long run relationship among variables, then the Error Correction Mechanism (ECM) has also be applied to find the short term relationship and to measure how quickly the equilibrium can be restored. The ECM general form is:

$$\Delta Y = b_0 + b_1 \Delta X_{ti} + b_2 U_{t-1} + V_t \qquad (3.12)$$

Where Δ denotes the first difference operator, V_t is the error term and U_{t-1} is the one period lagged value of the error term, X_{ti} are explanatory variables and V_t is the usual random term in time period t.

3.6.4 Forecasting Technique

For forecasting components of energy consumption and supplies, Autoregressive Integrated Moving Average (ARIMA) models are used. The ARIMA model was introduced by Box and Jenkins (1978). The ARIMA, has been originated from the Autoregressive Model (AR), the Moving Average Model (MA) and the combination of the AR and MA, the ARMA models. It stresses on their own stochastic properties of time series analysis rather than depend on OLS and simultaneous equations models. The general form of the ARIMA (p,d,q) model is:

$$Z_t = b_0 + b_1Z_{t-1} + b_2Z_{t-2} + \ldots\ldots + b_pZ_{t-p} + \alpha_0U_t + \alpha_1U_{t-1} + \alpha_2U_{t-2} + \ldots\ldots + \alpha_qU_{t-p} \quad (3.13)$$

Where p is order of autoregressive, d is order of differencing and q is order of moving average, Z_t is the time series to be forecasted in time period t, Z_{t-p} and U_{t-p} are the lagged values of Z_t up to lag p respectively.

These models require determining the order of autoregressive scheme, order on moving average and order of differencing. To determine the order of differencing, the ADF Test has used. Further, to determine the order of autoregressive scheme and order of moving averages, the autocorrelation and partial autocorrelation functions have been used. Root Mean Square Error (RMSE) has used for the evaluation of the forecasts.

Statistical packages such as Eviews and Minitab have been used for estimation of the models.

Chapter 4

RESULTS AND DISCUSIONS OF THE DETERMINANTS AND FORECASTING OF ENERGY CONSUMPTION

4.1 Introduction

This chapter presents the empirical results of the study. The chapter starts from the stationarity of the data which is necessary to check co integration and to estimate short run and long run relationship between the variables of the study.

4.2 Stationarity Test

This study has used ADF for the investigation of unit root in the reported data. Usually the time series data have the problems of stationarity. Unit root test is prerequisite for applying co integration test and for analysis of time series data. The procedure of ADF test is to test against the null hypothesis that there is unit root existed in the data. The results of ADF are more likely to the same as the results of Phillips Peron (PP) test. Therefore only the results of the ADF test are mentioned here. All variables are given almost in natural logs form and Modified Schwarz Information Criterion has used for maximum lag selection. The regressions include an intercept only.

4.2.1 Results of ADF Test

The table 4.1 shows the results of Augmented Dickey Fuller test. The ADF statistic for all variables (LEMPLY, LGDP, LGFCF, LPOP, LTEC, LTEMP, LTENRC, LTGC, LTCC, LTOPC, LTCM, LTED, LTO, LTVR, CPROD, UPROD, LTCA, LSPE, LFOP, LFGP and 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 4.1: ADF Test for Unit Root

Variables	Level		First difference		Conclusion
	Statistic value	Critical value at 5%	Statistic value	Critical value at 5%	
LTEC	-2.035337	-2.943427	-4.279257*	-2.943427	1(1)
LGDP	-0.869259	-2.943427	-3.398987*	-2.943427	1(1)
LPOP	-2.190579	-2.943427	-9.943071*	-2.945842	1(1)
LSPE	-1.936823	-2.943427	-3.408085*	-2.945842	1(1)
LTEMP	-2.472006	-2.954021	-3.807504*	-2.957110	1(1)
LQIM	-1.971976	-2.941145	-4.538824*	-2.943427	1(1)
LTPC	-1.673519	-2.941145	-5.438711*	-2.943427	1(1)
LTVR	0.145121	-2.943427	-3.977703*	-2.945842	1(1)
LFOP	0.419443	-2.943427	-5.002766*	-2.945842	1(1)
LFGP	0.183458	-2.943427	-3.939647*	-2.945842	1(1)
LTGC	-1.534412	-2.941145	-7.897497*	-2.943427	1(1)
UPROD	-0.711049	-2.943427	-4.977999*	-2.943427	1(1)
LTCC	0.174720	-2.943427	-3.420721*	-2.945842	1(1)
LTCM	1.529653	-2.943427	-3.792004*	-2.945842	1(1)
CPROD	1.274443	-2.957110	-4.672324*	-2.957110	1(1)
LSPC	-1.249828	-2.943427	-5.080457*	-2.945842	1(1)

LTENRC	-2.537886	-2.941145	-4.727426*	-2.943427	I(1)
LEMPLY	1.208590	-2.941145	-6.271997*	-2.943427	I(1)
LGFCF	-2.791136	-2.957110	-4.011347*	-2.960411	I(1)
LTED	-2.359664	-2.945842	-4.510808*	-2.945842	I(1)
LTO	-1.861251	-2.941145	-10.17811*	-2.943427	I(1)
LTCA	-1.841162	-2.943427	-10.70937*	-2.943427	I(1)

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

4.3 Johansen Co Integration Test

After checking unit root problem the Johansen co-integration test is used to test co-integration amongst the 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 the long run relationship among the variables of interest, which is decisive for acquiring meaningful results from the multiple regression models.

4.3.1 Co Integration Test for Total Electricity Consumption

The results of Johansen co integration test for TEC are given in table 4.2. Trace statistics and Maximum Eigen values are used to show the number of co-integration vectors. The null hypothesis of no co-integration (R = 0) against the alternative of co integration (R ≤ 1). The value trace statistics is 160.6254, which is greater than the value of critical value of 95.75366 and the maximum Eigen value is 57.38702, which is greater than the critical of 40.07757 at 5 percent level of significance. Hence null hypothesis is rejected and alternative hypothesis there is co-integration is accepted. The trace statistics confirm 3 co-integrating vectors and the maximum Eigen value also confirm 2 co-integrating vectors at 5 percent significance level.

Thus the results of the data confirm the existence of long-run relationship between total electricity consumption, GDP, population, sale price of electricity, temperature and no of manufacturing industries.

Table 4.2: Results of Johansen Co Integration Test for Total Electricity Consumption

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max- Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	160.6254*	95.75366	57.38702*	40.07757
R ≤ 1	R ≥ 2	103.2384*	69.81889	47.54094*	33.87687
R ≤ 2	R ≥ 3	55.69745*	47.85613	35.06046	27.58434
R ≤ 3	R ≥ 4	20.63700	29.79707	10.96810	21.13162
R ≤ 4	R ≥ 5	9.668894	15.49471	8.579657	14.26460

- Represent rejection of null hypothesis at 5% level

Critical values of Trace and Eigen are taken from Mackinnon-Haug-Michelis (1999)

4.3.2 Co Integration Test for Total Petroleum Consumption

Table 4.3 indicates the results of Johansen co integration test. The values of trace statistics and the maximum Eigen are greater than the critical value at 5 percent level of significance. Hence null hypothesis is rejected and alternative hypothesis presence of co-integration is accepted. The trace statistics justify 2 co integrating vectors and the maximum Eigen value also justify 2 co integrating vectors at 5 percent significance level. Thus the results verify the presence of long run relationship between TPC and explanatory variables.

Table 4.3: Results of Johansen Co Integration Test for Total Petroleum Consumption

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max- Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	137.1257*	95.75366	54.69070*	40.07757
R ≤ 1	R ≥ 2	82.43503*	69.81889	37.04347*	33.87687
R ≤ 2	R ≥ 3	45.39156	47.85613	21.04262	27.58434
R ≤ 3	R ≥ 4	24.34894	29.79707	13.96840	21.13162
R ≤ 4	R ≥ 5	10.38054	15.49471	7.786598	14.26460
R ≤ 5	R ≥ 6	2.593940	3.841466	2.593940	3.841466

4.3.3 Co Integration Test for Total Gas Consumption

The results of Johansen co-integration test for TGC are specified in Table 4.4. The resultant values of trace statistics and the maximum Eigen are greater than the critical value at 5 percent level of significance. Hence null hypothesis is rejected and alternative hypothesis presence of co-integration is accepted. The trace statistics and the maximum Eigen justify two and two co-integrating vectors value respectively at 5 percent significance level.

Thus the results confirm the presence of long run relationship between TGC and independent variables.

Table 4.4: Results of Johansen Co Integration Test for Total Gas Consumption

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	248.7824*	159.5297	82.48463*	52.36261
R ≤ 1	R ≥ 2	166.2977*	125.6154	66.43955*	46.23142
R ≤ 2	R ≥ 3	90.85819	95.75366	35.84647	40.07757
R ≤ 3	R ≥ 4	64.01171	69.81889	25.17397	33.87687
R ≤ 4	R ≥ 5	38.83775	47.85613	17.58403	27.58434

4.3.4 Co Integration Test for Total Coal Consumption

The results of Johansen co-integration test for TCC are given in Table 4.5. 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 4.5: Results of Johansen Co Integration Test for Total Coal Consumption

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

4.3.5 Co Integration Test for Economic Growth Model

The results of Johansen co integration test are given in table 4.6. Trace statistics and Maximum Eigen values are used to show the number of co integration vectors. The values of trace statistics and the maximum Eigen are greater than the critical value at 5 percent level of significance. Hence null hypothesis is rejected and alternative hypothesis is accepted means there is co-integration. The trace statistics and the maximum Eigen values confirm 3 each co integrating vectors at 5 percent significance level.

Thus the results verify the existence of long run relationship between GDP and explanatory variables.

