DYNAMIC EFFECTS OF ENERGY SECTOR PUBLIC INVESTMENT ON SECTORAL ECONOMIC GROWTH

Experience from Pakistan Economy

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Abstract

This study is an addition to a pool of very few studies in the developing countries generally, and in Pakistan particularly to see the effects of public investment in energy sector on sectoral output, investment and employment. This study estimates the dynamic elasticities of private investment with respect to public investment to find crowding-out or crowding in phenomenon in Pakistan, and also to find out the long term marginal productivity and the share of benefits. The study also reveals the changes in labor absorption due to additional capital. The study covers eight sectors of the Pakistan economy and used the annual time series data from 1981 to 2011. This study uses Vector Auto Regressive (VAR/VECM) technique as developed by Pereira (2000, 2001) which allows measuring the dynamic feedback effect among the variables.

The study gives 24 sectoral elasticity coefficients from public investment in energy sector and concludes 7 out of eight confirms crowding-in phenomenon in Pakistan economy. This overwhelming majority confirms that this public investment has positive effect on private investment. The 3 out of eight elasticity coefficients shows public investment has increased labor absorptions and remaining 5 shows labor is substituted by capital as a result of increased public investment. In case of output 7 out of eight have positive output effect, however the overall marginal productivities are lower compare to several developing countries like Portugal and Spain where such analysis is conducted.

Keywords*: Public investment, Economic performance, Sectoral analysis, Pakistan*

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1. Introduction:

The successive economic and financial crisis in recent time has reemphasized the importance of fiscal policy. Modern literature has also revisited the debate regarding the effectiveness of fiscal policy on growth. The issue of the effectiveness of public investment on growth is debated in economic literature since seminal work Solow (1955). The issue is tackled from different angles. Some have used production function approach [Ligthart (2002), Otto and Voss (1994, 1996), Sturm and de Haan (1995) and Wang (2004)]. Then another seminal work by Aschauer (1989) led a series of work on this issue once again in empirical literature (1989A, 1989B). These approaches used single equation method for estimation and captured only the direct effects of public investment on growth. Periera (2000) gave another twist to this literature by highlighting the indirect effects of public investment on output through its effects on other inputs like private investment and employment. Periera's works (1999, 2000, 2001, 2003, 2005, 2007 and 2011) also contributed empirically in this literature by using vector autoregressive (VAR) technique. This work accounts for both the direct and indirect effects of public investment on growth and also considers the feedback effects of each input into other and finally their effects on output.

The classical school believes that an increment in public spending slows down growth and crowd out the private investment. Since higher spending requires higher taxes at individual or corporate level, it creates distortion in the choice of economic agents and increases interest rate. Barro (1991) in his most famous work associated with government size found a negative relationship between growth and government size. Razzolini and Shughart (1997) in the case of United States found a negative relationship between growth rate and relative size of government. Parker (1995) in case of India found crowding out effect of overall public investment while infrastructure investment crowd in private investment. Alesina et. al. (2002) measured the effect of fiscal spending in case of OECD countries in a Tobin's Q model and confirmed a crowding out phenomena. Many other empirical studies found evidence of crowding out of government expenditures including [Ganelli(2003), Voss (2002), Engen and Skinner (1992), Folster and Henrekson(2001), Devarajan et al. (1996), Milesi and Roubini, (1998) and Majumdar(2007)].

The Keynesians on the other hand, consider government spending as a key variable for economic growth. They argue that development expenditures on health, education and infrastructure increases labor productivity and reduce cost of business which motivates private investment. Many empirical studies support this view. For instance like Chakraborty (2007) examined the real and financial crowding out effect in India using data from 1971 to 2003 through a VAR model and found that public and private investment are complementary. Easterly and Rebelo (1993) in their work found a positive growth effect

of public investment, specially transport and communication. Baotai (2004) analyzed the effect of public investment through cointegration model during the period 1961 to 2000 for Canada and found a mixed result; some public expenditure such as health and education have a positive effect while infrastructure and social security have a negative growth effect. Bose, Haque and Osborn (2007) using data for 30 developing countries found out that government capital expenditures have a positive effect on growth, while at the disaggregate level only education expenditures are positively correlated with growth.

