The Response of Macro Economic Indicators to Electricity Crisis and Circular Debt

A Case Study of Pakistan

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Acronyms and Abbreviations

ADB	*Asian Development Bank*
CPPA	*Central Power Purchasing Agency*
DESCO	*Distribution Company (Electricity)*
GOP	*Government of Pakistan*
GENCO	*Generation Company (Electricity)*
IPP	*Independent Power Producer*
IMF	*International monetary fund*
IRF	*Impulse Response Function*
NEPRA	*National Electric Power Regulatory Authority*
NESP	*National Energy Security Plan*
NPCC	*National Power Control Centre*
NTDC	*National transmission and Dispatch Company*
PEPCO	*Pakistan Electric Power Company Limited*
SEM	*Structural Equation Modeling*
SOI	*State of Industry (report)*
SVAR	*Structural Vector auto Regression*
SBP	*State Bank of Pakistan*
VDF	*Variance Decomposition Function*
VAR	*Vector auto Regression*
WAPDA	*Water and Power Development Authority*

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Bushra Faizi

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Abstract

The thesis seeks to analyze the effect of electricity crisis and circular debt on macroeconomic indicators, namely, GDP, inflation rate and exchange rate. The analysis is based on monthly time series observations over the period of peak electricity crisis 2005-2013 in Pakistan economy. Two methods of estimation are used to test the two hypotheses of the study. SVAR results indicate that the electricity shortage causes inflation and currency depreciation in the short run, however, no significant short run impact was seen on economic output. The mediation results confirm that circular debt and electricity shortfall have significant correlation. The circular debt was found to completely mediate the relationship of electricity shortage and GDP, while partially mediates the relationship of electricity shortage with the inflation rate and exchange rate. In the light of the results, the possible suggestions are: firstly diversification of the energy mix, as the heavy import of oil to meet electricity needs, causes currency depreciation. Secondly, the inflation created by an electricity crisis could be controlled by proper planning and implementation of the tariff differential subsidy to cover up the increase in the cost of electricity. Institutions need to be built for rigorous monitoring to control the stock of circular debt as it exacerbate electricity crisis.

Chapter 1

Introduction

The Energy sector is of fundamental importance to the economic, social and industrial development of a nation. The importance of energy has widely been recognized as a traditional factor of production (Berndt et al., 1975; Hu and Wang, 2006; Hu and Hu, 2013). The dependency of the production process on energy has been increased with growing industrialization. Sufficient supply of energy is considered important for sustainable economic growth. The projected growth of an economy depends heavily on the performance and the growth of the energy sector. Sound energy sector is a prerequisite for modern industrialization. No nation could develop and industrialized without enough power resources. Economic stability is not possible to achieve in the presence of the unstable power sector. Indeed, industrial sector serves as an engine of rapid economic growth, yet electric power is considered a key determinant of the so called second industrial revolution. Uninterrupted supply of energy is observed one of the leading determinants of industrial sector performance.

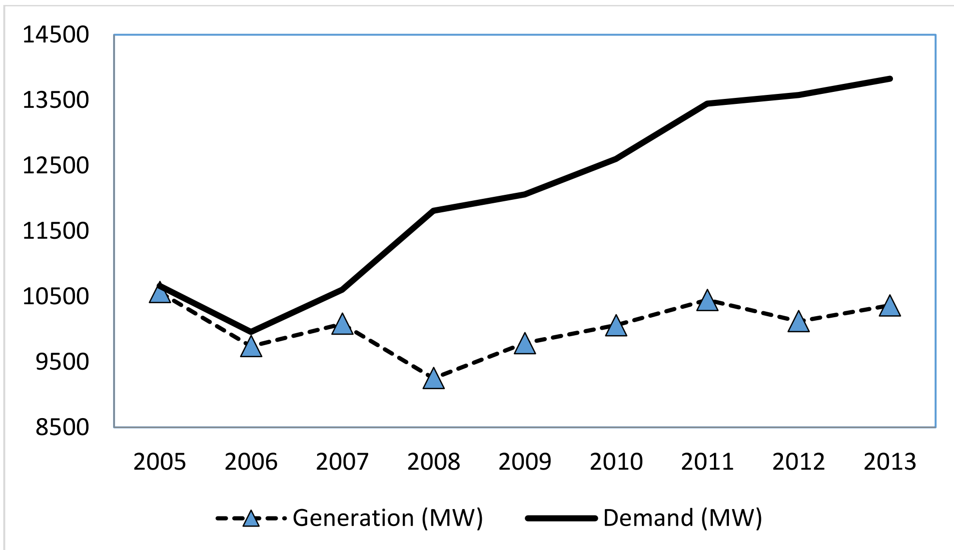
Energy is the basic element of economic growth (Lorde et al. 2010). Energy consumption is an important part of production function along with capital and labor and affects economic output. Energy consumption and economic growth have a positive relationship (Akarca and long, 1980; Yu and Choi, 1985; Narayan et al. 2009; Noor and Siddiqui; 2010). Likewise, energy industry plays a vital role in Pakistan economy. The economic contribution of energy sector can be categorized in many ways. Electricity being a secondary source of energy plays a vital role in every sector of the economy; especially it acts as fuel in the commercial sector of the economy. The impact of energy use, specifically that of electricity use on economic growth is found highly significant (Siddique, 2004; Iqbal, 2011)

Energy crisis is defined as either an increase in energy prices or interruption in the provision of energy supplies. Energy crisis, beginning from Fluctuation in oil prices leaves immense impact on developing economies (Jbir, et al. 2008; Cunado, et al., 2005; Rafiq et al., 2008). Electricity crisis can be viewed as energy crisis because electricity falls within the energy sector.

Historically, Pakistan suffered from an electricity deficit from 1990 to 1997. The demand and supply of electricity were balanced in 1997, (State of Industry report 2007). After that, the economy is again in the grip of severe shortfall since 2006. Pakistan economy faced electricity crisis since decade of 2000s. Electricity sector of Pakistan remained under a deep crisis due to a combination of different factors. Power sector instability of Pakistan can be viewed in many ways. The foremost is that demand exceeds electricity supply. The supply fails to cope up with growing demand as depicted in fig: 1.1. Resultantly, electricity shortage leaves an immense impact on the socioeconomic structure of the whole economy. The electricity sector fell in deep crisis at the start of 2006, and Pakistan is still facing the severe shortage. Multiple factors are responsible for the chronic electricity shortfall including the Poor energy mix, increase in demand of electricity due to papulation growth, T&D losses, circular debt, and inefficient structural and institutional set up of the sector.

On one hand, the growth of electricity demand is rising due to papulation growth. On the other hand, the electricity sector fails to supply enough electricity to cater the demand due to many issues. Electricity demand was growing by 3% to 4% annually up to 2003-2004. It spiked in subsequent years and reached 10% in 2007-2008, in line with higher economic growth.

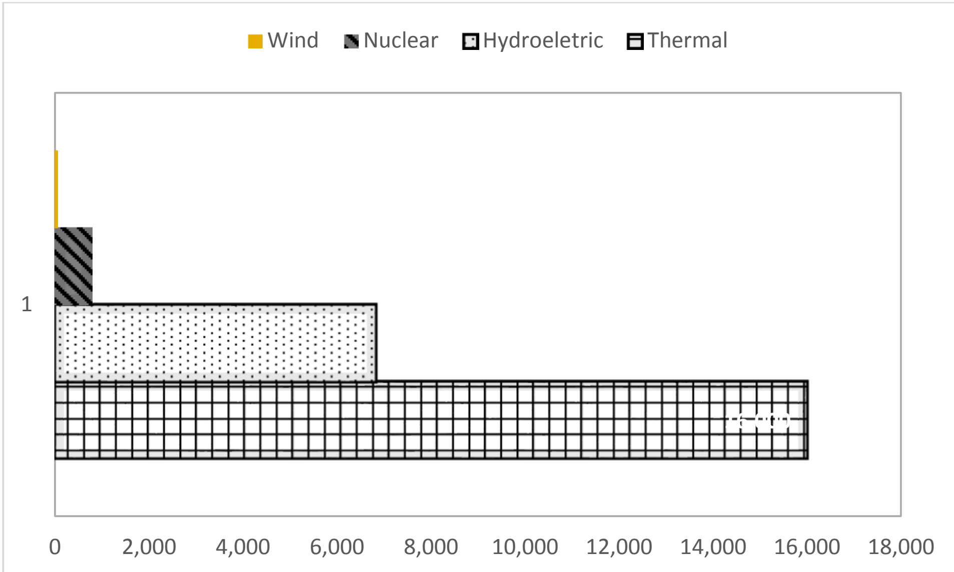
Figure 1.1: Electricity Supply- Demand Gap



Source: National Transmission and Dispatch Company (NTDC), Islamabad,

The major portion of electricity generation in Pakistan is based on the thermal source. IPPs and GENCOs incur high production cost due to dependency on the expensive input, i.e. furnace oil. Sources of electricity generation in Pakistan are depicted in fig: 1.2. According to State of Industry report (2013), the total nominal power generation capacity of Pakistan as on June 30, 2013 was 23,663 MW; of which 16,000 MW which forms 67.62% of the total generation was thermal, 28.85% was hydroelectric, 787 MW (3.33%) was nuclear and 50 MW (0.21%) was wind.

Figure 1.2 Electricity production (MW) by source



Source: State of Industry (SOI), NEPRA, 2013

The distribution network is old and poorly managed. Generation capacity is insufficient keeping the load management at high level. The reliability of transmission & distribution (T&D) system to handle load is 11500-12500MW during a specific period. Any load greater than this capacity causes power breakdown, which is very common in our electricity sector. Despite of the decrease in load management, the generation shortfall is not decreasing due to the inefficient T&D network. Almost 65% of the load management is attributed to faulty distribution network. (SBP, 2014). This is the reason due to which, the capacity addition does not meet targets.