Table 4.6: Results of Johansen Co Integration Test for GDP

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max- Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	168.0475*	125.6154	53.79364*	46.23142
R ≤ 1	R ≥ 2	114.2538*	95.75366	42.14873*	40.07757
R ≤ 2	R ≥ 3	72.10510*	69.81889	36.71636*	33.87687
R ≤ 3	R ≥ 4	35.38873	47.85613	18.19806	27.58434
R ≤ 4	R ≥ 5	17.19067	29.79707	10.50896	21.13162
R ≤ 5	R ≥ 6	6.681713	15.49471	5.523987	14.26460

4.4 Multiple Regression Models Estimation

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 at same difference and co integrated after applying suitable tests, then results obtained from OLS are not spurious. Therefore the results obtained from OLS are consistent.

4.4.1 Estimation of Determinants of Total Electricity Consumption

The results of multiple regressions have been reported in table 4.7. The results show that GDP and electricity consumption are directly related and according to economic theory. The coefficient of GDP shows that 1 percent increase in GDP will increase electricity consumption by 0.372906 percent which indicates income inelastic demand of electricity. The coefficient of GDP is statistically significant at 5 percent level of significance. The sign of the variable is in conformity with Alberinia (2011), Babatunde and Shuaibu, Chaudhary (2010), Erdogdu (2007), Faris (2012), Halvorsen (1975), Kankal et al (2011), Khan et al (2008), Shurva (2011) and Vita et al (2006).

Population (pop) directly affects electricity consumption. The implication of this result is that 1 % increase in population will bring 0.752713 % increase in electricity consumption. The sign of pop confirms with theoretical expectation and dominant effect on total electricity consumption in Pakistan and statistically significant at 5 percent level. The sign of the variable agrees with the study of Babatunde and Shuaibu, Fillippini and Pachauri (2004), Hsiao et al (2009), Kankal et al (2011) and Shurva (2011).

The price elasticity is -0.071070 which shows inverse relationship between electricity consumption (TEC) and price of electricity (P). This implies that if the price of electricity increase by 1 %, electricity consumption will decrease by -0.071070 % its shows inelastic demand with response to price. The coefficient of price of electricity is statistically insignificant at 5 % but significant at 10 % level of significance, due to the reasons that electricity is supplied under government owned companies and profit making is not primary objective. Moreover there is no close substitute and no large private producers of electricity. Also price of electricity is not determined by market forces. Hence consumers are coercing to consume electricity irrespective of their price. Therefore price is not dominant factor of electricity consumption in Pakistan. The result is validating with Babatunde and Shuaibu (2009), Biancao (2010), Fillippini and Pachauri (2004), Halvorsen (1975), Khan et al (2008), Shurva (2011) and Vita et al (2006).

The value of coefficient of maximum temperature (TEMP) is 0.504075, indicates positive relationship between maximum temperature and electricity consumption. This means that 1 percent increase in temperature would lead to 0.504075 percent increase in electricity consumption. This variable is in line with economic theory but statistically insignificant at 5 percent level. Maximum temperature is statistically insignificant determinant of total electricity consumption, because electricity has many uses and electricity is demanded more in maximum and minimum temperature as well. Therefore electricity is consumed more irrespective of high temperature.

Also, coefficient of numbers of manufacturing units (QIM) is positive and valid with theoretical expectation. In other words, 1 percent increase in QIM will increase electricity consumption by 0.200180 percent. The result indicates that QIM is statistically significant at 5 percent level.

The results imply that GDP, population and number of industrial units are crucial determinants of electricity consumption.

The adjusted R^2 is 0.8997765 hence the fit is good. The value of R^2 shows that 89 % of variation in total electricity consumption due to changes in included explanatory variables. The value of F- statistic indicates that overall model is statistically significant at 5 % level of significance. The Durbin- Watson statistic value is 1.760740 which is closer to 2, indicates there is no serious autocorrelation problem.

Table 4.7: Regression Results of Determinants of Total Electricity Consumption

Dependent variable LTEC			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	4.021270	0.995891	0.3285
LGDP	0.372906	3.213759	0.0024
LPOP	0.752713	2.326681	0.0232
LSPE	-0.071070	-1.211861	0.1080
LTEMP	0.504075	0.635968	0.2464
LQIM	0.200180	2.608734	0.0137

R^2= 0.900059
AdjR^2= 0.8997765
F-Stat = 431.5883
Prob(F-stat)= 0.000000
Durbin-Watson = 1.760740

4.4.2 Estimation of Determinants of Total Petroleum Consumption

Table 4.8 shows the results of regression indicate that all variables have positive effect on total oil and petroleum consumption except price and the relationship among variables in line with economic theory. Only GDP, TVR and FOP are statistically significant, the rest of the variables are statistical insignificant at 5 percent level of significance. The coefficients show that on average 1 percent increase in GDP, POP, TVR and FGP lead to 0.469602, 0.095488, 0.305979 and 0.044350 percent increase in total petroleum consumption respectively. While 1 percent increase in current price brings -0.362176 percent decrease in total petroleum consumption. General population is insignificant determinant of petroleum consumption due to the reason that the data used in this research is taken as whole for the country while a part of population have concern with the consumption of petroleum. Moreover natural gas is not perfect substitute of petroleum in each and every sector of the economy; hence price of gas has insignificant impact on petroleum consumption. Whereas, CNG is used as a substitute fuel for vehicles till from 1992, in order to decrease reliance on pricey imported fuel. The given results are in support of past studies under taken by Furtadoa and suslick (1993), Geem (2011), Ibrahim and Hurst (1990), Kebede et al (2010), Naryan and Wong (2009) and Vita et al (2006).

The values of adjusted R^2 and F-statistic are 0.900088 and 385.7374 shows that the overall fit is good. The value of D-W statistic is 1.665376 which is about to 2, which show that the problem of autocorrelation is not in severs form.

Table 4.8: Regression Results of Determinants of Total Petroleum Consumption

Dependent variable LTOPC			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	13.09156	7.712990	0.0000
LGDP	0.469602	3.472014	0.0015
LPOP	0.095488	0.199194	0.8433
LTVR	0.305979	2.143513	0.0395
LFOP	-0.362176	-4.966949	0.0001
LFGP	0.044350	0.405427	0.6878
R^2= 0.913232 AdjR^2= 0.900088 F-Stat = 385.7374 Prob(F-stat)= 0.000000 Durbin-Watson = 1.665376			

4.4.3 Estimation of Determinants of Total Gas Consumption

The results of regression show that POP has positive and statistically insignificant effect on total gas consumption. While the following determinants of total gas consumption i.e GDP, FGP, FOP and UPROD are significant at 5% level of significance. The elasticity of GDP is 0.933150, shows that if 1% increases in GDP the total gas consumption will increase by 0.933 and elasticity of gas price is -0.105258, it indicates that 1% increase in price of natural gas, in response total gas consumption will decrease by 0.11 units. The coefficients of POP, FOP and UPROD are 0.229217, 0.148578 and 0.000117 respectively it can be read in the same way. The signs of the coefficients are in line with theory. The reasons behind the insignificant effect of total population on natural gas consumption are that the majority of populations living in rural areas are lack of facility of natural gas due to not connected with gas pipe line. Furthermore people have no facility of gas; they use fire wood, faun gas, and kerosene as substitute of natural gas. The following obtained results are given in table 4.9. The obtained results are in line with the company of Alberinia (2011), Erdogdu (2010), Halvorsen (1975), Khan et al (2008) and Liu (1983).

The values of adjusted R^2 and D-W statistic are 0.939265, 1.755126 respectively, which illustrate the fitted model is good and no serious autocorrelation problem is exist.

Table 4.9: Regression Results of Determinants of Total Gas Consumption

Dependent variable LTGC			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	12.66714	9.036395	0.0000
LGDP	0.933150	3.321444	0.0001
LPOP	0.229217	1.190625	0.2431

LFGP	-0.105258	-1.951356	0.0582
LFOP	0.148578	5.042078	0.0001
UPROD	0.000117	3.984372	0.0004
R^2= 0.941106 AdjR^2= 0.939265 F-Stat = 538.5758 Prob(F-stat)= 0.000000 Durbin-Watson = 1.755126			

4.4.4 Estimation of Determinants of Total Coal Consumption

Table 4.9 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 and F-statistic are 0.965540, 213.9463 which show that the overall model is good fitted. The value of DW is 1.585992 which is near to 2 which reflects that the problem of serial correlation is not severe.

Table 4.10: Regression Results of Determinants of Total Coal Consumption

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= 0.910074 AdjR^2= 0.905540 F-Stat = 213.9463 Prob(F-stat)= 0.000000 Durbin-Watson = 1.705992			

4.4.5 Estimation of Determinants of Economic Growth of Pakistan

The results given in table 4.11 indicate that TEC value is positive and in accord with economic theoretical expectation. This implies that a raise in the level of total energy consumption will boost GDP of Pakistan, ceteris paribus. The coefficient of TEC shows that an increase in the level of energy consumption by 1 per cent would lead to a

0.993954 per cent increase in gross domestic growth (GDP). The result shows that the total energy consumption (TEC) is statistically significant at 5 per cent level, which further explains that Pakistan being developing country required more energy to different sectors of economy for attainment of ultimate objective of economic development.

The gross fixed capital formation (GFCF) is positive, statistical significant at 5 % level and conforms to economic theory. This means that if gross fixed capital formation increases by 1 per cent, GDP will increase by 0.438685 per cent. In the study GFCF is used as proxy of investment and investment is considered as important component of GDP, hence any addition to stock of capital will augment GDP.

The total external debt (TED) is positive and in conformity with theoretical expectation. This implies that if the external debt increases by 1 per cent, the level of GDP will increase by 0.020296 per cent. But, the coefficient of the TED is statistically insignificant at 5 per cent level of significance. This implies that external debt has not used effectively for development purposes.

The coefficient of trade openness (TO) is positive and in support with economic theory. The result illustrate that a 1 per cent increase in trade openness will increase the GDP of Pakistan by 0.050664 per cent, however the coefficient of trade openness is statistically insignificant at 5 percent level of significance, hence TO is not reliable determinant of GDP. This implies that external debt has not used effectively for development purposes and trade openness also has not effectively contribution to GDP of Pakistan because deteriorate terms of trade and Pakistan mass exports comprise of raw materials and semi-finished goods, while imports are contained final goods and services.