Pereira (2000) investigated the effects of aggregate public investment and infrastructure investment at a disaggregate level by using the VAR model for US and found that both at aggregate and disaggregate levels, public investment positively affects output and crowd in private investment. This study estimated a marginal productivity of 4.46 indicating that a one dollar investment will increase private output by about $4.46 and found out that the highest rate of return is in electric, gas, transit system and airfield sectors..

Pereira and Oriol (2001) analyzed the marginal productivity of private investment, output and employment with respect to public infrastructure investment in the case of Spain by using VAR methodology. The study based on five VAR models one for aggregate level and remaining four were agriculture, services, manufacturing and construction. The results evident that at aggregate level public infrastructure investment has positive marginal productivity for each variable while at sectoral level manufacturing, services and construction have positive output, private investment and employment marginal productivity but in the case of agriculture there is negative marginal products of output, private investment and employment. The highest output marginal productivity was found in the case of manufacturing 2.43 indicating one peseta will generate 2.43 pesetas output.

Pereira and Andraz (2005) analyzed the effect of aggregate public transportation infrastructure and its components (national roads, municipal roads, highways, ports, airports and railways) on aggregate private investment, aggregate output and employment in Portugal by using a VAR approach on annual data from 1976 to 1998. They found out that in the long term, aggregate public infrastructure investment of one euro will generate an output of 9.5 euros and also have a positive effect on private investment and employment. At a disaggregate level, they found similar trends on output, employment and revenue. Pereira and Sagales (1999) using the VAR model for Spain found a crowding in effect of public capital and private output and employment. Pina and Aubyn, (2006) examined the rate of return of public investment in the case of US economy using VAR model for a period of 1956-2001. The four variables used were real private investment, real public investment, private employment and real private GDP and found a positive Partial-cost dynamic feedbacks rate of return of 7.33% while the total or Full-cost dynamic feedback came out to be 3.68%.

Pereira and Pinho (2011) using the data of twelve euro-zone countries for 1980 to 2003 employed the same methodology and found diverse results. For example, they established that public investment have a positive effect on private investment and employment in all countries except Austria, Belgium Luxembourg and Netherland, while on output all countries have a positive effect except Luxembourg and Netherland. They also concluded that in the case of Austria, Belgium, Luxembourg and Netherland the public investment has a negative output affect. But in Finland, Portugal and Spain public investment have positive growth effect; still it is unable to generate sufficient tax revenue. While in case of France, Greece and Ireland public investment pays for itself and finally in the case of Germany and Italy, public investment not only pays for itself but also generates extra tax revenue.

Afonso and Aubyn (2008) utilized accumulated impulse response function of VAR model which consists of real interest rate, real output, real taxes, real public investment and real private investment for 14 European Union countries and some non-European countries including Japan, Canada and the United States. The results show that output elasticity of private investment is higher than public investment. Further in most of the countries they found a positive marginal productivity accompanied with a crowd-in effect. Voss (2002) investigated the crowding in or out effect in case of Canada and US using quarterly data through a VAR model which consist of real GDP, real interest rate, and share of public and private investment to the GDP. In both countries he found a negative effect of public investment on private investment. Mittnik and Neumann (2001) examined the relationship between public investment, private investment and output using the VAR model for six industrial countries. Results reveal that public investment crowd in private investment in three countries only; however the public investment has a positive output effect in all six countries.

Kamps (2005) measured the elasticites of private investment, employment and output with respect to public investment under a VAR estimation technique based on the variables "net public capital stock", "number of employed persons", "real GDP" and "private net capital stock". The study was based on 22 countries and showed that public capital stock has a positive effect on output in majority of the countries excluding Japan and Portugal. Further public investment and private investment are complementary and crowding in exists except for Belgium, Japan and US. However in the case of employment there is no significant role of public capital.