1.1 Circular Debt in the Power Sector of Pakistan

Circular debt is the amount payables within the central power purchasing agency (CPPA) that it is unable to pay power generation companies. This results in the revenue shortfall which cascades across the entities and block the energy supply chain. Electricity generators owes to fuel suppliers, fuel suppliers owes to refiners, refiners owes to producers and the debt flows in the form of circle across the entities. Resultantly, there is shortage of fuel supply to GENCO's and IPPs halting the power generation. Circular debt although is an alarming issue in the energy sector as a whole resulting the gas and oil shortage as well, but electricity being the crucial component of the energy sector is the most effected due the fact that oil and gas are used as an input in electricity generation. The ultimate adverse effect of circular debt is observed on electricity sector in Pakistan.

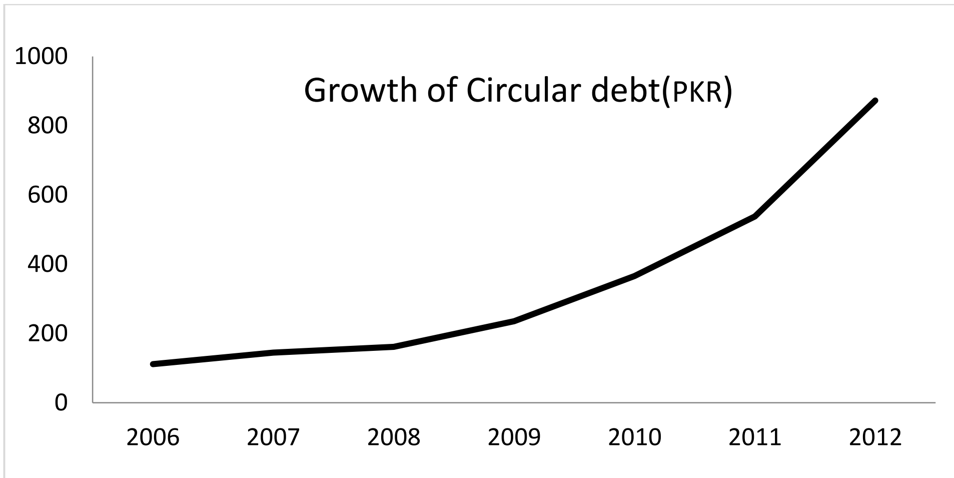
Circular debt came into play in 2006. Many factors contributed to the emergence of circular debt. Three main factors contributes in the building up of circular debt stock. Firstly, the inefficient distribution system as the DISCOs have low revenue collection high line losses. Secondly, the tariff policy is not rigorously managed to cover up the cost of electricity generation. Thirdly, due to the fiscal constraints, the electricity subsidies are not regularly paid.

There are many structural issues within the power setup. In the literature, the initial emergence of circular debt is attributed to tariff policy. The inherent flaw in tariff policy is such that National Electric Power Regulatory Authority (NEPRA) determines tariff for each Distribution Company (DISCO) and government notifies a rate which is somewhat different from what is suggested by NEPRA. Government notifies a uniform tariff normally at the rate below the rate determined by NEPRA. The government had frozen tariffs between 2003 and 2007 at very low level. However, during that period, crude oil and gas prices globally hiked. Subsequent tariff increase didn't make up for the shortfall. Rising cost of imported fuel further aggravated the situation. Imported furnace oil contributes about one third of fuel mix in the power generation. Between FY2004 and FY2008, price of furnace oil increased by 76% and gas price also increased by 78%. Cost of electricity generation resultantly increased. Notified tariff were unable to cover the higher cost. In addition to this, higher commercial and technical losses of DISCO's increased the service cost. The government started providing tariff differential subsidy to cover the gap. Due to fiscal constraints, the government was unable to pay tariff differential subsidies on a regular basis. This caused a serious financial instability in the power sector and problem of circular debt arose. Distribution companies were unable to pay power producers; power producers in turn were unable to make payment to fuel suppliers.

The problem began when the government became obliged to compensate energy companies with subsidies to cover up higher costs rather than allowing them to increase prices, but subsidies then went unpaid. As a result, energy companies have borrowed to make their payments, with many now reaching a point where they cannot afford to borrow further. As a result, with energy companies unable to pay fuel suppliers, fuel supplies have been curtailed, or worse still, halted, which in turn means that power companies have insufficient supplies to run their plants, reducing generating capacity (ADB, 2010). Circular debt is a major constraint to sustainable power sector. It fully disturbs the supply chain of power sector. Circular debt has grown fast as the price of oil stayed high (until the recent decline).

At the beginning of 2006, when circular debt rose, it was recorded Rs.111.26 billion. No serious remedy of the problem was made, and it grew quickly to Rs.365.66 billion in 2010.

Figure 1.3: Annual growth of circular debt



Source: Planning commission of Pakistan, 2013

The circular debt stood at Rs.872 billion during fiscal year 2012-2013 due to subsidy payment arrears (Rs.197 billion unpaid bills in the private sector + Rs.133 billion unpaid bills in government entities), non-collection from private consumers (Rs.330 billion) and delay in tariff increase (Rs.72 billion). Subsidies and reevaluation delays constitute a large portion of debt (42%) and they are the direct outcome of wrong policies of the 1990's (Khan; 2015). [1] In June 2013, the government paid Rs.480 billion and declared the clearance of circular debt. However, due to lack of structural reforms, it again climbed to Rs.300 billion in May 2014.

[1] See chapter:7 Pakistan's Self-Inflicted Economic Crises, in the book Pakistan's enduring challenges

Circular debt causes serious consequences and disturbs the economy. The most obvious is that of load shedding, which hurts industrial production and ultimately halt economic growth. The economic cost of power load shedding is high. According to a study conducted by institute of power policy (IPP) the cost ranges from Rs.23 per kWh to domestic consumers to Rs.28 per kWh to agricultural consumers, Rs.53 per kWh to industrial consumers and Rs.68 per kWh to commercial consumers. According to an estimate, the economic cost of outages for the country as a whole was Rs.948 billion in 2013-2014, which was equivalent to 37% of GDP.

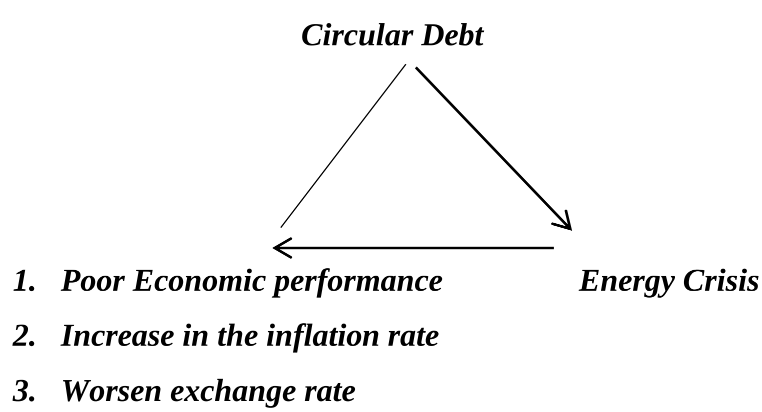
Low power production of electricity affects the manufacturing sector which affects in turn export earnings. Due to accumulation of circular debt, payment for international oil supplies is arranged by huge government subsidies which really contribute to the federal budget deficit by diverting the productive public investment. This also accounts for rising public debt. Moreover, circular debt discourages power sector investment.

1.2 Motivation of the Study

A variety of studies have shown that this energy crisis has alarming consequences for the economic growth of Pakistan (Malik, 2007; Asif, 2011; Trimble et al., 2011; Alhadad, 2012; Hayat, 2015). These studies conclude that rapid growth in energy demand, insufficient generation capacity, transmission and distribution losses, circular debt and huge dependency on furnace oil for electricity generation are reasons for the prevailing electricity crisis in Pakistan. The ongoing electricity crisis is a critical issue for the country's economic revival and stability.

The present crisis is a different take on a long enduring challenge. For Pakistan economy, electricity crisis is empirically discussed at household level, however, the impact of electricity shortfall on macroeconomic indicators using the real demand supply data has never been accesses yet. Also, none of the study takes into account the circular debt in relation with electricity crisis. Although circular debt hits the whole energy sector including oil and gas, but electricity is the most affected sector because of the fact that both oil and gas are major input in production of electricity. The research tends to specifically analyze the circular debt in the context of electricity crisis of Pakistan. Hence, it is crucial to access the impact of circular debt and electricity crisis. The thesis is an attempt to fill the mentioned research gap.

While focusing on one component of energy crisis, namely circular debt, the consequences of the electricity crisis can be analyzed in a specific way. Electricity crisis has an obvious negative consequence on the overall economy of Pakistan. Circular debt is expected to mediate the relationship. The thesis will analyze two relations. The direct relation states that electricity shortfall causes reduction in economic activity in the country. The indirect relation explains the way energy crisis, channelized by circular debt, hinder business activity, increases inflation and deteriorate exchange rate. The flow sheet is given below.



The current study picks up circular debt as one of the critical factors of supply shortfall. The purpose of the thesis is to pin down the economic consequences of circular debt and to check the two facts. Firstly, does electricity crisis really disturbs the economy. Secondly, does circular debt really plays a mediating role in defining the intensity of electricity crisis and its impact on the economy.

1.3. Objectives of the Study

- To analyze the relationship between electricity crisis and macroeconomic indicators
- To decompose the effect of electricity crisis on macroeconomic indicators between direct effect and indirect effects through its correlation with circular debt.