The coefficient of employment shows that 1 percent increase in EMPLY will increase the GDP of Pakistan by 0.949200 percent. The coefficient is significant at 5 % level of significance and parallel with economic theory, it indicates that more opportunities created in the economy the unemployed and disguise unemployed labor will utilize and will add their contribution to GDP of Pakistan.

Further the total cropped area has positive effect on GDP and match with theoretical expectation. The result shows that 1 percent increase occur in TCA will increase GDP of Pakistan by 0.428026 percent, moreover the result is statistical significant at 10 % level of significance, which point out that Pakistan is agrarian economy. But coefficient of TCA is insignificant at 5 % level of significance, owing reasons that agriculture contributed only 21 %, manufacturing 19 % of GDP and major share hold in GDP of Pakistan by services, it explain that agriculture share is less than other given sectors (Economic Survey of Pakistan 2010-11).

The value adjusted R^2 is 0.898544, indicates that the fit is good. The value of Durbin Watson statistic is 1.725861 which shows autocorrelation is not severe.

Table 4.11: Regression Results of Determinants of GDP

Dependent variable LGDP			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	-3.734079	-1.350755	0.1884
LTEC	0.993954	5.190452	0.0000
LGFCF	0.438685	5.518244	0.0000
LTED	0.020296	0.125760	0.9009
LTO	0.050664	0.656029	0.5176

LEMPLY	0.949200	3.457308	0.0019
LTCA	0.428026	0.973242	0.1094
R^2= 0.908817 AdjR^2= 0.898544 F-Stat = 3658.178 Prob(F-stat)= 0.000000 Durbin-Watson = 1.725861			

4.5 Short Run Dynamics ECM

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

4.5.1 ECM Results for Total Electricity Consumption

The results of ECM are given in table 4.12 are shown that in short run lag value of total electricity consumption, GDP, population and numbers of manufacturing industries have positive effect on total electricity consumption, whereas only lag value electricity consumption and total population are statistically significant determinants of total electricity consumption in short run. Furthermore the effect of lag value of GDP, price and lag value of price and temperature have negative but statistically insignificant beside only the lag value of electricity which is statistically significance at 10 percent. The table shows that the variables have no strong relation in short-run analysis; further the results indicate the effect of lags value of all variables on total electricity consumption were insignificant. The coefficient of error correction term is negative and has statistically significant at 5 per cent level, which proof long-run equilibrium among variables of interest are stable. In case of any short run shock there will be a convergence to long run equilibrium, while equilibrium will be restored on the basis of short run dynamics. The speed of convergence will be almost 27 %.

Table 4.12: ECM results for Total Electricity Consumption

Dependent variable D(LTEC)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.049118	1.768833	0.0847
D(LTEC-1)	0.350827	1.850363	0.0877
D(LGDP)	0.265217	1.124214	0.2742
D(LGDP-1)	-0.239810	-1.059756	0.3019
D(LPOP)	0.360667	2.260337	0.0316
D(LSPE)	-0.087135	-0.744942	0.4650
D(LSPE-1)	-0.072683	-0.621083	0.5416
D(LTEMP)	-0.231095	-0.763468	0.4580
D(LQIM)	0.065785	0.855722	0.4023
ECT01(-1)	-0.272521	-2.464525	0.0201
R^2= 0.350263 AdjR^2= 0.170468 F-Stat = 1.928171 Prob(F-stat)= 0.421904 Durbin-Watson = 2.041057			

4.5.2 ECM Results for Total Petroleum Consumption

Table 4.13 illustrates the ECM results. In short-run all explanatory variables have negative effect except TVR and FGP have positive effect on total petroleum consumption. All variables are statistically insignificant at 5% level however only FGP has statistically significant at 10 percent. Except GDP and total population the rest of the variables are in line with economic theory. The coefficient of error correction term is negative and has statistically significant at 5% level of significance. This further confirms stable long run equilibrium among variables. In case of shock there will be a convergence to long run equilibrium with pace of 44%.

Table 4.13: ECM results for Total Petroleum Consumption

Dependent variable D(LTOPC)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.038730	1.099356	0.2804
D(LGDP)	-0.030143	-0.126577	0.9001
D(LPOP)	-0.034673	-0.154847	0.8780
D(LTVR)	0.130993	0.529421	0.6042
D(LFOP)	-0.088164	-1.242792	0.2285
D(LFGP)	0.148283	1.715039	0.0956
ECT02(-1)	-0.449412	-3.662858	0.0009
R^2= 0.348804 AdjR^2= 0.221988 F-Stat = 2759522 Prob(F-stat)= 0.057172 Durbin-Watson = 1.698556			

4.5.3 ECM Results for Total Gas Consumption

Table 4.14 demonstrates the ECM results. In short run all explanatory variables have positive effect except FGP has negative effect on TPC. All variables are statistically insignificant at 5% level. The entire variables are in line with economic theory. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms stable long run equilibrium among variables. In case of shock there will be a convergence to long run stable equilibrium with pace of 37 percent.

Table 4.14: ECM results for Total Gas Consumption

Dependent variable D(LTGC)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.016540	0.426600	0.6731
D(LGDP)	0.288635	1.105059	0.2789
D(LPOP)	0.098967	0.495068	0.6246
D(LFGP)	-0.002794	-0.039707	0.9686
D(LFOP)	0.082903	1.502260	0.1446
D(UPROD)	4.377405	1.118230	0.2733
ECT03(-1)	-0.375140	-2.525959	0.0177
R^2= 0.260993 AdjR^2= 0.069399 F-Stat = 1.362220 Prob(F-stat)= 0.261097 Durbin-Watson = 1.586517			

4.5.4 ECM Results for Total Coal Consumption

The ECM results are specified in Table 4.15. 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 4.15: 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 AdjR^2= 0.408275 F-Stat = 5.254849 Prob(F-stat)= 0.000782 Durbin-Watson = 1.910232			

4.5.5 ECM Results for Gross Domestic Product

Table 4.16 shows the ECM results. In short run all explanatory variables have positive effect on GDP. Only two variables of GFCF and TO are statistically significant and the rest of variables are statistically insignificant at 5% level. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms long run equilibrium among variables of interest are stable. In case of shock there will be a convergence to long run equilibrium with speed of 34%.

Table 4.16: ECM results for GDP

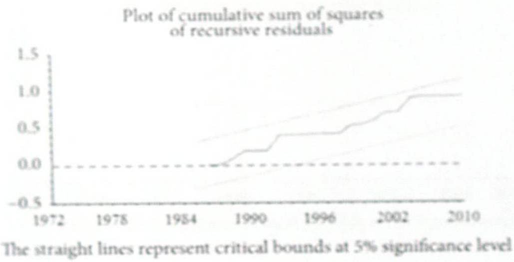
Dependent variable D(LGDP)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.055287	2.602553	0.0156
D(LTEC)	0.246887	0.666732	0.5113
D(LGFCF)	0.288575	2.759590	0.0109
D(LTED)	0.207733	1.651579	0.1116
D(LTO)	0.056665	2.162515	0.0408
D(LEMPLY)	0.467671	1.664720	0.1090
D(LTCA)	0.277958	1.410747	0.1712
ECT01(-1)	-0.338990	-2.113592	0.0451
R^2= 0.551653 AdjR^2= 0.420885 F-Stat = 4.218570 Prob(F-stat)= 0.003671 Durbin-Watson = 1.667037			

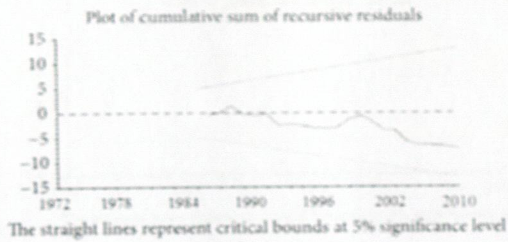
* Shows significance at 5% level. Source: Author's own calculation using E. view 5

4.6 Graphic Representation of CUSUM Tests

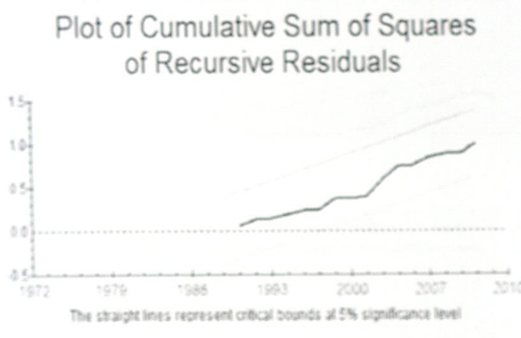
In order to examine the stability of the multiple regressions coefficients, the cumulative sum and the cumulative sum of squares are applied. A graphical representation of CUSUM and CUSUMsq are given below. The null hypothesis that the regression equations are properly specified cannot be rejected if the plots of these statistics stay within the critical boundaries at the 5 percent level of significance. Given figures show that the plots of both the CUSUM and the CUSUMsq are within the acceptance bound, which show that all models coefficients are stable.