Pereira (2001) estimated the VAR model with private gross domestic product; private investment, public investment and private employment for US economy and both private and public investment are further disaggregated into high ways and streets, electric and gas facilities, sewage, water supply, education, hospital building and development structure. At aggregate level he found that public investment has a

positive effect on private investment, the marginal productivity was $4.5 with an annual rate of return of 7.8%. Pereira and Andraz (2003) examined the effect of aggregate public investment on aggregate private output, employment and investment in the case of US using VAR impulse response methodology and found at aggregate level, public investment have positive effect on all variables. The study found that an investment of one million dollar will generate 27 new jobs in the long term and one dollar investment of public investment will create $1.112 of private investment and $4.991 of output with an annual rate of return 8.4%. Pereira and Andraz (2003) further analyzed the effect of aggregate public investment on disaggregate level and found six out of twelve industries have positive employment effect; in five industries crowding in prevailed, while in case of output, 8 out of 12 have a positive effect.

Such literature is scarce in Pakistan, Hyder (2001) examined the effect of real public investment on private investment and growth through a VEC model during 1964 to 2001 and found a complementary relationship between public and private investment and positive growth effect. Saeed et. al (2006) examined the effect of public investment at aggregate and disaggregate level in a VAR model using the real variables i.e. public investment, employed labour force, GDP and private investment. The study reveals that in agriculture there is crowding in while in manufacturing there is crowding out and at the aggregate level it is inconclusive. For example Hussain et. Al (2009) found that defense and debt servicing crowd out investment while development expenditures crowd in investment. Naveed (2002) showed that public capital formation has a crowding in effect. Haque and Montiel (1993) found a crowding out effect in case of Pakistan.

This study is an addition to a pool of very few studies generally for the developing countries. The effectiveness of aggregate public investment on growth is examined vastly in the economic literature. This paper captures both the direct and indirect effects of public investment in energy sector on sectoral output, private investment and employment. This will highlight first the size of the impact of public energy investment on sectoral output and second it impacts on private investment. This study also indicates which sector of Pakistan's economy is getting most benefit of energy investment. These are useful information for the policy makers.

The remaining study is organized as follows: Section 2 illustrates methodological framework, Section 3 gives data and diagnostic test, section 4 based on empirical results and finally conclusion and policy implications is drawn in section 5.

2. Methodological Framework

The selection of the methodology and the variables for the present study are based on the empirical studies such as Pereira (2000) and Kamps (2005); where a Vector Auto Regressive (VAR/VECM) technique is used for measuring the dynamic effects of public investment. This methodology significantly differ from the previous studies related to Pakistan, although some studies applied Vector Auto Regressive (VAR/VECM) models, yet there finding based on error correction term; when there is cointegration, some others measured causality among public investment, private investment and output or the results are merely based on impulse response graphs for measuring the nature of effects either positive or negative. For our analysis, we have divided Pakistan's economy into the following sub sectors; Agriculture, Manufacturing (large and small scale), Mining & Quarrying, Construction, Electricity and Gas Distribution, Transport Storage and Communication, Finance and Insurance plus Ownership of Dwellings and Public Administration, Defence & Community Services. Hence, total eight VAR models are estimated; each one for eights sectors. The VAR models corresponding to each sector is specified as follow:

$$X_t = C + \sum_{i=1}^{p} A_t X_{t-i} + \varepsilon_t \qquad \text{----------(2.1)}$$

Where X is the vector of (4x1), C is the intercept vector also (4x1), A is the matrix of coefficient (4x4) and ε is the vector of error term. Each VAR model consists on Public energy investment, Private investment, Output and employment for each sector. The linear form of the model is

$$Xt = \Delta\log lpub, \Delta\log lpriv , \Delta\log Y, \Delta\log Emp \text{ ----------(2.2)}$$

Where lpub, lpriv, Emp and Y are log of real public investment, log of real private investment, log of real output and employment respectively. The paper uses same order in the analysis i.e. public investment first and then private investment, output and employment.