1.4. Hypotheses

$H_{10:}$ Electricity crisis has no relation to macroeconomic indicators.

$H_{11:}$ Electricity shortfall has a significant adverse effect on the macro-economic indicators.

$H_{20:}$ Effect of energy shortfall on macroeconomic indicators is not mediated by circular debt.

$H_{21:}$ Effect of energy shortfall on macroeconomic indicators is mediated by circular debt.

The hypotheses are tested using monthly time series data over a time span 2005-M1 to 2013-M12. In the thesis, two techniques are employed. The Structural vector autoregressive model checks the first hypothesis of the thesis. SVAR has been employed with short run restrictions to establish the short run relationship among the variables in the analysis. The second hypothesis of mediation is tested conducting mediation analysis using structural equation modeling. The reason of employing mediation technique is to conduct a path analysis and finding correlations of circular debt, electricity crisis and macroeconomic indicators.

1.5. Plan of the Study

Chapter 1 gives an introduction of the thesis. Chapter 2 includes the prior researches conducted on the subject under discussion. Chapter 3 introduces a methodology which includes the economic and econometric models, estimation procedure and variables description. Chapter 4 comprises of estimation results and discussion. Chapter 5 is the last chapter and gives the summary and conclusion of the entire thesis.

Chapter 2

Literature Review

2.1 Introduction

The causes and consequences of energy crisis have been broadly discussed in literature. So before proceeding with the thesis, it is important to have a broad idea about current development in the literature on the energy crisis and its impact on economy to identify the research gap and to introduce a mechanism to cover the identified research gap. The first section of literature review briefly discusses energy and growth. The second part presents the link between the energy (electricity) crisis and macro-economic indicators. The third portion discusses the fact that circular debt worsens electricity shortfall and energy crisis.

2.2 Energy and Growth

It remained controversial among researcher that whether growth encourages energy use or energy consumption stimulate economic growth. There is rich literature available examining the relationship between energy consumption and economic growth. However, the mixed empirical results are found across the countries, depending on the economic structure and methodology used in the studies. Besides, a number of studies are ending up with elusive and inconsistent results. As a consequence of controversial approach, the direction of causality among income and energy use is well analyzed issue in energy economics, Soytas et.al (2003).

Literature outlines four potential hypothesis regarding energy-GDP relationship. **Conservation hypothesis** refer to unidirectional causality running from the output to the energy usage. It drives the conclusion that the economy does not depend upon energy and hence policies regarding conservation of energy can be practiced without any unpleasant effect to the economic growth. **Growth hypothesis** refers to unidirectional causality from energy use to economic growth. This scenario concludes that the economy has a dependence on energy and it stimulates the economic growth**. Feedback hypothesis** propose bi-directional dependence of economic growth and energy use. It means that policies concerning energy and growth affect both in one way or another, if there is no causal relation between energy use and GDP, then the policies regarding energy may be practiced without any effect on both. However shortage of energy may lead towards a negative effect on economic activities and may result in poor economic performance with the reduction in income and employment level. **Neutrality hypothesis** support no relationship between economic growth and energy use.

Keeping in view the aforementioned hypothesis, a number of studies have been carried out to explore the association between energy use and growth. Stern (2000) examined the US macro economy and infers that energy significantly explains GDP. Ang (2007) found causality running from economic growth to the growth of energy use in France. Lorde et al. (2010) for Barbados economy confirms bidirectional causality between electrical energy consumption and real GDP in the long run. Nevertheless, Odhiambo (2008) found a unidirectional causality running from total energy consumption to economic growth in Tanzania. Payne (2010) systematically surveyed the literature of electricity consumption versus growth for countries specific case studies. The results show that 31% studies support neutrality hypothesis, 28% case studies supports conservation hypothesis, 23% studies support growth hypothesis and 18% studies support feedback hypothesis.

For Pakistan, several studies proved the positive relation of energy consumption and economic growth. However, there is no consensus on the direction of causality. Adel and Butt (2001), Siddiqui (2004), Masih and Masih (1996) and Lee (2005) provided evidence for growth Hypothesis. Shahbaz and Feridun (2012), Jamil and Ahmad (2010) support Conservation Hypothesis. Whereas, Shahbaz and Lean (2012a, 2012b) and Iqbal et al. (2013) examined the feedback hypothesis. Yet, whatever is the direction of causality, the relation between energy and growth is significantly positive. Energy is a driver of growth both in the short and long run.

2.3 Energy Crisis, Electricity Crisis and Macro-economy

The energy crisis has severe macroeconomic implications. Energy crisis is defined as either supply constraint or energy price hike. In one way or the other, both situations lead to similar consequences. Energy crisis is although old phenomena, but it becomes an alarming issue after world oil crisis of 1973 attracted considerable attention of researchers toward socio-economic cost of energy crisis emerging from oil crisis. The literature on oil crisis is important to study, because in the history electricity crisis mainly stemmed from oil crisis. A number of studies have found negative impact of oil price shock on macro economy. Hamilton (1983; 1996; and 2008) studied the causes and consequences of oil price shock, and found a significant relationship between oil price shock and macro economy of US.

The impact of oil price fluctuation on macro economy of Pakistan is extensively studied by Malik (2008), Ishaque (2008), Zaman et al. (2011), Nazir and Qayyum (2014) and many others. Summarizing literature, the fragile economy of Pakistan is sensitive to oil supply shocks because it is a net importer of oil. Oil price hike puts subsequent pressure on import bills. Energy inflation and general inflation, thus move together. Haider et.al (2013) conducted a study on determinants of energy inflation in Pakistan for the period 1973-2012 and concluded that broad money, international oil prices, exchange rate and adaptive expectation significantly explain energy inflation in Pakistan. There was a 42 percent contribution of adaptive expectation in overall inflation of 15.3 percent, which shows that oil price shock of 70's created expectation of higher inflation. Lewis E Hill (1980) also stated that the inflation component of stagflation comes from high energy cost. Ahmed (2013) studied the impact of oil prices on unemployment for Pakistan economy and found that oil prices significantly affect unemployment.

Economists agree on the conclusion that the oil price shock gives rise to inflation and slow down economic activity. The findings for Pakistan economy are almost same that high oil prices put inflationary pressure, worsen the balance of payment, deteriorate exchange rate and affect macro economy. On the other hand, the recent decline in oil prices had no positive significant impact on energy inflation and economic output of Pakistan. One reason is that at the time when oil prices come down, the circular debt came into play which deteriorated the scenario. End consumers were not benefited by oil price reduction because the tariff rate remained high due to payment issues of energy companies and persistent gap between production cost and revenue of power sector.

Arshad et.al (2014) estimated the impact of energy prices on over-all economic growth. The study finds that energy prices significantly influence output growth through six macro-economic channels. It affects output growth positively through interest rate and government expenditures and negatively through real exchange rate, investment, stock prices and unemployment. High energy prices depreciate the local currency through trade deficit.

Electricity is the most important source of energy. Morimato and Hope (2004) found significant positive relationship between electricity supply and real GDP of Siri Lanka. Similar study was conducted by Lean and Smyth (2010) found a unidirectional causality from economic growth to electricity growth in the economy of Malaysia. Ghosh (2009) found that real GDP growth and growth in electricity supply leads to higher level of employment in India. Yoo and Kim (2005) observed that economic growth granger causes electricity generation in short run. This research was conducted in Indonesia covering the period (1971-2000).

Like other developing countries, electricity plays important role in the economy of Pakistan. Qazi et.al (2012) conducted a study for Pakistan economy and find that electricity consumption and oil consumption significantly affect industrial value-added in the short run. Based on the findings, the study concludes that energy shortage deteriorates the performance of the manufacturing sector in Pakistan.

Electricity crisis is a burning issue in every economy. Developing economies are more vulnerable to energy shocks due to the fragile economic structure. The current electricity crisis is considered worst crisis Pakistan is facing since its inception. Due to the electricity crisis, productions of all sectors of the economy are less than the potential level. However, the difference between actual and potential output differs across the sectors depending on the scale of production and level of dependency on energy. In Pakistan economy, energy consumption stimulates growth. Several studies found the unidirectional causality running from energy consumption to GDP growth in Pakistan (Aqeel and Butt; 2001, Hye and Riaz; 2008, Kakar and Khilji; 2011, Chaudhry et al.; 2012, Javed et al.; 2013 and Muhammad et al.; 2013). It is the supply of electricity, which ensures consumption. Hence supply blockage deteriorates economic growth. Amjad et.al (2011) identified supply shocks as the root cause of stagflation which Pakistan economy was facing in 2007-2008. The paper explains that among the supply shocks which constrained output, energy shortage is foremost important. The paper recommends that Pakistan economy can come out of stagflation by prudent macroeconomic management, loosening monetary policy to boost the private sector, highlighting the role of the government in development to achieve fiscal discipline and improving social safety nets.

Shahbaz (2015) found that electricity shortage has negative significant relation with sectoral output in Pakistan. OLS estimates shows that 1 % increase in electricity shortage reduces industrial output, service sector output and agriculture output by 0.707%, 0.027 and 0.169% respectively. The study estimated a combined sectoral loss of RS. 242 billion due to electricity crisis over a period of 1991-2013.

Ali and Nawaz (2013) estimated the production loss due to energy crisis of textile sector using a primary data from 125 firms of Faisalabad textile industry, Pakistan. The production losses in gas dependent industries are found greater than those electricity dependent industries. Due to load shedding, there was reduction in national and international supply order, resulting overall output loss. The study also calculated that 64 percent producers out of total sample were willing to pay for interrupted power supply. The study shows that increased labor-hour is not proportionate to output loss, as for 8 labor-hour shift, the production loss was 23 to 65 percent, while for 10 labor-hour shift, it was 21 to 60 percent. The study suggests that the firm can increase output by increasing labor hours.