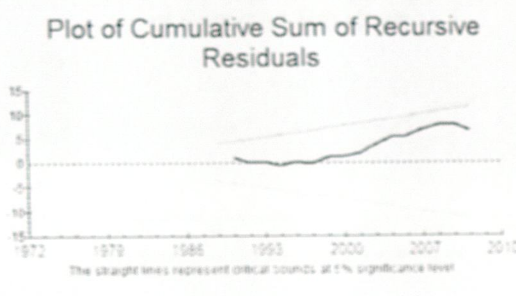
4.6.1 Total Electricity Consumption



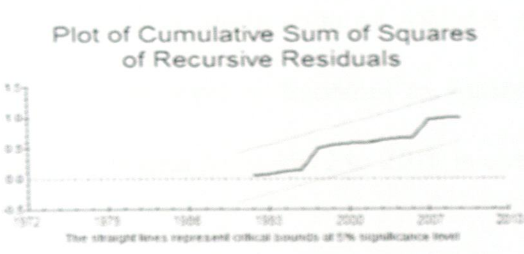


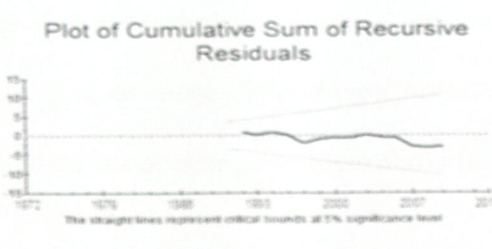
4.6.2 Total Petroleum Consumption



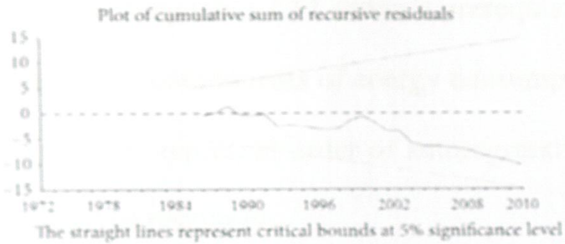


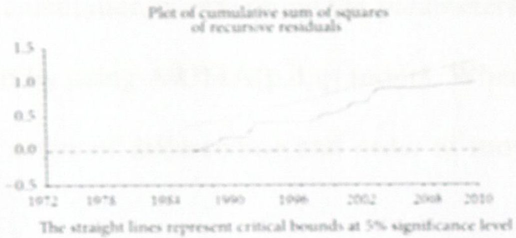
4.6.3 Total Natural Gas Consumption



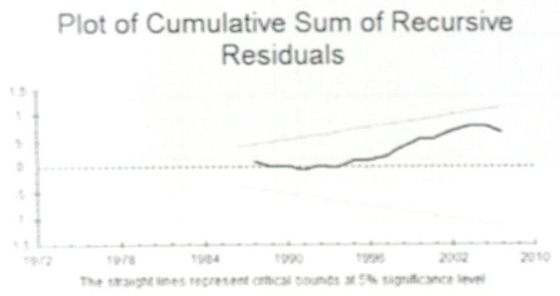


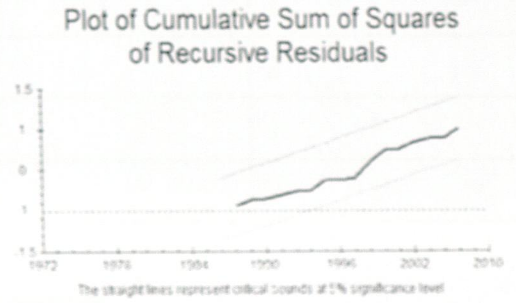
4.6.4 Total Coal Consumption





4.6.5 Economic Growth and Energy Consumption





4.7 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 2010 is used and data is not change to logarithms form.

4.7.1 Determining the Parameters of Statement of the Problem for Forecasting

The following table 4.17 shows a prerequisite calculation to determine the parameters for forecasting components of energy consumption by using ARIMA(p,d,q) model. Where p, d and q are represent order of autoregressive, order of differencing and order of moving average respectively.

Table 4.17: ARIMA(p,d,q)

Variables	Order of Auto regressive (p)	Order of differencing (d)	Order of moving average (q)
TEC	2	2	1
TOPC	1	2	2
TGC	1	2	1
TCC	2	1	2

4.7.2 Forecasts of Total Electricity Consumption

The forecasted values of total electricity consumption from 2011 to 2025 by using ARIMA model are given in table 4.18. Average electricity consumption for the year 2011 to 2015, 2016 to 2020 and 2021 to 2025 will be 82711.6, 98251.4 and 114837.8 Gwh respectively and as whole average electricity consumption in Pakistan from 2011 to 2025 will be 98600.27 Gwh. The result of ARIMA model shows that there will be increasing trend in total electricity consumption and it will be 121627 Gwh in 2025. Furthermore forecast results are within acceptable bound at 95% of confidence interval. The estimated forecasts are low from official forecasts of electricity consumption conducted by NTDC (2008). The NTDC forecast given for the year 2012, 2014, 2016, 2018, and 2020 are 74340 Gwh, 86138 Gwh, 98789 Gwh, 112954 Gwh and 128121 Gwh correspondingly, it is over estimated. Whereas the study forecast of electricity consumption is better than the forecast of NTDC due to the reason that in actual electricity consumption in 2011 is 77099 Gwh (Economic Survey of Pakistan 2010-11), which is almost equal to estimated forecast as 76635 Gwh. Hence the estimated forecasts are real and match with ground reality.

Table 4.18: Forecasting of Total Electricity Consumption from 2011 to 2025

Projected Years	Forecasted electricity consumption (Gwh)	Lower 95% confidence interval	Upper 95% confidence interval
2011	76635	72858	80412
2012	79998	72178	87818
1013	82482	69625	95340
2014	85928	67405	104452
2015	88515	63586	113444
2016	92057	60212	123901
2017	94744	55366	134122
2018	98382	51032	145731
2019	101170	45307	157032
2020	104904	40137	169670
2021	107792	33633	181951
2022	111622	27715	195529
2023	114611	20509	208713
2024	118537	13911	223164
2025	121627	6061	237193

4.7.3 Forecasts of Total Petroleum Consumption

By using ARIMA model the forecasts of total petroleum consumption in Pakistan from 2011 to 2025 are obtained in table 4.19. The results indicate on average petroleum consumption for the year 2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 21177309, 24917136.8 and 29062744.2 tons respectively and as whole average petroleum consumption in Pakistan from 2011 to 2025 will be 25052396.67 tones. The result shows that there will be growth in total petroleum consumption and in 2025 it will be 30818608 tons.

Table 4.19: Forecasting of Total Oil and Petroleum Consumption from 2011 to 2025

Projected Years	Forecasted petroleum consumption (tons)	Lower 95% confidence interval	Upper confidence interval
2011	19770886	18131944	21409827
2012	20475568	18219163	22731973
1013	21153370	18520520	23786220
2014	21885792	18968653	24802931
2015	22600929	19492739	25709119
2016	23362221	20108378	26616064
2017	24113697	20765792	27461602
2018	24904738	21490418	28319058
2019	25691777	22240717	29142837
2020	26513251	23041499	29985003
2021	27335249	23856800	30813698
2022	28187690	24708142	31667237
2023	29044176	25563899	32524453

2024	29927998	26441795	33414201
2025	30818608	27313998	34323217

4.7.4 Forecasts of Total Gas Consumption

The forecast results of total gas consumption for the year up to 2025 are determined below in table 4.20. By using ARIMA model it indicates on average the forecasted values of total gas consumption for the year 2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 1415437, 1690409.6 and 19933765.6 mm cubic feet respectively and as whole average gas consumption in Pakistan from 2011 to 2025 will be 1699870.74 mm cubic feet. The result shows that in future there will be increase occurred in total gas consumption and turn out to be 2121533 mm cubic feet in 2025.

Table 4.20: Forecasting of Total Natural Gas Consumption from 2011 to 2025

Projected Years	Forecasted of gas consumption (mm cubic feet)	Lower 95% confidence interval	Upper 95% confidence interval
2011	1315231	1250809	1379654
2012	1362377	1253504	1471249
1013	1413278	1266542	1560015
2014	1466083	1285624	1646542
2015	1520216	1308623	1731810
2016	1575500	1334414	1816586
2017	1631879	1362361	1901397
2018	1689336	1392075	1986597
2019	1747866	1423304	2072428
2020	1807467	1455878	2159057

2021	1868139	1489673	2246606
2022	1929882	1524601	2335163
2023	1992695	1560595	2424795
2024	2056579	1597603	2515554
2025	2121533	1635586	2607479

4.7.5 Forecasts of Total Coal Consumption

Table 4.21 is demonstrates forecast results of total coal consumption for the year 2011 to 2025.The results ARIMA model show on average the forecasted values of total coal consumption for the year 2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 6657.4, 6404.68 and 6946.66 thousand metric tons respectively and as whole average total coal consumption in Pakistan from 2011 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 4.21: Forecasting of Total Coal Consumption from 2011 to 2025

Projected Years	Forecasted coal consumption (000 tons)	Lower 95% confidence interval	Upper 95% confidence interval
2011	7785.6	6741.0	8830.1
2012	6855.3	5496.8	8213.7
1013	6342.5	4265.4	8419.5
2014	6159.0	3245.7	9072.3
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

Chapter 5

RESULTS AND DICUSIONS OF THE DETERMINANTS AND FORECASTING OF ENERGY SUPPLY

5.1 Introduction

This chapter highlights the empirical results of the determinants and forecasting of energy components supply. The study focused on to check co integration and to estimate short run and long run relationship amongst the variables of the study, hence we start from the stationarity of the data which is necessary for the said analysis.

5.2 Stationarity Test

The study has used Augmented Dickey Fuller test for stationarity of data. The results of ADF test are given in table 5.1. According to the t-statistics value of ADF test for all the following variables (LEMPLY LGDP LGFCF LRF LTEC LTEMP LTES LTPS LTCDS LTGS LTVR LFDI LETDL LSPE LFOP LFGP LSPC) are statistically significant at first difference. Thus the variables turn out to be stationary at first difference or order 1(1).