Dynamic Feedback Effects:

For measuring the effect of public investment on other variables, an impulse response function for each VAR model was generated. By definition an impulse response function measures the effect of a shock in an endogenous variable to other variables in the model. It is known that residual of the VAR are

contemporaneously correlated. For measuring the effect of shock in one variable to other variable, these residuals should be uncorrelated or in form of matrix the VAR model is modified in such a way that contemporaneous correlation among the residuals is diagonal, called orthogonalization. To attain these uncorrelated residuals, Choleski decomposition is used and accumulated impulse response is calculated to measure the cumulative response of all variables due to innovation in policy variable i.e. Public investment in energy. The outcome of accumulated impulse response function provides the accumulated long term elasticity of the selected variables due to shock in policy variable and the long term is defined as the time period in which shock disappeared.

Long Term Accumulated Marginal Productivity:

The long term accumulated marginal productivity of policy variable measures the unit change of the VAR model variables due to one unit change in policy variable. This concept of marginal productivity is different from the conventional concept. One of the main distinctions is that it is not based on the assumption on ceteris paribus; it refers to the accumulated marginal product and captures all the dynamic feedback among the variables. The value of marginal productivity is obtained by multiplying the accumulated long term elasticity with the ratio of policy variable to the response variable.

$$\varepsilon_{IPUB} = \frac{\Delta \log Y_i}{\Delta \log IPub_i} \text{ ---------(2.3)}$$

The above equation (2.3) is the long term elasticity, which is obtained directly from an accumulated impulse response function against each sector; which measures the accumulated change in growth rate of different variables. The numerator is the accumulated change in output growth rate of the ith sector, while the denominator is the accumulated change in growth rate of public investment in the ith sector.

The above elasticity is transformed into long term marginal productivity by using following formula

$$MP \equiv \frac{\Delta Y}{\Delta IPub} = \varepsilon_{IPUB} \frac{Y_i}{IPub_i} \text{ ---------- (2.4)}$$

In this fashion for each sector; marginal productivities of private investment, output and employment (in terms of number of jobs creation) are measured.

3. Data Sources and Description:

This study is based on annual time series data from 1981 to 2011 obtained from the State Bank of Pakistan Annual Report, 50 Years of Pakistan Economy and various issues of Economic Survey of Pakistan. All variables are converted into real on 1999-2000 prices and its first difference in log form is used in the analysis.

Univariate analysis:

Stationarity of each variable is one of the necessary conditions for forecasting using the VAR model and if there is cointegration then the order of integration must be the same. Augmented Dickey-Fuller (1979) and Philips Perron (1988) test are used to check the order of integration. The final decision based on Philips Perron test which results in table-1 shows[3] that all the variables are non-stationary at level using a 5% confidence interval, except three variables which are level stationary. However, at first difference, all the variables are stationary.

VAR Order Selection:

Appropriate number of lags is a crucial decision for VAR estimation. There are different information criteria available for choosing a more parsimonious model and we have applied Schwarz (1978) information criterion (SC) and Akaike (1974) information criterion (AIC). For each model lag selection was made on the basis of Schwarz information criterion. The results reveal[4] that in most cases one lag is showing minimum information criterion value while maximum of four lags were incorporated to avoid too many parameters.

Diagnostic Test:

The results of the diagnostic tests are given in table-2. The results evident that there is no Heteroskedasticity in any model. The results of LM test also support no serial correlation in all the cases except services sector model. The assumption of Normality is also tested in all the cases and the results do not support the normality assumptions in five out of eight cases, but we can ignore this issue as Lutkepohl (1991) discussed that the VAR parameters estimators do not depend on the normality assumption.

[3] Due to lack of space just Philips Perron results are reported, but the complete results are available on demand.
[4] Due to lack of space results are not reported, but available on demand.