The most recent work on electricity shortfall for Pakistan is carried out by Jamil (2013). Load shedding and T&D losses are used as a proxy for electricity shortfall and electricity theft respectively. It was observed that electricity theft plays a significant role in electricity shortage and tariff change.

The electricity generation growth has a significant positive impact on industrial share of GDP. Power shortage is the responsible factor for de-industrialization in Pakistan. Yasmin and Qamar (2013) conducted a study on the role of electricity crisis in de-industrialization in Pakistan for the period 1970-2010 and concluded that the power generation and volatility of electricity consumption significantly affect industrial share in GDP. Abassi (2011) found that the electricity shortage causes about 2% annual loss in GDP in Pakistan. A similar study was carried out by Siddiqui (2011) found that a 12-37 % decline in industrial output occurs due to power crisis.

Manufacturing sector of Pakistan, contributing a large portion of exports, is vulnerable as it affects the economy due to its linkages with other sectors. Chronic electricity shortage, power breakdown and circular debt further increase the vulnerability of industrial sector. Siddiqui, et al. (2008) conducted survey in four industrial cities of Punjab and examined that the loss in industrial output and delay in delivery of supply orders is due to energy shortage. Power outages have increased production cost of firms, however, no significant drop was found in employment.

Mirza et al. (2014) examined a positive association between electricity consumption with the value-added of industrial sector and service sector in Pakistan. Also technical efficiency was found to have a positive relationship with sectoral value-added. Electricity prices were found to have a negative link with value-added in both the sectors. Hence consumption curtailment policies adversely affect both the sectors in the long run.

Theoretically, there is a negative relation of Investment and energy crisis. Energy crisis affects investment decision by creating uncertainty and investment level by creating financial constraints. Zeeshan (2013) studied the impact of electricity production on private business investment in Pakistan for the period 1975-2010. The study found that one percent decline in the electricity production leads to 1.58 percent reduction in private business investment in the long run.

Economic growth and development depend not only on the monetary and fiscal policies implemented, but also on the availability of electricity supply (Udah et al. 2011). Limited supply of electricity can be managed to bridge the supply-demand gap by optimal allocation of electricity. Electricity produced, but not supplied to end users due to heavy losses form a significant portion of GDP. Ermias et al (2011) observed a significant adverse effect of electricity shortage on Ethiopian economy resulting output loss of 3.1 percent of GDP.

K.B et al (2014) presented a process graph approach for the optimal allocation of electricity to various economic sectors in the event of a power crisis using a case study based on Philippine input-output data. The result indicates 4.95 % reduction in GDP as compared to the normal state.

Imran et al (2014) proposes a 3-stage optimization model for power sector of Pakistan to resolve the energy crisis. By modeling of efficient utilization of available resources, T&D losses will be minimized and ultimately power sector revenue will grow. An analytical study recently conducted by Sheikh Et.al (2015) shows that insufficient installed capacity and uneconomical power mix are the main reasons of the prevailing electricity crisis in Pakistan. In addition to this, poor infrastructure and financial crisis of power sector, including circular debt and revenue shortage accounts for electricity crisis.

Sheikh et al (2015) analyzed the National Energy Security Plan (NESP)[2].The study pins down that the GOP failed to achieve any of the objectives set in NESP plan 2005. Otherwise, only the short term targets included in NESP were enough to equalize the demand supply gap.

Jamil (2013) studied the relation between electricity thefts, load shedding and electricity prices in Pakistan. The study found co-integration between the three variables. Electricity theft plays fundamental role in the increasing power shortage.

2.4 Circular Debt Hampers the Power Production Capacity

Circular debt arose in 2006 in power sector of Pakistan and remained debatable among researchers till now. Circular debt affects the power generation capacity and non-availability of electricity raises the supply constraints in each segment of the economy. The pile up of huge circular debt adversely affects the potential GDP as this issue cascades from power sector to the manufacturing sector. Among the factors responsible for supply shortage,

[2] NESP was the strategy to meet energy needs of Pakistan for next 25 years, approved by GOP in the year 2005

circular debt in the power sector is one the most critical. Electricity shortages are huge damage to the economy, not only brings down GDP, but also has hurt employment, international competitiveness and export (Kessides; 2013).

Mills (2012) states that for the economist, energy crisis is primarily a circular debt issue. Circular debt limits the import of oil, affecting the production level. Pakistan does not produce enough energy to meet demand. As a result, it currently has an electricity shortfall of approximately 5,000 megawatts (MW) per day.

Malik (2012) observed that the critical factor of the energy crisis is circular debt primarily stem from DISCO's inefficiency in revenue collection. The government made a partial payment to lessen circular debt, but it was a temporary solution. Circular debt re-emerged with much larger impact. Circular debt lowers power generation capacity and effects credit worthiness of the country. To combat energy crisis, financial viability of the sector is on top priority. Circular debt weakens the financial stability of the power sector and further deteriorates existing crisis. Power outages are most obvious and frequent consequence of the electricity shortfall, adversely affecting the economy. Several studies empirically proved that power outages, lower the GDP growth. (Zachariadis and Poullikkas 2012; Andersen and Dalgaard 2013).

Inam (2013) discussed the current energy crisis facing Pakistan and states that the two key issues exacerbating the crises are circular debt and transmission & distribution losses. Eliminating these issues could surely curtail supply-demand gap of the electricity sector. It is estimated that resolving these two problems will result addition of 3885 MW electricity to the national grid and the load-shedding will be minimized. It is witnessed that in 2013, when the government made payment of Rs.480 billion to the IPPs, 1752 MW electricity was added in the national grid because of an increase in utilization capacity of IPPS from 55% to 66%.

2.5 Conclusion

A brief survey of literature strengthens the case for the current research in three ways. Firstly, the electricity crisis affect the economy dearly. Secondly, the circular debt is a constraint to electricity production by limiting the import of oil due to nonpayment by power producers. A portion of the cost incurred by economy due to the electricity crisis, is mediated by circular debt.

Many theoretical and empirical studies have been conducted so far on different aspects of the electricity crisis in Pakistan. Major part of literature discusses demand side of electricity sector. Few studies are available on electricity supply. The thesis attempts to pin down the causes and consequences of electricity shortage in Pakistan. The circular debt in relation with energy crisis is well documented in annual reports and in the press. Circular debt affects the economy through direct and indirect channels. It exacerbates energy crisis and hinder economic growth. However, there is a dearth of studies for Pakistan quantifying the relationship between electricity shortfall and circular debt. The current study is an attempt to fill the vacuum by quantifying the extent to which circular debt accounts for the relation of supply shortage with the macroeconomic indicators. It is concluded from literature that electricity shortfall and circular debt affects the macroeconomic indicators and threaten the energy security of Pakistan economy.

Chapter 3

Methodology

3.1 Conceptual Framework

Electricity supply and demand are two major principles of electricity economics (Hu and Hu; 2013). Simultaneous balance of electric power supply and demand ensures stable power system. Imbalance between electricity supply and demand results in massive power outages and creates electricity crisis. Disequilibrium in electricity sector also affects the supply-demand scenario in other production sectors of the economy due to the interdependence of all sectors.

The use of energy as a critical factor input in production function dates back to classical economist and neo classical economist. Production function with electricity is an important component of electricity demand economics and extensively used in energy economics. Electricity supply economists examine the optimal allocation of resources and electricity supply. Energy supply is a key factor of production.

According to endogenous growth theory, the general endogenous production function is

$$Y=A\ f\ (K, L)$$

Where:

A= Efficiency parameter

K=capital

L=labor

Assuming that the impact of electricity supply (ES) on economic output operates through total factor productivity, or the efficiency parameter (A), the model could be re-specified as:

$$Y=f\ (ES, Tech, K, L) \quad (1)$$

Diving equation Eq. (1) by L

$$Y/L=F\ (ES, tech, K)$$

Above equation reveals that per capita gross domestic product is a function of electricity supply, technology and capital. Electricity crisis, in the similar way is a negative shock to the economy.

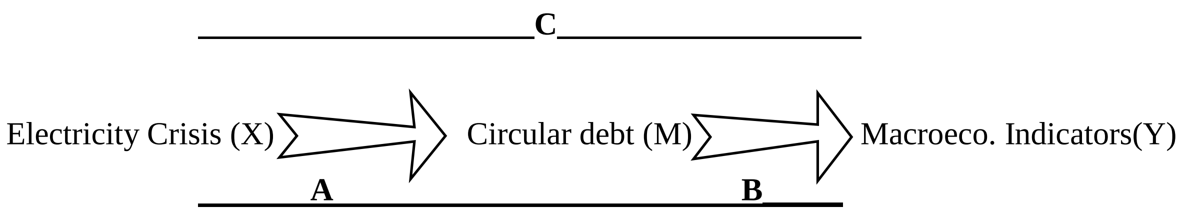
There exist a strong correlation between energy supply and economic development (Morimoto; 2004). On the other way, energy shortage hampers growth. The acute electricity crisis adversely affects every segment of the economy. Circular debt causes power production below capacity. It is critical factor responsible for energy inflation. Energy deficiency can be a binding constraint to economic growth. To ensure energy availability, energy need must be met either through meeting import requirement or by expanding domestic energy production through investment. In either way, the country requires foreign exchange resources. Foreign exchange reserves ensure long run energy security, (Mangla and Uppal; 2014). Electricity sector of Pakistan heavily relies on imported fuel to meet unmet needs. Fuel cost is the most leading factor to influence electricity generation cost in future, (Perwez; 2015).