Table 5.1: ADF Test for Unit Root

Variables	Level		First difference		Conclusion
	Statistic value	Critical value at 5%	Statistic value	Critical value at 5%	
LTEC	-2.035337	-2.943427	-4.279257*	-2.943427	1(1)
LGDP	-0.869259	-2.943427	-3.398987*	-2.943427	1(1)
LSPE	-1.936823	-2.943427	-3.408085*	-2.945842	1(1)
LTEMP	-2.472006	-2.954021	-3.807504*	-2.957110	1(1)
LTVR	0.145121	-2.943427	-3.977703*	-2.945842	1(1)

LFOP	0.419443	-2.943427	-5.002766*	-2.945842	1(1)
LFGP	0.183458	-2.943427	-3.939647*	-2.945842	1(1)
LSPC	-1.249828	-2.943427	-5.080457*	-2.945842	1(1)
LTES	-2.448330	-2.943427	-3.210393*	-2.945842	1(1)
LRF	-2.170968	-2.954021	-3.755754*	-2.957110	1(1)
LEMPLY	1.208590	-2.941145	-6.271997*	-2.943427	1(1)
LETDL	-1.941196	-2.941145	-6.409272*	-2.943427	1(1)
LTPS	-0.851112	-2.943427	-3.436241*	-2.945842	1(1)
LFDI	-2.061731	-2.945842	-8.279103*	-2.948404	1(1)
LTGS	-2.106817	-2.941145	-3.945266*	-2.943427	1(1)
LTCS	-1.529082	-2.945842	-6.001931*	-2.945842	1(1)
LGFCF	-2.791136	-2.957110	-4.011347*	-2.960411	1(1)

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

5.3 Johansen Co Integration Test

For existence of co integration relationship between variables of interest, it is a preconditioned that the variables should turn out to be stationary at the same order of difference. From the above ADF test it is concluded that all variables of the study are stationary at first difference, hence the Johansen co integration test is used to test out co integration amongst variables of interest.

5.3.1 Co Integration Test for Total Electricity Supply

The results of Johansen co integration test are given in table 5.2. Trace statistics and Maximum Eigen values are used to show the number of co integration vectors. The null hypothesis of no co integration (R = 0) against the alternative of co integration ($R \leq 1$). The value trace statistics is 141.1862, which is greater than the value of critical value of

95.75366 and the maximum Eigen value is 68.56691, which is greater than the critical value of 40.07757 at 5 percent level of significance. Hence null hypothesis is rejected and co-integration is accepted as alternative hypothesis. The trace statistics confirms two co integrating vectors and the maximum Eigen value also confirms one co integrating vectors at 5 percent significance level.

Thus the results confirm the existence of long run relationship between total electricity supply, rain fall, petroleum import, electricity transmission and distribution loss, sale price of electricity, price of oil and technology.

Table 5.2: Results of Johansen Co Integration Test for Total Electricity Supply

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	141.1862*	95.75366	68.56691*	40.07757
R ≤ 1	R ≥ 2	72.61927*	69.81889	30.98785	33.87687
R ≤ 2	R ≥ 3	41.63142	47.85613	21.36195	27.58434
R ≤ 3	R ≥ 4	20.26947	29.79707	9.978867	21.13162
R ≤ 4	R ≥ 5	10.29061	15.49471	8.952858	14.26460
R ≤ 5	R ≥ 6	1.337750	3.841466	1.337750	3.841466

5.3.2 Co Integration Test for Total Petroleum Supply

Johansen co integration test's results are given in table 5.3. The values of Trace statistics and Maximum Eigen values are employed to investigate the co-integration. The value comparison among the trace statistics, the maximum Eigen and the critical values (at 5 percent level of significance) are tested. The comparison justified that the value of trace statistics, the maximum Eigen is greater than critical values. Hence null hypothesis is rejected and alternative of existence of co integration is accepted means, there is co-integration. The trace statistics confirm one co integrating vectors and the maximum Eigen value also confirm one co integrating vectors at 5 percent significance level.

Thus the results confirm the existence of long run relationship between total petroleum supply and GFCF, TEC, FDI and FOP.

Table 5.3: Results of Johansen Co Integration Test for Total Petroleum Supply

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	74.73160*	69.81889	36.54995*	33.87687
R ≤ 1	R ≥ 2	38.18165	47.85613	22.12337	27.58434
R ≤ 2	R ≥ 3	16.05828	29.79707	9.605437	21.13162
R ≤ 3	R ≥ 4	6.452840	15.49471	5.983355	14.26460

5.3.3 Co Integration Test for Total Gas Supply

The results of Johansen co integration test are given in table 5.4. Trace statistics and Maximum Eigen values are used to show the number of co integration vectors. The values of trace statistics and the maximum Eigen are greater than the critical value at 5 percent level of significance. Hence null hypothesis of no co integration is rejected and alternative hypothesis of co integrating vector is accepted. The trace statistics confirms two co integrating vectors and the maximum Eigen value also confirms one co-integrating vector at 5 percent significance level.

Thus the results verify the existence of long run relationship between total gas supply and explanatory variables.

Table 5.4: Results of Johansen Co Integration Test for Total Gas Supply

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	140.9818*	117.7082	47.71473*	44.49720
R ≤ 1	R ≥ 2	93.26706*	88.80380	36.05628	38.33101
R ≤ 2	R ≥ 3	57.21078	63.87610	23.72922	32.11832
R ≤ 3	R ≥ 4	33.48156	42.91525	14.33054	25.82321
R ≤ 4	R ≥ 5	19.15102	25.87211	10.43671	19.38704

5.3.4 Co Integration Test for Total Domestic Coal Supply

Table 5.5 shows the results of Johansen co integration test. Trace statistics and Maximum Eigen values are used to show the number of co integration vectors. The values of trace statistics are greater than the critical value at 5 percent level of significance. Hence alternative hypothesis of co integrating vector is accepted. The trace statistics confirm two co integrating vectors and the maximum Eigen value also confirms one co integrating vector at 5 percent significance level.

Thus the results verify the existence of long run relationship between total domestic coal supply and independent variables.

Table 5.5: Results of Johansen Co Integration Test for Total Domestic Coal Supply

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max-Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	81.51682*	69.81889	34.78577*	33.87687
R ≤ 1	R ≥ 2	49.73106*	47.85613	21.30036	27.58434
R ≤ 2	R ≥ 3	26.43070	29.79707	15.37934	21.13162
R ≤ 3	R ≥ 4	11.05136	15.49471	10.08128	14.26460
R ≤ 4	R ≥ 5	0.970079	3.841466	0.970079	3.841466

5.4 Multiple Regression Models Estimation

The variables of the study are stationary and co integrated after applying the ADF and Johansen co integration tests. Therefore the results obtained from OLS are not spurious. The following multiple regression models are used to estimate the determinants of components of energy consumption.

5.4.1 Estimation of Determinants of Total Electricity Supply

The results of multiple regressions have been given in table 5.6. The results show that Rain fall (RF) directly affects electricity supply. The implication of this result is 1 %, increase in RF will bring 0.059337 % increase in electricity supply. The sign of RF confirms with theoretical expectation but statistically insignificant at 5 percent level. This means that the whole electricity is not generated from water reserve, only 33.6 percent electricity is generated from hydel and the rest of electricity is generated from other sources (Economic Survey of Pakistan 2011-12). The given result is unison with Isola (2007) and Ubi (2012). Water resource is one of the important sources of electricity generation but it is not considerably use due to some political and social issues. But rainfall is not a considerable portion of water sources.

The value of coefficient of petroleum import (TPM) is 0.176960, indicates positive relationship between total petroleum import and electricity supply. This means that 1 percent increase in TPM would lead to 0.100085 percent increase in electricity supply. This variable is in line with economic theory and also statistically significant at 5 percent level. In case of Pakistan the contribution of both gas and oil in electricity generation is about 65 % which is very much high.

Also, value of electricity transmission and distribution loss (ETDL) is negative and according to theoretical expectation. In other words, 1 percent increase in ETDL will decrease electricity supply by 0.068233 percent. The coefficient of the ETDL is statistically significant at 10 percent level of significance. The result indicates that electricity transmission and distribution loss is dominant determinant of electricity, which suggests the injection of funds in favor of technology related to transmission and distribution of electricity. The sign of the coefficient is in line with Ubi (2012).

The inelastic price elasticity is 0.083617, showing direct relationship between electricity supply (TES) and price of electricity (P). This implies that if price of electricity increase by 1 %, electricity supply will increase by 0.083617 %. The coefficient of price of electricity is statistically insignificant at 5 % level of significance due to the reasons that electricity is supplied under government owned companies and profit making is not primary objective. Along with this Pakistan government provided subsidies on electricity consumption about Rs 346.096 bn in 2010, it may perhaps under price. Therefore price is not dominant factor of electricity supply in Pakistan. The result has the same opinion with Ubi (2012).

The cross inelastic price elasticity is -0.166118 shows inverse relationship between electricity supply (TES) and price of substitute (final oil prices, FOP). This implies that if price of substitutes increase by 1 %, electricity supply will increase by 0.166118 %. The coefficient of price of electricity is statistically significant at 8 % level of significance rather on 5 %. Again due to the same reason discussed above electricity generation in Pakistan is not dependent as a whole on petroleum, but contribution of electricity generation from petroleum was also 35.1 % in 2010 and the rest of electricity was generated from other sources (Economic Survey of Pakistan 2011-12).

The result shows that technology (@TREND use as proxy of technology) is statistically significant at 5 % level of significance and has positive relationship with electricity supply. A one percent increases in technology will least impact in the form of increase in electricity supply by 0.070843 %. Technology is one of the vital determinants of electricity supply and impels policy attention. The result is corresponding with Isola (2007) and Lwayemi (2008).

The adjusted R^2 is 0.914155 which shows that 91 % of variation in total electricity supply has been explained due to changes in included explanatory variables, hence the fit is good. The value of F- statistic indicates that overall model is statistically significant at 5 % level of significance. The Durbin- Watson statistic value is 1.650678, which indicates that autocorrelation problem is not too much severe.