Table 1: Unit Root Test

Variable	Phillips-Perron Test Statistic							
	Level				First Difference			
	Without Trend		With Trend and Intercept		Without Trend		With Trend and Intercept	
	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*
LAgr_IPub	-0.544194	0.8729	-1.961717	0.6065	-9.31261	0	-9.993371	0
LAgr_IPrv	-0.771485	0.8178	-2.679558	0.2494	-6.833569	0	-6.749098	0
LAgr_Emp	1.355936	0.9986	-2.668833	0.2537	-8.362981	0	-8.815865	0
LMing_GDP	-0.487884	0.8843	-2.191037	0.4833	-6.817256	0	-6.751895	0
LMing_IPrv	0.053368	0.9585	-1.956587	0.6092	-7.043074	0	-7.235855	0
LMing_Emp	-2.396637	0.1481	-2.754807	0.2207	-5.685598	0	-5.644688	0.0001
LMfg_GDP	-0.292774	0.9181	-2.522159	0.3166	-5.750705	0	-5.68134	0.0001
LMfg_IPrv	-0.657962	0.8472	-1.986704	0.5933	-5.112176	0.0001	-5.053197	0.0008
LMfg_Emp	-0.321594	0.9136	-1.962546	0.6061	-6.843413	0	-6.833039	0
LConst_GDP	-2.153902	0.2254	-1.578453	0.7865	-5.429063	0	-5.744962	0.0001
LConst_IPrv	-1.263144	0.6389	-3.388271	0.0652	-10.32539	0	-10.17403	0
LConst_Emp	-3.485632	0.0127	-5.753265	0.0001	-15.32939	0	-16.14105	0
LElec_GDP	-3.033429	0.039	-1.417099	0.843	-7.213615	0	-9.89615	0
LElec_IPub	-1.954775	0.3053	-1.363139	0.8589	-7.555604	0	-13.90007	0
LElec_IPrv	-1.212813	0.6613	-1.613274	0.7726	-5.892388	0	-6.015573	0
LElec_Emp	-2.104588	0.2439	-3.762389	0.0277	-12.33055	0	-12.90363	0
LTranp_GDP	-0.911304	0.776	-3.171151	0.1027	-6.598544	0	-6.506002	0
LTranp_IPrv	-0.737195	0.8271	-2.069132	0.549	-4.622056	0.0005	-4.566332	0.0034
LTranp_Emp	-3.044822	0.038	-18.15966	0	-31.51532	0.0001	-33.01162	0
LFinc_GDP	-0.907251	0.7724	-2.47431	0.3375	-5.001994	0.0003	-4.92316	0.0021
LFinc_IPrv	-1.352439	0.5923	-2.562142	0.2987	-5.476395	0.0001	-5.471944	0.0005
LFinc_Emp	-1.937825	0.3114	-2.648321	0.2634	-6.564159	0	-6.570572	0
LSrv_GDP	-1.509704	0.5201	-2.513062	0.3208	-7.695887	0	-7.932222	0
LSrv_IPrv	-0.310469	0.9154	-2.38316	0.3832	-6.381415	0	-6.31137	0
LSrv_Emp	-0.072283	0.9464	-6.040012	0	-16.19263	0	-15.71361	0
LAgg_GDP	-1.01663	0.7399	-3.168162	0.1033	-10.29256	0	-9.94885	0
LAgg_IPrv	-0.246937	0.9247	-2.376024	0.3868	-5.751953	0	-5.703555	0.0001
LAgg_Emp	1.100535	0.997	-1.926615	0.6249	-6.48744	0	-6.597266	0

LAgr is representing the log of agriculture sector, Lming is representing the log of mining sector, LMfg is representing the log of manufacturing sector, Lconst is representing the log of construction sector, Lelec is representing the log of electric and gas sector, LTranp is representing the log of transport and communictaion sector, LFinc is representing the log of finance and insurance sector, LSrv is representing the log of services sector and LAgg is representing the log of Aggregate economy

EMP is representing the employment, IPub is representing the public investment, Iprv is representing the private investment.