Fiscal relation and energy chain can be viewed in two contexts; firstly high cost energy production compels the government to give more subsidies. Secondly, when power producing companies default due to circular debt, the government has to pay handsome amount to Independent Power Producers (IPP's) to run the energy supply chain. There seems a trade-off between fiscal deficit and power sector operation. A portion of fiscal deficit is created by energy subsidies, while payment to resolve the circular debt in order to run an energy supply chain, and forms another greater portion.

Industrial sector provides a major portion of employment. Adequate supply of electricity to industrial sector enhances the sector performance and ensures employment. The power shortage, resulting from circular debt, creates unemployment in the industrial sector and in the power sector as well. The consequences of circular debt are a serious threat to economic sustainability. A huge burden on federal budget comes from the power sector. Circular debt leads to fiscal instability, a reduction in economic output, creates unemployment by lowering production, lower export earnings, affects credit worthiness of the country, causes disequilibrium in the balance of payment and increases the public debt.

An important channel developed from existing literature states that circular debt plays a role of mediator and the effect of electricity shock on key macroeconomic indicators can be captured in a real term through incorporating circular debt as a mediator. To attain this objective, the thesis first analyses the dynamic relationship among the electricity crisis and macroeconomic indicators. In the second part, the mediation theory developed is tested, introducing circular debt as a mediator. Electricity shortfall is taken as initial variable while circular debt serves as a mediator, and macro-economic variables are used as an outcome. To analyze the path of mediation among the three categories, mediation process proposed by Baron and Kenny (1986), is carried out using structural equation modeling

Here is the visual depiction of mediation



X= Electricity shortfall

M= Circular Debt

Y=Macroeconomic indicators

The correlation paths are given as:

a) Path A define correlation of circular debt and energy crisis.

b) Path B defines the correlation of energy crisis with macro-economic indicators.

c) Path C depicts the indirect relation of electricity crisis with macro-economy mediated by circular debt.

3.2 Sample Selection

The analysis has been carried out for the period 2005-2013. The selection is based on availability of data set and limited span of the circular debt problem. Data are taken on a monthly basis, including 108 observations.

3.3 Data Source

Monthly data on circular debt are taken from finance division. Data of electricity generation and electricity demand are taken from NPCC-NTDC Islamabad. Electricity shortfall is computed by taking the difference of electricity demand and electricity supply. Data of general inflation rate is taken from “Inflation Monitor” (various issues) published by

State Bank of Pakistan. The quantum index of manufacturing (QIM) and the exchange rate is taken from International Financial Statistics, published by the IMF.

3.4. Variable Descriptions

Table 3.1: Definitions of Variables

Variables	Definition
Electricity shortfall	Deficit/ surplus is the difference between the net generation of electricity by generation companies and aggregate demand by DISCOs. The word shortfall is used due to the fact that in the power sector of Pakistan, demand always exceeds generation. Electricity shortfall is computed from electricity generation and electricity supply data. Electricity shortfall represents electricity crisis.
Circular debt	Circular debt involves many components which add up to form a figure of circular debt. The circular debt here is taken as the sum of the stock of debt at the beginning of the year, the total non - collection of all DISCO's and CPPA and sub-total tariff and subsidy issues.

Quantum Index of Manufacturing (QIM)	Quantum index of manufacturing (QIM) measures the change in production of large scale manufacturing (LSM). Since the monthly series on GDP is not available, we use the Quantum Index Number of Manufacturing as proxy[3] of economic activity.
Inflation Rate	Inflation rate is the growth rate of general level of inflation, i.e. Consumer price index (CPI). Consumer price indices measures the changes in average retail prices of a fixed basket of goods and services representing household consumption. CPI basket contains 487 consumers' goods.
Exchange rate	A bilateral exchange rate of Pak-rupee relative to US-dollar is used in the analysis. The reason of using bilateral exchange rate against US-dollar is that the main import in the energy sector of Pakistan is oil and the import payments are made in Us-dollar.

Although, electricity crisis affects the economy through many channels, but in the thesis, we are proceeding to focus on inflation rate, exchange rate along with economic activity. The reason of using inflation rate is, the electricity prices and electricity crisis, both have a close link with the inflation rate in Pakistan. The electricity crisis influence inflation through its effect on electricity tariff. Electricity prices play a crucial role in determining inflation Khan and Qasim (1996).

[3] SBP-Research Bulletin Volume 2, Number 1, 2006

The exchange rate has a close link with electricity crisis. Energy need must be met either through meeting import requirement or by expanding domestic energy production through investment. In either way, the country needs foreign exchange reserves. There is a correlation between foreign exchange reserves and long run energy security (Mangla and Uppal; 2014). The financial constraint in electricity sector caused by circular debt, deteriorates exchange rate due to heavy borrowing and increase in import of furnace oil to meet the growing demand of electricity (Faisal et al;2015).

Third macro-economic variable used here is economic output. Ultimately, it is the business activity which is connected with all the macroeconomic indicators. Any negative or positive shock to the economy affects the economic activity either in the short run or in the long run or in both. Similarly, economic output is been used here to quantify the impact of electricity supply shock on economic activity.

3.5 Methodology- Structural VAR Modeling

The prime objective of this research is to assess the impact of electricity shortfall on three macroeconomic variables, namely GDP proxy by quantum index of manufacturing, inflation rate and exchange rate. SVARs are used by economists to recover economic shocks from observables by imposing a minimum of assumptions compatible with a large class of models. The reason of using SVAR is here to access the effect of electricity supply shock. SVAR models better analyze the dynamics of a model in response to unexpected shock as compared to simultaneous equation modeling (Gottschalk; 2001)

To assess the relationship among energy shortfall and macroeconomic indicators, system of equations is constructed to be estimated by SVAR.

Starting with AR (1) model in VAR specification is given as:

$$Y_t = A_O + \sum A_i \, Y_{t-i} + \mu_t \tag{1}$$

Where Y_t is a (*4*1*) vector of endogenous variables, $A_{i(i=1\ldots\ldots p)}$ are *(4*4*) fixed co-efficient matrices, μ_t is (*4*1*) vector of VAR observed residuals; p is the order of VAR model.

The residual vector μ_t is presented as a linear combination of structural shock, ϵ_t as:

$$\mu_t = A^{-1} B \epsilon_t \tag{2}$$

Where, B is a structural parameter matrix

Substituting equation (2) in equation (1), we have

$$\mathrm{A} Y_t = \; A_O + A_1^{*} y_{t-1} + \cdots + A_p^{*} Y_{t-p} + \; B\epsilon_t \tag{3}$$

Where $A^{*}_{j(j=1\ldots.p)}$ is a (*4*4*) matrix of co-efficient; $A_j = A^{-1} A_{j(j=1\ldots..p)}$ and ϵ_t are (*4*1*) vector of unobserved structural shocks.

The AB - model is suggested by Amisano and Giannini (1997), and followed by Serletis et al., (2010); Ahmed et al., (2011); Qurat-ul-Ain and Tufail, (2014); Hasary et al., (2015). The relationship between reduced form and structural shocks can be represented in the form given below:

$$A \, \mu_{t=} \, B\epsilon_t \tag{4}$$

Incorporating our model, A and B are (4*4) matrices, whereas ϵ_t are structural shocks. We have a total of four variables, i.e. $Es_t, inf_t, EX_t, and \;\; Y_t$ which are Electricity shortfall, CPI based inflation rate Exchange rate and Quantum index of manufacturing as a proxy for GDP, respectively. $\mu_{et}, \mu_{inf_t}, \mu_{xt}$ *and* μ_{yt} are the errors of reduced form VAR, while $\varepsilon_{est}, , \varepsilon_{inf_t}, \varepsilon_{xt}$ *and* ε_{yt} are the structural disturbance. Constructing Matrix according to AB model, incorporating identification restriction gives the following two matrices.

Matrix-A **Matrix-B**

$$\begin{matrix} & lnES_t & inf_t & lnEX_t & lnY_t \end{matrix} \qquad \begin{matrix} & lnES_t & inf_t & lnEX_t & lnY_t \end{matrix}$$

$$\left|\begin{matrix} lnES_t \\ inf_t \\ lnEX_t \\ lnY_t \end{matrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & 0 & 1 \end{bmatrix} \begin{matrix} \mu_{est} \\ \mu_{inft} \\ \mu_{ext} \\ \mu_{yt} \end{matrix}\right| = \left|\begin{matrix} lnES_t \\ inf_t \\ lnEX_t \\ lnY_t \end{matrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{matrix} \varepsilon_{est} \\ \varepsilon_{inft} \\ \varepsilon_{ext} \\ \varepsilon_{yt} \end{matrix}\right|$$

VAR captures the mutual effects among variables. Hence all the variables are treated endogenous, a large set of parameters need to be estimated, which do not get reliable estimates. The number of parameters is reduced by making prior assumptions based on theory. These assumed relationships are called restrictions and VAR model based on restrictions is known as SVAR. Structural estimates are robust as they are not subject to the Lucas critique.

Identification restrictions are imposed on structural parameters of our model, following the literature in case of Pakistan. In the **matrix A**, first equation of the system explains that electricity shortfall is assumed as an exogenous shock to the system. The exchange rate is expected to affect all the variables in the analysis due to its fragile behavior.

Energy shocks have a direct effect on output by altering the relative energy price. Inflation rate captures real balance effect in output equation. Inflation rate and output are found to have a positive link, (Yasmin and Qamar; 2013). According to the theory of inflation, there is a link between the rising cost of production and rising prices of consumer goods. On the other hand, rising prices of consumer goods enhance production activity. Electricity crisis and output are expected to affect each other. Response of industrial output to electricity shortfall is significant (Ali and Nawaz; 2013). In the last equation, all the variables are assumed to affect economic activity except exchange rate. Using the restriction by Khan and Ahmed (2014), the coefficient of exchange rate is equalized to zero in output equation. In the **matrix B**, all the innovations of variables are allowed to affect only their own values in the current period "t".