Table 5.6: Regression Results of Determinants of Total Electricity Supply

Dependent variable LTES			
Variable	Coefficient	T-statistic	Prob.
Constant	7.525798	8.101936	0.0000
LRF	0.059337	0.894760	0.3776
LTPM	0.176960	2.341769	0.0256
LETDL	-0.068233	-0.486016	0.1003
LSPE	0.083617	0.427341	0.6720
LFOP	-0.166118	-1.766113	0.0869
@TREND	0.070843	4.548094	0.0001
R^2= 0.926657 AdjR2= 0.914155 F-Stat = 394.3667 Prob(F-stat)= 0.000000 Durbin-Watson = 1.650678			

5.4.2 Estimation of Determinants of Total Petroleum Supply

The results from regression are given in table 5.7. The results confirm that all independent variables have positive effects on total petroleum supply and the relationship among variables is in line with economic theory. The following determinants of petroleum supply such as GFCF, TEC, FOP and technology are statistically significant at 5% level of significance. Whereas the coefficient of Foreign Direct Investment (FDI) is statistically significant at 10 percent level but insignificant at 5 percent level of significance, due to the basis that little portion of FDI attracted to the field of oil exploration. Minute attraction of FDI to the field may be due to the reason of political instability, law and order situation and inefficient government policy. The coefficients show that on average one percent increase in GFCF, FDI, FOP and technology leads to 0.001184, 0.027267 and 0.094488 percent increase in total petroleum supply respectively.

The value of adjusted R^2 is 0.906272 which is greater than 50% indicates fit is good. The value of D-W statistic is 1.700837 which shows no severe autocorrelation problem.

Table 5.7: Regression Results of Determinants of Total Petroleum Supply

Dependent variable LTPS			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	-0.377759	-0.166274	0.8692
LGFCF	0.001184	3.357371	0.0024
LFDI	0.027267	0.813416	0.1034
LFOP	0.229339	2.960512	0.0055
@TREND	0.094488	3.017614	0.0056
R^2= 0.918164 AdjR^2= 0.906272 F-Stat = 78.89329 Prob(F-stat)= 0.000000 Durbin-Watson = 1.700837			

5.4.3 Estimation of Determinants of Total Gas Supply

Table 5.8 shows the results of regression which indicate that all variables have positive effect on total gas supply except TPM and the relationship among variables is in line with economic theory. Only FGP and FOP are statistically insignificant owing that natural gas is supplied under government monopoly and prices are not set by the market forces, also petroleum is not used as a perfect substitute in the market. While FDI, TVR, TPM and technology are statistically significant variables at 5 percent level of significance. The coefficient of the variables shows that on average one percent increase in FDI, TVR, FGP, FOP and technology leads to 0.042096, 0.388958, 0.099974, 0.061121 and 0.020494 percent increase in total gas supply respectively. While One unit increase in TPM brings -0.111585 units decrease in TGS.

The values of adjusted R^2, F-statistic and D-W statistic are 0.884495, 1114.949 and 1.795406 respectively, which show the fitted overall model is good.

Table 5.8: Regression Results of Determinants of Total Gas Supply

Dependent variable LTGS			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	12.58232	34.73678	0.0000
LFDI	0.042096	2.522074	0.0170
LTVR	0.388958	4.736552	0.0000
LTPM	-0.111585	-2.645385	0.0127
LFGP	0.099974	1.506862	0.1420
LFOP	0.061121	1.313396	0.1987
@TREND	0.020494	2.568324	0.0153
R^2= 0.895387 AdjR^2= 0.884495 F-Stat = 1114.949 Prob(F-stat)= 0.000000 Durbin-Watson = 1.795406			

5.4.4 Estimation of Determinants of Total Domestic Coal Supply

Table 5.9 shows the effect of explanatory variables (GDP, EMPLY, TEMP, SPC and Technology) on total domestic coal supply. Whereas GFCF, EMPLY and technology has significantly positive effects while prices of coal is in line with theory but statistically insignificant at 5 % due to the reasons mentioned above for other sources of energy. At the same time as Temperature has negative and statistically insignificant effects on total domestic coal supply at 5 % level of significance, holds up with theory. It implies that in the long run temperature is not crucial determinant of total coal supply. This may be due to the reason that coal supply is not much affected by the temperature.

The values of adjusted R^2 and D-W statistic are 0.875756, 1.819161 respectively, which explain the fitted model is good and no severe autocorrelation problem exists.

Table 5.9: Regression Results of Determinants of Total Domestic Coal Supply

Dependent variable LTDCS			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	-2.214634	-0.400183	0.6916
LGFCF	0.471096	1.668266	0.0262
LEMPLY	1.889521	2.738455	0.0036
LTEMP	-0.080007	-0.063606	0.9497
LSPC	0.232601	1.954161	0.0611
@TREND	0.166667	5.047452	0.0005
R^2= 0.888157 AdjR^2= 0.875756 F-Stat = 94.67904 Prob(F-stat)= 0.000000 Durbin-Watson = 1.819161			

5.5 Short Run Dynamics ECM

Once co integration among variables has existed, then we are able to use the ECM technique to estimates short run relationship between variables of interest.

5.5.1 ECM Results for Total Electricity Supply

The results of ECM are given in table 5.10. It shows that in short run lag value of TES, RF and lag value of RF and TPM have positive but statistically insignificant effects on total electricity supply but TPM has statistically significant at 8%. While other variables of SPE and lag value of SPE and FOP have negative but statistically insignificant effects on TES except ETDL has significant at 5% level of significant. The table illustrates that the variables have no strong relation in short run analysis; further the results indicate the effects of lag values of all variables on TES were insignificant. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms long run equilibrium among variables of interest is stable. In case of shock there will be a convergence to long run equilibrium.

Table 5.10: ECM Results for Total Electricity Supply

Dependent variable D(LTES)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.088725	3.577229	0.0013
D(LTES-1)	0.129595	0.731458	0.4708
D(LRF)	0.033153	1.007939	0.3224
D(LRF-1)	0.020534	0.582525	0.5650
D(LTPM)	0.130796	1.830004	0.0783
D(LETDL)	-0.181612	-2.298605	0.0295

D(LSPE)	-0.108223	-0.915483	0.3680
D(LSPE-1)	-0.176789	-1.375551	0.1803
D(LFOP)	-0.014734	-0.216989	0.8298
ECT05(-1)	-0.192146	-1.991321	0.0567
R^2= 0.379894 AdjR2= 0.173192 F-Stat = 1.837882 Prob(F-stat) = 0.106940 Durbin-Watson = 1.487981			

5.5.2 ECM Results for Total Petroleum Supply

Table 5.11 shows the results of ECM. In short run all explanatory variables have positive effects except GFCF has negative effects on TPS. The GFCF and TEC are statistically significant and FDI and FOP are insignificant at 5% level. All variables are according to economic theory except of GFCF. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms stable long run equilibrium among variables.

Table 5.11: ECM Results for Total Petroleum Supply

Dependent variable D(LTPS)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.006096	0.160016	0.8742
D(LGFCF)	-0.331309	-2.208303	0.0370
D(LTEC)	0.992892	2.863871	0.0086
D(LFDI)	0.008504	0.341495	0.7357
D(LFOP)	0.024699	0.241077	0.8115
ECT06(-1)	-0.375123	-2.177214	0.0395

R^2= 0.386227
AdjR^2= 0.258358
F-Stat = 3.020483
Prob(F-stat) = 0.029689
Durbin-Watson = 1.308311

5.5.3 ECM Results for Total Gas Supply

The results of ECM are given in table 5.12 show that in short run FDI, FGP and FOP have positive effects on TPS, but FGP is statistically insignificant at 5% level. While other variables of TVR and TPM have negative effect on TPS. Moreover TPM is statistically significant and TVR is insignificant at 5% level of significance. The table shows that the variables have no strong relation in short run analysis; further the results are in line with economic theory except the TVR. The coefficient of error correction term is negative and is statistically significant at 5% level, which confirms long run stable equilibrium among variables of interest.

Table 5.12: ECM Results for Total Gas Supply

Dependent variable D(LTGS)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.056455	3.990569	0.0004
D(LFDI)	0.037449	3.567462	0.0013
D(LTVR)	-0.087091	-0.603811	0.5507
D(LTPM)	-0.097301	-2.500683	0.0183
D(LFGP)	0.060509	1.076089	0.2908
D(LFOP)	0.069945	1.719911	0.0961
ECT07(-1)	-0.448097	-3.039419	0.0050

R^2= 0.476479
$AdjR^2$= 0.368164
F-Stat = 4.399021
Prob(F-stat)= 0.002809
Durbin-Watson = 1.289111

5.5.4 ECM Results for Total Domestic Coal Supply

The ECM results are shown in Table 5.13. All variables have positive effects except EMPLY has negative effects on TDCS. According to result GFCF, TEMP and SPC are statistically significant at 5% level. Whereas employment is statistically insignificant determinant of coal supply at 5% level of significance and against the economic theory, which indicates that total employment is not critical determinant of total coal supply. The coefficient of error correction term is negative and is statistically significant at 5% level, which confirms long run equilibrium among variables, with pace of 37 percent to restore equilibrium in case of any shock.