We have 4 variables. Exact identification requires: $\frac{n^2 - n}{2} = \frac{4^2 - 4}{2} = 6$

Short run restrictions: $a_{12} = a_{13} = a_{14} = a_{23} = a_{24} = a_{43} = 0$

Hence, our model is exactly identified, having 4 variables and 6 short-run identification restrictions. The reason of using SVAR model is that we can assess the effect of exogenous shock, i.e. electricity shortfall on macroeconomic indicators overtime.

3.6 Mediation Analysis

Mediation, introduced by Barron and Kenny (1986) is defined when one variable (M) mediates the effect of initial variable (x) on the outcome variable (y). Mediation analysis includes three parts. The initial variable is a determining variable to which the other variables are associated. A variable is called a "mediator to the extent that it accounts for the relationship between the predictor and criterion. Mediation testing is widely used in behavioral science and psychology to test the influence of latent variables. There are two techniques to detect mediation. The regression technique and structural equation modeling. Barron and Kenny (1986) and Sobel (1982) presented the basic approach of mediation based on regression analysis. Deng et al. (2007) explains that the structural equation modeling is preferred over the regression proposed by Barron and Kenny (1986).

Structural equations are superior to regression due to many reasons. Firstly, Barron and Kenny regression is pretty applicable to three variables only building a tri-variate relationship. It is not applicable to multi-item scale of each construct. Reason is that the proliferation of each construct in a regression context requires multiple coefficients to estimate the resulting problem of multicollinearity and unreliable estimates. Structural equation analysis does allow such a multi-scale constructs yielding reliable estimates. The second reason why SEM is preferred over regression is that SEM minimizes standard error with greater capacity than regression because of simultaneous estimation of all parameters in one model. The third reason is that SEM accommodates smaller sample exactly the way it handles large samples. The smaller the sample size is, the more advantageous is to prefer SEM over regression because as sample size increases, the distinctions between the two techniques become minor.

Due to the above stated reasons, we choose an SEM to test the hypothesized mediation.

Chapter 4

Model Estimation and Results

4.1. SVAR Results

A system of equations is estimated including 4 variables, i.e. Electricity shortfall (ES), inflation rate (Inf), exchange rate (ex) and output (Y). We followed cholesky ordering of variables as lnES, Inf, lnEX, lnY. Electricity shortfall is assumed to be exogenous to other variables. This implies that inflation rate, exchange rate, GDP are not determinants of electricity shortfall in electricity in time period (t). Total observations included are 108, (2005 M1 to 2013 M12). SVAR is estimated using E-views.

After analyzing the time series properties of variables, we proceed toward SVAR estimation. The unit root is tested using Augmented Dickey Fuller (ADF) test.[4] All the variables are found to be integrated of first order, i.e. non stationary.

Table 4.1: Stability Condition of VAR

Root	Modulus
0.992462	0.992462
0.863849 - 0.058965i	0.865859
0.863849 + 0.058965i	0.865859
0.524005 - 0.216651i	0.567026
0.524005 + 0.216651i	0.567026
-0.305416	0.305416
0.159375	0.159375
-0.020101	0.020101

[4] See table(a) in the Appendix

Table 4.1 depicts that all roots are lying within the unit circle satisfying the stability condition of VAR.

Two sets of statistics are used to assess the impact of electricity crisis on macro-economic indicators. First, impulse responses to the electricity shortfall are estimated over a two-year (24-months) horizon. Second, variance decompositions are used to assess how much of the (forecast) variance in macroeconomic indicators over this period can be attributed to shock of electricity.

Fig 4.1: Impulse Response Function of Electricity Shortfall Shock

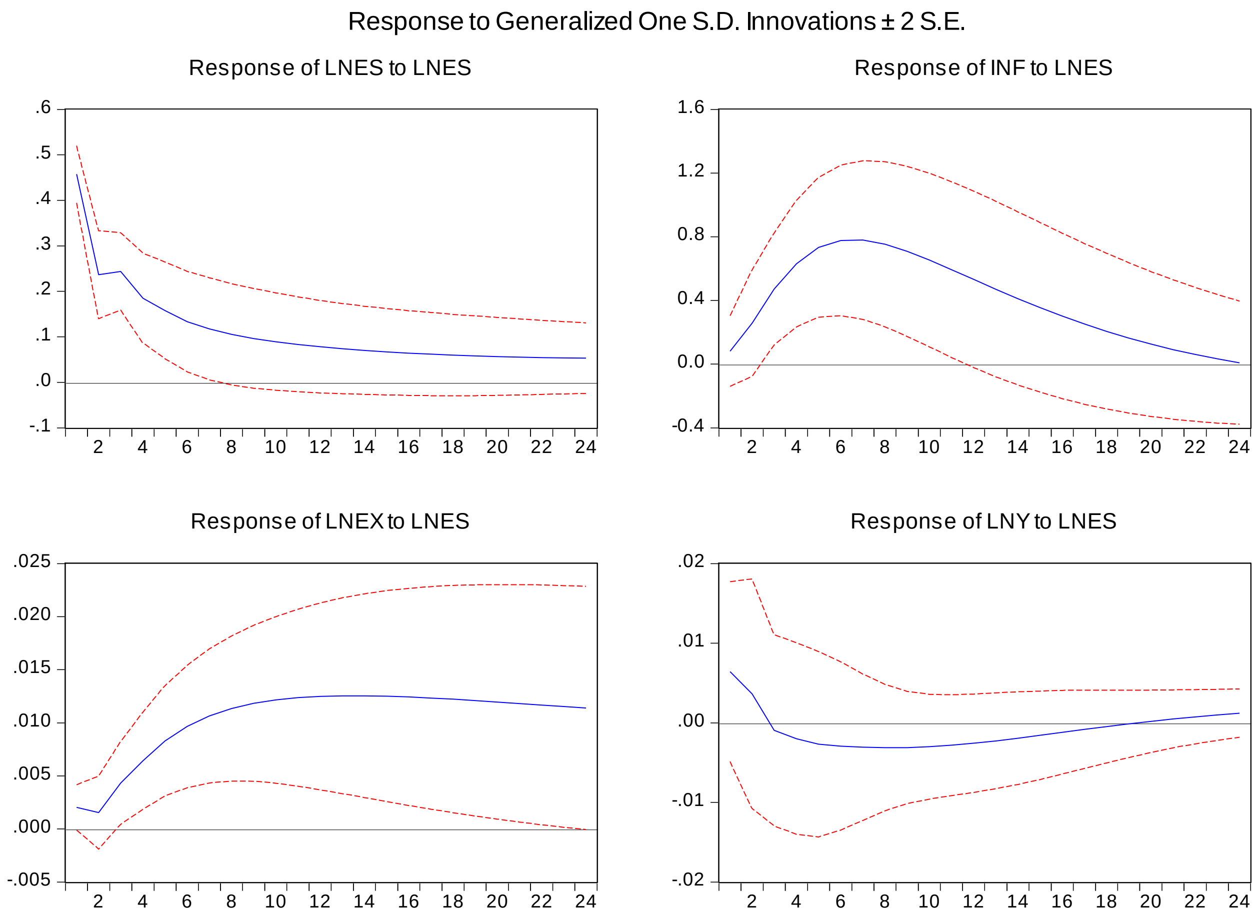


Table: 4.2 Variance Decomposition of Macroeconomic Indicators in Response to Electricity Shock.

Months	LNY	LNEX	INF
1st	1.216296	3.361884	0.508249
6th	1.031870	17.95130	20.13430
12th	1.703793	30.04306	26.46964
18th	1.856644	31.54881	25.61769
24th	1.886478	31.68049	25.12370

From the table: 4.2, the electricity shortfall contributes 31% variation in exchange rate. After exchange rate, it is the inflation rate which is affected by a negative shock to electricity. The variance decomposition result shows that electricity shock does not explain variation in business activity.

From the impulse response function, Fig: (4.1) display the response of macroeconomic variables to a positive one unit standard deviation shock in electricity shortfall. Inflation initially shoots up in response to electricity shock. Maximum impact can be seen at 5^{th} month. After that, inflation comes back to equilibrium at 24^{th} month. Electricity crisis significantly affects inflation for the period of two years. Our result implies that electricity shock has no significant short run impact on economic output of Pakistan.

One valid argument is that the unavailability of electricity or load shedding during the production process compels the producers to switch to an alternative power system, to retain power supply in short-run. Hence, in the short run, no power cut is observed in the production process. The persistent electricity shortage may affect the long run production, as alternative measures are not reliable in the long run. Also, the counter load shedding measures increases the cost of production and results in inflation ultimately. From fig (4.1), electricity supply shock effects inflation tremendously. One reason could be rise in tariff rate.

Electricity shortage is handled through tariff adjustments in the short run. The nominal tariff increased from 319.0 Paisa/Kwh in 2005 to 539.0 paisa/Kwh in 2008 for domestic consumers. The average tariff change for different categories of consumers is displayed in the table (4.3). Secondly, due to load shedding, use of generator raises the cost, creating inflation immediately. Load shedding causes an increase in consumer cost of electricity as consumer switches to alternative measures for uninterrupted power supply. These replacement measures increase overall living costs due to high use of electrical appliances in routine life. Simply, an increase in the price of electricity increases the cost of production and reduces productivity and output level, which ultimately raises the price level in the economy**.**

Table 4.3: Average Tariff Changes

Years	Domestic	Commercial	Industry	Agriculture
1990	0.63	2.17	1.06	0.43
2000	2.33	7.03	4.16	2.31
2005	3.19	7.24	4.45	3.11
2008	4.39	8.73	5.69	4.08
2013	11.22	18.12	12.3	11.29

Source: SOI report (various issues), NEPRA

Electricity shortfall thus creates inflationary pressure in the short run. Khan and Qasim (1996) examine three kinds of inflation (overall inflation, food inflation and non- food inflation) and conclude that electricity prices play a vital role in determining inflation.

Exchange rate, after a short initial appreciation, depreciates in response to shock in electricity and maximum impact can be seen at 10th month. After a year it become steady and remains positive. It can be seen that electricity shortfall causes currency depreciation. The possible logic to justify this relationship is the electricity demand is not met. More oil is imported to meet the increasing demand of electricity. As a result, foreign reserves decreases and exchange rate increases or in the other way, currency depreciates.

Now there is a need to explore how a shock to electricity sector is itself is distributed. The variance decomposition of electricity shortfall tells which of the component is causing major variation in electricity shortfall.

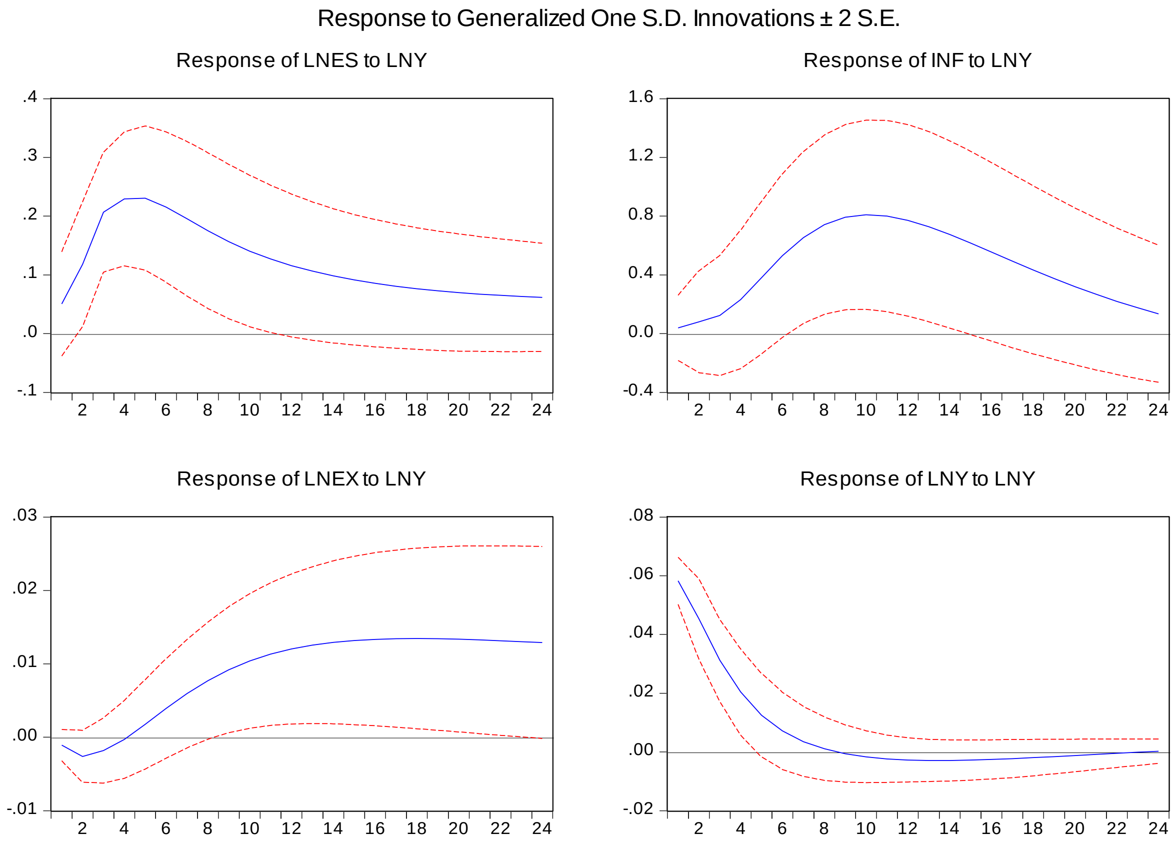
Table 4.4: Variance Decomposition of Electricity Shortfall

Months	S.E.	LNES	INF	LNEX	LNY
1st	0.457391	100.0000	0.000000	0.000000	0.000000
6th	0.771034	67.52899	3.091860	0.177054	29.20210
12th	0.904701	55.79571	5.704062	1.084479	37.41575
18th	0.955540	52.90267	6.301523	2.082113	38.71369
24th	0.987339	51.43262	6.594827	3.009281	**38.96327**

Table: 4.4 explains the decomposition of electricity shock. One important result derived from the decomposition of electricity shocks is that economic activity causes the major variation, about 39%, in electricity shock. After its own innovation, it is the economic output, which causes major variation in electricity shortfall. This indicates that electricity shortage is demand driven. As obvious from variance decomposition of electricity shortfall, a shock to output exacerbates shortfall. Increase in economic activity demands more electricity, as economic growth leads to electricity demand extensively discussed in literature, Yoo (2006). Our result is an implication of causality between economic growth and electricity demand without any feedback effect. Here, 51 % of electricity shock is self-explained.

To have a clear vision of how responsive the electricity shortfall is to output, we have a look on the impulse response of output shock given in fig: 4.2.

Fig 4.2: Impulse Response Function of Output Shock



From the fig: 4.2, electricity shortfall and inflation both are highly responsive to output shock. Electricity shortfall is highly responsive to one S-d shock in output. Electricity shortfall immediately increases in response to output shock. Peak effect is observed at 6th month. After that, it declines slowly and remains positive and steady after one year. Inflation rate rises in response to output shock till one year. After one year, it is slowly falling.

Although, electricity shortfall has no significant impact on output, output shock significantly affects electricity shortfall in the short run. The higher the business activity is, the more electricity the economy needs. Yoo and Kim (2005) observed that economic growth granger causes electricity generation in short run. The electricity generation growth has a significant positive impact on industrial share of GDP, (Yasmin and Qamar; 2013). As a result, one way electricity generation is increased, but the supply is not enough to cut the demand. So the shortfall prevails in the electricity sector of Pakistan, due to positive output shock (increase in GDP).

Exchange rate depreciates, after an initial short appreciation in response to output shock. A positive shock to output causes currency depreciation. This is a genuine result because increase in business activity induces more imports causing a deficit of the current account. Resultantly, exchange rate rises.

4.2. Mediation Test Results

In our model, electricity shortfall serves as an initial variable; circular debt is hypothesized to serve as a mediator and economic indicators, GDP, inflation rate and exchange rate are outcome variables. Mediation is carried out using SPSS-Amos.

X= electricity shortfall

M= circular debt

y_1= Economic output

y_2= Inflation rate

y_3 = Exchange rate

Table 4.5: Path Estimates of Electricity Shortfall and Output

Paths	Estimate	S.E.	C.R.	P-value
Y <------- Es	.002	.001	3.861	***

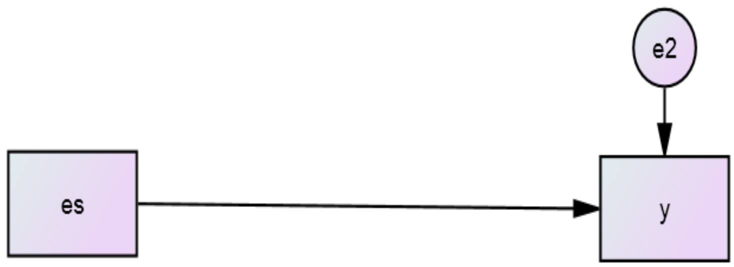


Table 4.6: Path Estimates of Electricity Shortfall and Inflation Rate

Paths	Estimate	S.E.	C.R.	P-value
inf <-------- es	.001	.000	2.838	.005

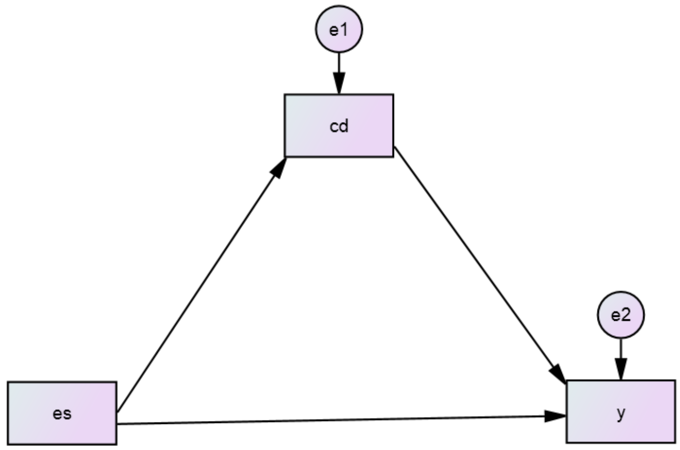
Table 4.7: Path Estimates of Electricity Shortfall and Exchange Rate

Path	Estimate	S.E.	C.R.	P-value
Er <------- Es	.008	.001	13.045	***

In the first stage of analysis, the independent variable is a significant predictor of $y_{1,}$ y_2 and $y_{3.}$ Results in table (4.5-4.7) show that electricity shortfall is significant predictor of output, inflation rate and exchange rate. The pre-condition for the mediation to proceed with is satisfied, that confirms that the independent variable is significant predictor of all the three dependent variables. Now we will introduce mediating variable, circular debt in the analysis and will re-visit the relation of independent variable and outcome variables.