Table 5.13: ECM Results for Total Domestic Coal Supply

Dependent variable D(LTDCS)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.097421	2.270836	0.0317
D(LGFCF)	0.368671	2.112648	0.0444
D(LEMPLY)	-1.297314	-1.418939	0.1678
D(LTEMP)	1.440235	2.007632	0.0552
D(LSPC)	0.200434	2.763681	0.0104
ECT08(-1)	-0.3708	-2.445771	0.0301
R^2= 0.388637			

AdjR^2= 0.271067

F-Stat = 3.305582

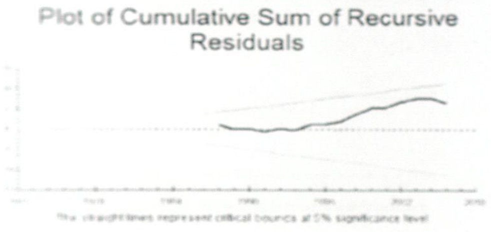
Prob(F-stat)= 0.003902

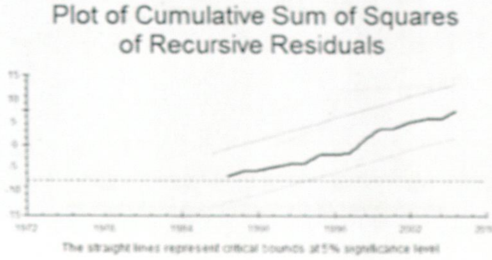
Durbin-Watson = 2.055266

5.6 Graphic Representation of CUSUM Tests

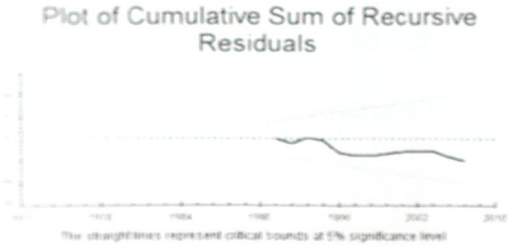
From the given below plots of CUSUM and CUSUM squares are lies within the given bound at 5 % levels of significance, which show that all the models are stable.

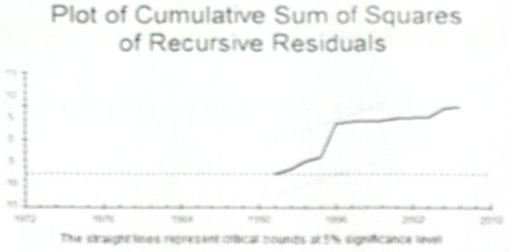
5.6.1 Total Electricity Supply



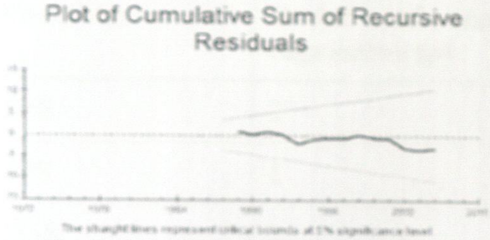


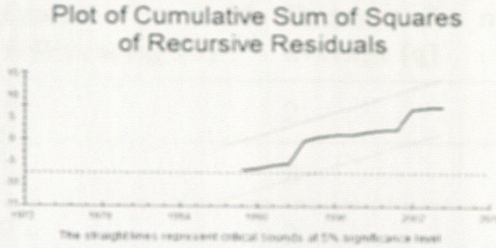
5.6.2 Total Petroleum Supply



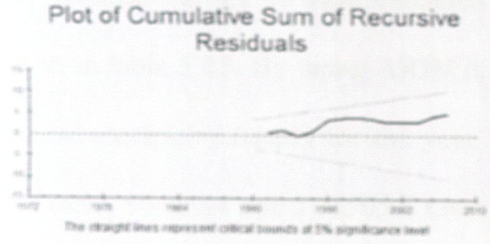


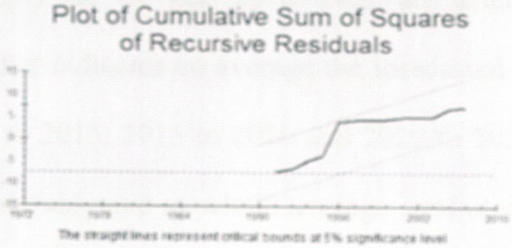
5.6.3 Total Gas Supply





5.6.4 Total Coal Supply





5.7 Determining the Parameters of Statement of the Problem for Forecasting

The table 5.14 illustrates a necessary calculation for forecasting components of energy supply by using ARIMA (p,d,q) model. Where p, d and q are represent order of autoregressive, order of differencing and order of moving average respectively.

Table 5.14: ARIMA (p,d,q)

Variables	Order of Auto regressive (p)	Order of differencing (d)	Order of moving average (q)
TES	2	1	2
TPS	1	1	0
TGS	2	2	2
TDCS	2	1	1

5.7.1 Forecasts of Total Electricity Supply

The forecast results of total electricity supply for the year up to 2025 are determined below in table 5.15. By using ARIMA model it indicates on average the forecasted values of total electricity supply for the year 2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 87450, 95429.4 and 106505.6 Gwh respectively and as whole average total electricity supply in Pakistan from 2011 to 2025 will be 96461.66 Gwh. The result shows that in future the increase will occur in total electricity supply and turn out to be 112499 Gwh in 2025. Forecast conducted NTDC (2008) are over estimated then estimated forecast. The NTDC forecast for the years 2010, 2015, 2020 and 2025 are 83463, 181018, 276937 and 409874 Gwh respectively. Also actual electricity supply in 2010 is 80424 Gwh (Economic Survey of Pakistan 2010-11), it is quite low then forecast by NTDC. The study forecasts are within acceptable bound at 95 % confidence interval and estimated forecast of electricity supply in 2011 is almost equal to actual value that is 77099 Gwh (Economic Survey of Pakistan 2011-12). Hence the study forecast is better than official forecast.

Table 5.15: Forecasting of Total Electricity Supply from 2011 to 2025

Projected Years	Forecasted electricity supply (Gwh)	Lower 95% confidence interval	Upper 95% confidence interval
2011	86549	82395	90704
2012	83438	76587	90288
1013	82360	74166	90553
2014	90625	81769	99481
2015	94278	84264	104292
2016	89147	77700	100593
2017	91239	79142	103336
2018	100836	88268	113404
2019	100752	87118	114387
2020	95173	80533	109813
2021	101376	86365	116387
2022	110379	94897	125861
2023	106056	89515	122597
2024	102218	84999	119437
2025	112499	95040	129958

5.7.2 Forecasts of Total Petroleum Supply

Table 5.16 is reveals forecast results of total petroleum supply for the year 2011 to 2025.The results ARIMA model show on average the forecasted values of total petroleum supply for the year 2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 9314.4, 10061.4 and 10812.4 tons respectively and as whole average total petroleum supply in Pakistan from 2011 to 2025 will be 10063.16 tons. The result illustrates that in future there will be an increase in trends of total petroleum supply and turn out to be 11113.3 tons in 2025.

Table 5.16: Forecasting of Total Petroleum Supply from 2011 to 2025

Projected Years	Forecasted petroleum supply (tons)	Lower 95% confidence interval	Upper 95% confidence interval
2011	9027.0	7992.7	10061.3
2012	9162.7	7608.7	10716.7
1013	9311.2	7363.0	11259.4
2014	9461.2	7185.1	11737.3
2015	9611.3	7048.9	12173.8
2016	9761.5	6941.6	12581.4
2017	9911.7	6856.0	12967.5
2018	10061.9	6787.3	13336.5
2019	10212.1	6732.4	13691.9
2020	10362.3	6688.8	14035.8
2021	10512.5	6655.1	14370.0
2022	10662.7	6629.6	14695.8
2023	10812.9	6611.6	15014.3
2024	10963.1	6600.0	15326.3
2025	11113.3	6594.2	15632.5

5.7.3 Forecasts of Total Gas Supply

The forecasted values of total gas supply from 2011 to 2025 by using ARIMA model is given in table 5.17. Average total gas supply for the year 2011 to 2015, 2016 to 2020 and 2021 to 2025 will be 1621676.6, 1904880.2 and 2213775.6 million cubic feet respectively and as whole average total gas supply in Pakistan from 2011 to 2025 will be 1913444.14 mcf. The result of ARIMA model shows that there will be an increase in trend of total gas supply and it will be 2341811 mcf in 2025.

Table 5.17: Forecasting of Total Gas Supply from 2011 to 2025

Projected Years	Forecasted gas supply (mcf)	Lower 95% confidence interval	Upper 95% confidence interval
2011	1521207	1458286	1584129
2012	1567402	1450471	1684333
1013	1618528	1457891	1779166
2014	1672605	1477506	1867704
2015	1728641	1507190	1950091
2016	1786071	1544958	2027184
2017	1844593	1589251	2099935
2018	1904039	1638825	2169253
2019	1964318	1692674	2235962
2020	2025380	1749951	2300809
2021	2087198	1809905	2364490
2022	2149756	1871841	2427671
2023	2213047	1935087	2491007
2024	2277066	1998974	2555158
2025	2341811	2062836	2620785

5.7.4 Forecasts of Total coal Supply from 2011 to 2025

By using ARIMA model the forecasts of total coal supply in Pakistan from 2011 to 2025 are obtained in table 5.18. The results indicate the average total coal supply for the year

2011 to 2015, 2015 to 2020 and 2020 to 2025 will be 4001.23, 4317.32 and 4655.77 thousand tons respectively and as whole average total coal in Pakistan from 2011 to 2025 will be 4324.78 thousand tones. The result shows that there will be growth in total coal supply and in 2025 it will be 4799.01 thousand tons.

Table 5.18: Forecasting of Total Domestic Coal Supply from 2011 to 2025

Projected Years	Forecasted coal supply (000 tons)	Lower 95% confidence interval	Upper 95% confidence interval
2011	4071.32	3396.44	4746.19
2012	3843.99	3011.67	4676.31
1013	3888.14	3011.58	4764.70
2014	3098.48	5198.82	5198.82
2015	4054.04	2923.30	5184.79
2016	4164.01	2966.94	5361.07
2017	4287.84	2987.38	5588.30
2018	4281.95	2916.37	5647.52
2019	4388.03	2954.73	5821.33
2020	4464.75	2956.24	5973.26
2021	4504.62	2936.75	6072.49
2022	4595.33	2964.95	6225.70
2023	4660.11	2967.85	6352.36
2024	4719.80	2972.21	6467.39
2025	4799.01	2994.78	6603.24

Chapter 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Introduction

Since sufficient and economical energy is crucial for fundamental social services, socio-economic conditions, transport and communication, infrastructure, construction, standard of living of the masses and ultimate objective of economic development. Hence energy has gained significant importance in developed countries and particularly in developing countries for the last few decades.