Table 4.8: Path Estimates of Electricity Shortfall, Circular Debt and Output

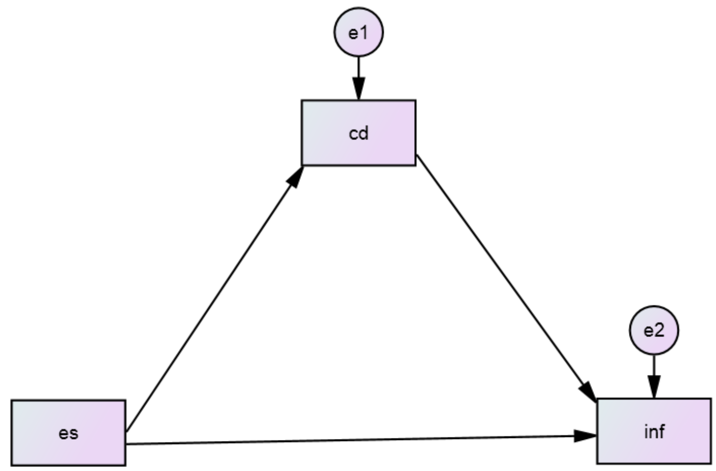
Path	Estimate	S.E.	C.R.	P-value
CD <------ es	46.435	9.199	5.048	***
y <------- es	.001	.001	1.026	.305
y <------- cd	.000	.000	1.285	.199



The relation of electricity shortfall and output turns out to be insignificant with the inclusion of mediating variable. Also, there is significant correlation between electricity shortfall and circular debt. The correlation coefficient between electricity shortfall (initial variable) and circular debt (mediator) is 38.089. The correlation between the mediator and a dependent variable is statistically significant at 10%. Circular debt fully mediates the relation of electricity shortfall and Economic output.

Table 4.9: Path Estimates of Electricity Shortfall, Circular Debt and Inflation Rate

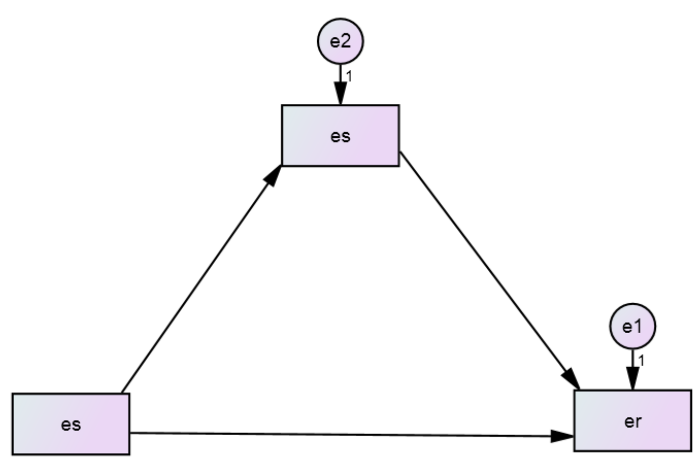
Path			Estimate	S.E.	C.R.	P-value
cd	<-----	es	38.089	8.780	4.338	***
inf	<-----	es	.002	.000	3.485	***
inf	<-----	cd	.000	.000	-2.285	.022



There is a significant correlation between electricity shortfall and the inflation rate. Also, the mediator (circular debt) is a significant predictor of inflation. However, the relation between electricity shortfall and inflation is still significant even after inclusion of mediator.

Table 4.10: Path Estimates of Electricity Shortfall, Circular Debt and Exchange Rate

Path	Estimate	S.E.	C.R.	P-value
cd <----- es	60.394	8.236	7.333	***
er <----- es	.004	.001	3.524	***
er <----- cd	.000	.000	4.146	***



The correlation between electricity shortfall and exchange rate is still significant after inclusion of the intervening mediator, circular debt. However, the value of co-efficient has been reduced from .008 to .004, indicating the partial mediation.

The coefficient associated with circular debt and electricity crisis has a positive and significant impact on exchange rate, which in other words means that energy crisis leads to a fall (depreciation) in the value of local currency. Power crisis causes reduction in production, which in turn reduces exports and increases imports. This resulting decline in reserves, put pressure on domestic currency and the value of domestic currency decreases or in other words currency depreciates. The above findings are consistent with theoretical link and present a true picture of existing scenario in Pakistan Economy. Oil is the most important source of imported energy in Pakistan, (Malik; 2007). Pakistan's electricity sector is highly dependent on imported oil, which adversely affects foreign exchange reserves and makes the economy vulnerable to macroeconomic shocks.

Chapter 5

Summary and Conclusion

5.1. Conclusion

The main objective of the thesis is to empirically analyze the consequences of electricity crisis and circular debt on macroeconomic indicators. Two techniques are employed for this purpose using a monthly time series data. The SVAR assesses the short run impact of electricity crisis on inflation rate, output and exchange rate. The impulse response functions show that a shock in the electricity market (electricity shortfall) raises inflation rate and causes currency depreciation in the short run, however no impact of the shock is observed on the output. This result is well justified as the supply shortage of electricity immediately raises the tariff rate increasing inflation rate. Also the heavy dependency of electricity producers on imported oil put pressure on domestic reserves, compels the currency to depreciate. In the second part of the analysis, Mediation testing was carried out to check the hypothesis that whether circular debt mediates the relationship of electricity crisis and macroeconomic indicators or not. Circular debt was hypothesized to mediate the electricity shortage and macroeconomic indicators. The results indicate that there is a significant positive correlation of circular debt and electricity shortfall as expected. Circular debt is found to fully mediate the relationship of electricity shortage and output. However, the relationship of electricity shortfall with the exchange rate and inflation rate is found to be partially mediated by circular debt.

The SVAR result indicates that electricity crisis do not significantly affect GDP in the short run. In the second part of analysis, it is observed circular debt has a mediating role in defining the relationship of electricity shortfall and output. The SVAR analysis implying short run restrictions reveals the short run affect only. Practically speaking, in the short run, the firms do not incur loss due to power cut because during the production process, the power supply is retained with alternative measures.

5.2. Policy Recommendations

- ✓ There should be a serious strategy to address the issue of circular debt. As circular debt has a strong correlation with electricity shortfall and it mediates the relationship of ES and economic output.
- ✓ Institution need to be built for rigorous monitoring of the non-collections of DISCOs, subsidy issues, so that the circular debt flow can be mitigated to prevent its stock. Subsidy reforms should be initiated as it form a portion of circular debt. One way is, to withdraw electricity subsidy from wealthier citizen.
- ✓ As the electricity crisis immediately raises inflation, rather than raising the tariff rate as a short term remedy, cost recovery should be focused on the long run. In the short run, demand should be curtailed.
- ✓ Electricity shortage causes currency depreciation in the short run. There is need to diversify energy mix to decrease the heavy reliance of electricity generation on imported furnace oil.

5.3. Further Extension

The study can be extended by incorporating structural issues, like tariff flaws and distribution losses which greatly counts for the supply demand gap. Incorporating governance variable and policy variables could be possible extension of the work.

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Appendix

Table (a): Unit Root Results

ADF-Test			
Variables	At level	At 1st difference	Order of integration
Electricity shortfall (ES)	-1.220849	-3.860879**	I(1)
Exchange rate (EX)	-2.433713	-4.327653***	I(1)
Inflation rate (Inf)	2.630734	-7.663752***	I(1)
Economic output (Y)	-2.403795	-3.430115*	I(1)

All the variables are taken in log form except inflation rate. Unit root is tested including time trend and drift. shows significant at 10%, ** shows significance at 5% and *** shows significance at 1%.*

SVAR- The (4*4) AB- matrix with short run restrictions

Matrix-A Matrix-B

$$\begin{vmatrix} lnES_t \\ inf_t \\ lnEX_t \\ lnY_t \end{vmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & 0 & 1 \end{bmatrix} \begin{vmatrix} \mu_{est} \\ \mu_{inft} \\ \mu_{ext} \\ \mu_{yt} \end{vmatrix} = \begin{vmatrix} lnES_t \\ inf_t \\ lnEX_t \\ lnY_t \end{vmatrix} \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix} \begin{vmatrix} \varepsilon_{est} \\ \varepsilon_{inft} \\ \varepsilon_{ext} \\ \varepsilon_{yt} \end{vmatrix}$$

Table (b) Structural Coefficients

	Coefficient	Std. Error	Z-Statistic	Probability
a_{21}	**-0.178031**	0.241935	-0.735864	0.4618
a_{31}	**-0.004274**	0.002208	-1.935404	0.0529
a_{41}	**-0.013826**	0.012338	-1.120601	0.2625

a_{32}	**-0.002745**	0.000879	-3.121421	**0.0018**
a_{42}	**-0.001339**	0.004941	-0.270967	0.7864
a_{34}	0.023929	0.017282	1.384618	0.1662
b_{11}	0.457391	0.031414	14.56022	0.0000
b_{22}	1.139304	0.078248	14.56022	0.0000
b_{33}	0.010311	0.000708	14.56022	0.0000
b_{44}	0.057952	0.003980	14.56022	0.0000
Log likelihood	254.2638			

Mediation Statistics (SPSS-Amos outputs)

Table (c) Fitness of Model to Data

Model	NFI Delta1	RFI rho1
Default model	.987	.921
Saturated model	1.000	
Independence model	.000	.000

As the NFI RFI values are close to 1, it indicates a very good fit

Table (c) Chi-square Statistics

Chi-square = .336
Degrees of freedom = 1
Probability level = .562

Ho: The model fits the data

$\mathbf{H_1}$: Model does not fit the data

From chi-square statistics, p-value is insignificant, so do not reject Ho.