Pakistan is also a developing country and it suffers from energy crises since 2001and it escalated during 2005-06 and onwards, which reached 16 to 17 hours load shedding in different parts of the country. It occurred at the time when energy was much needed for stable economy.

This chapter describes conclusions drawn from empirical estimation of data. Finally, on the basis of findings of the study some policy recommendations are proposed.

6.2 Major Findings of the Study

Following are the important findings of the study.

- During 1971 to 2010 the average total electricity, oil and petroleum, gas and coal consumption are 32961.79 Gwh, 10465494.46 tons, 550732.21 mm cubic feet and 3362.21 thousand metrc tons respectively and the average total electricity supply, petroleum, gas and coal are 34466.72 Gwh, 5965.85 thousand tons, 630071.54 million cubic feet and 2647.18 thousand tons respectively. The average sale price of electricity, final oil price, final gas price and sale price of coal are 184.30 paisa per unit, 12.29 Rs per liter, 99.01 Rs per unit and 1148.16 Rs per tones.

- From the empirical results of the study, it is obvious and obtained that data on all variables are stationary, at first difference in order and according to Johenson co-integration test results confirm existence of long run relationship amongst variables of interest .Moreover, it is found from ECM technique that Error Correction Term is negative, and statistically significant which means that in case of any shock there will be restore stable long run equilibrium for all components of energy consumption and supply in Pakistan on the basis of short run dynamics.
- The regression results indicate that GDP, POP, TEMP and QIM have positive outcome while price has negative effect on electricity consumption and further sign of the coefficient are in line with theory. The elasticity of GDP and price are 0.372906 and -0.071070 respectively, thus means that electricity consumption has inelastic response to income and price. GDP, POP and QIM are significant at 5 % level and the coefficient of price of electricity is significant at 10 % level. While temperature is statistically insignificant at 5 % level of significance.
- The results of regression of determinants of petroleum consumption show that all variables i.e. GDP, POP, TVR and FGP have positive effect on total oil and petroleum consumption except price and the relationship among variables are held up with economic theory. GDP, TVR and FOP are statistically significant

determinants of total petroleum consumption at 5 percent level. In the long run, income and price have inelastic effect on total oil and petroleum consumption. The given results validate with Furtadoa and suslick (1993), Geem (2011), Ibrahim and Hurst (1990), Kebede et al (2010), Naryan and Wong (2009) and vita et al (2006).

- The empirical results show positive effect of independent variables i.e. (GDP, POP, FOP and UPROD) on total gas consumption whilst gas price has negative effect. All determinants of total gas consumption are statistically significant except population at 5 % level of significance. Whereas, sign of the variables are in line with theory. The results are in line with the company of Alberinia (2011), Erdogdu (2010), Halvorsen (1975), Khan et al (2008) and Liu (1983).
- According to the results all variables have positive effect on total coal consumption, apart from price of coal and temperature. Further, the relationships among variables are consistent with economic theory. The study concludes that, GDP, TCM and CPROD are statistically significant determinants of total domestic coal consumption at 5 % level except price of coal and temperature.
- It is found that RF, TPM, SPE, FOP and Technology have positive while ETDL has negative effect on total electricity supply. All variables are consistent with economic theory. Moreover TPM, ETDL, FOP and Technology are strong determinants of electricity supply in Pakistan.

- From the estimation it is assumed that all explanatory variables i.e. GFCF, TEC, FDI, FOP and Technology have positive consequence on total petroleum supply. Sign of the coefficient of the variables are in line with theory. The study concludes that GFCF, TEC, FOP and Technology are statistically significant determinants of total petroleum supply in Pakistan.
- The empirical results of the study show that all variables have positive effect on total gas supply except TPM and the relationship among variables are in line with economic theory. Further FDI, TVR, TPM and Technology are statistically significant determinants of total gas supply in Pakistan at 5% level of significance.
- From the estimation of the study it is obtained that GFCF, EMPLY, SPC and Technology have positive effect but TEMP has negative effect on total domestic supply. The sign of the independent variables matches with economic theory. In addition GFCF, EMPLY and Temperature are strong determinants of total domestic coal supply in Pakistan.
- According to results all explanatory i.e. TEC, GFCF, TED, TO, EMPLY and TCA have positive effect on economic growth. Moreover, the signs of coefficient of variables are according to economic theory. Further TEC, GFCF and EMPLY are significant determinants of economic growth of Pakistan.
- The study forecasted the energy components consumption and supply in Pakistan from 2011 to 2025 by using ARIMA model. The results show that average forecast value of total electricity, petroleum, gas and coal are 98600.27 Gwh, 25052396.67 tons, 1699870.74 mm cubic feet and 6669.58

thousand metrc tons respectively and average forecast value of total electricity, petroleum, gas and coal supply are 96461.66 Gwh, 10063.16 thousand tons, 1913444.14 million cubic feet and 4324.78 thousand tons respectively. According to the ARIMA forecasted results, there is increasing trend in both energy consumption and supply in Pakistan but, specifically the consumption of energy components shows more increasing trend than energy supply.

It is also found that economic, demographic and metrological variables have least effect on energy consumption and supply, because in energy sector there is government control monopoly due to this market imperfection, government intervention and no rival in market, hence the energy sector shows less response to socio economic variations. Further it is discovered that energy sector have significant and strong repercussions on economy of Pakistan.

6.3 Conclusion

According to the results of the study, Gross Domestic Product and population have positive impact on all sources of energy consumption. Whereas, GDP is statistical significant determinant of total energy consumption, it indicates that real economic activities rouse the total electricity, petroleum, gas and coal consumption.

The results of energy consumption models suggest that energy prices have negative impact on total electricity, petroleum, gas and coal consumption. Furthermore all components of energy have inelastic demand to energy prices and income, it indicates that fewer substitute of components of energy are available in the market. Moreover price elasticity of electricity is less then all energy sources, although price elasticity of coal and gas are less then petroleum. Hence all energy sources are essential but especially electricity is more necessary then other components of energy.

The finding of the study shows that electricity transmission and distribution loss and price of substitute (petroleum) have negative impact on total electricity supply while price of electricity, petroleum, gas , coal, and technology have positive impact on total electricity, petroleum, gas and coal supply. The results showed that price elasticity of all components of energy supply is inelastic.

The results of the study showed that total energy consumption plays significant role in economic growth of Pakistan. It concludes that price of energy have negative effect on energy consumption, it implies prices of energy increases the energy consumption will decrease, and it will deteriorate economic growth if supply of energy is not augment.

The results of forecasted values showed the increasing trend in components of energy consumption and supply; furthermore, growth rate of energy consumption is faster than energy supply in Pakistan and will carry on in future.

6.4 Policy Recommendations

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 underutilization 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 manifolds 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)

- This study finds from empirical findings that electricity transmission and distribution loss has negatively effect on electricity supply, because electricity transmission and distribution system of Pakistan is out dated and aging equipments. In order to get rid of this problem, government should inject funds in favor of technology in transmission and distribution system of electricity to ease power loss and raise electricity supply to meet increasing demand of electricity.
- The results of study demonstrate that price and income elasticity of energy consumption and supply are different and 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 start and as outcome minimize the production cost, diminish shortage and ultimate increase revenue generation. Further, economic growth will escalate and fiscal burden will decrease.
- To cope with increasing electricity demand needs energy conservation policy and demand management. As on the basis of finding of the study the gross

fixed capital formation has positive effect on energy supply. It suggest that Pakistan has plenty of water resources to properly utilize this resource, the optimum funds allocation is required to construct small and large scale dams, as well as small and large scale dams should be construct in mountainous regions in the Northern areas of Pakistan to boost electricity generation capacity at low average cost. Moreover, electricity tariff should be minimized and ensure competitive energy market.

- To bridge the increasing gap between energy demand and supply as we find from forecasting of energy consumption and supply, it is important to sort out alternative techniques and resources. It is also essential to focus on gas and coal base electricity in collaboration with private sector and public sector. Atomic energy sector also to be exploited more extensively instead of depending on costly fuel.
- In 2002 Alternative Energy Development Board (AEDB) of Pakistan set short term goal that 700 MW windmill electricity will add by 2007 and long term goal of AEDB that almost 9700 electricity will be added from renewable sources by 2030. Another objective of AEDB to provide renewable energy to 7874 far-flung villages of Balochistan and Sindh provinces of Pakistan. But AEDB does not seem to be successful in achievements of these targets. A comprehensive short and long term projects should be initiated to generate electricity from solar and wind through participation of private sector.
- Energy especially electricity shortage has augment due to electricity transmission and distribution loss, aging and poor technology and other

sectors of energy as coal, solar, nuclear and wind are not utilized properly. Along with Electricity theft is one of key concerned issue in Pakistan increasing day by day and exacerbates electricity crises. In order to minimize electricity theft introduction of technology and proper management of transmission and distribution system of electricity is of utmost importance. Moreover, the private sector should be encouraged in distribution of electricity to start competition and reduce electricity theft and losses.

- As we know from results that FDI has positive and significant effect on energy supply. So government should attract foreign and private investments to explore new and alternative energy resources. The government should also devise attractive policies and implement them in letter and spirit to utilize available energy resources properly.
- Finding of the study suggests that energy import escalate energy supply. To bridge gap between energy demands and supply an agreement should be made with different countries especially with neighboring countries to import electricity and gas. It will help in reducing energy crises and create competition in energy market, and achieve ultimate goal of reducing price of energy in a country.

6.5 Limitation of the Study

This study undergoes from the given limitations i.e. WAPDA average electricity sale price has been used as a proxy of average sale price of total electricity. Annual data on energy prices are not available to overcome this issue. we constructed weighted index for prices of petroleum and natural gas, also average price of coal has calculated from daily basis prices of coal given in energy year book of Pakistan (different issues).

6.6 Further Research

This study provide base for estimate simultaneous relationship among energy consumption, energy supply and economic progress. The study can also be diverted to micro level to identify the determinants of energy demand and supply, and elaborate their effect on standard of living of household.

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