Table 2: Diagnostic Test: Dynamic impacts of Public Energy Spending

Sectors/Model	Numbers of lags	Autocorrelation Test (p-value)[1]	Normality Test (p-value)[2]	Heteroskedasticity Test (p-value)[3]
Agriculture(Major & Minor Crops, Livestock, Fishingv and Forestry)	1	0.1958	0.1381	0.6523
Mining & Quarrying	2	0.5828	0.9435	0.5831
Manufacturing	1	0.3933	0.145	0.9859
Construction	1	0.1936	0.978	0.8569
Electricity and Gas Distribution	1	0.8288	0	0.9359
Transport, Storage and Communication	1	0.5089	0.766	0.8618
Finance and Insurance	1	0.5292	0.001	0.5744
Services (Community Services,Public Administration & Defense and Ownership of Dwellings)	1	0.0019	0.0017	0.1813

1: Based on VAR residula serial correlation LM test with null no serial correlation

2: Multivariate Jarque-Bera residual normality test. For the null hypothesis of normality

3: VAR Residual Heteroskedasticity Tests. For null hypothesis of no Heteroskedasticity

Conintegration Analysis:

Finally, to decide whether to use Vector Autoregressive Model (VAR) or Vector Error Correction (VEC), a cointegration test is applied to all the models by using Engle-Granger (1987) and Johansen (1991, 1995) approaches. The decision of cointegration based on Engle-Granger test results[5], in all the models this test reject the existence of cointegration, while in few models only Johansen test shows the existence of cointegration. The reason for using Engle-Granger approach is based on the finding of Gonzalo and Lee(1998) and Gonzalo and Pitarakis(1999) who mentioned that Johansen approach has small sample bias for cointegration when it does not exist. These finding are similar to other related studies e.g. in the case of Portugal Pereria and Andraz(2005) and in the case of US Pereria and Andraz(2003) did not find any cointegration.

[5] For the sake of brevity results are not reported, but available on demand.

4. Empirical Results:

This section discussed the empirical effects of public energy investment on sectoral output, private investment and employment. These effects are based on accumulated impulse response function. The effect of a shock in public energy investment on sectoral GDP is traced in terms of output elasticities. The effect of a shock in public energy investment on sectoral private employment is traced in terms of private investment elasticities, similarly the effects of a shock in public energy investment on employment are measured in terms of employment elasticities.

Table 3 Long Term Accumulated Impulse Response effects of Public Energy Investment

Sectors	On Output	On Private Investment	On Employment
Agriculture(Major Crops,Minor Crops, Livestock, Fishing & Forestry)	+	+	+
Mining & Quarrying	+	+	-
Manufacturing	+	+	-
Construction	+	+	+
Electricity and Gas Distribution	-	+	+
Transport, Storage and Communication	+	+	-
Finance and Insurance	+	-	-
Services (Community Services, Public Administration & Defense, Ownership of Dwellings)	+	+	-

Table-3 gives summary of results of public investment on output, private investment and employment and detailed graphs are given in Appendix-A which are based on accumulated impulse response function with a time horizon of 20 years. These unit shocks affects of public energy investment on output shows that all the sectoral outputs have a positive effect on output except electricity & gas distribution sector. In case of private investment the impulse response functions depicts that public energy investment also have a positive effect on private investment in all the sectors except finance & insurance, while in case of employment the impulse response function graphs show that only three sectors out of eight have a positive employment effect with respect to public energy investment. One more important feature of these graphs which is worth mentioning here is that in all the cases the shocks effect is die out after five years, except three sectors.

Table 4 Effects of Public Energy Investment on Output, Private Investment and Employment

Sectors	Share Contribution			Elasticities			Marginal Productivity			Shares of Benefits (%)		
	% of total Output	% of total Private Investment	% of total Employment	Output	Private Investment	Employment	Output	Private Investment	Employment	Output	Private Investment	Employment
Agriculture	21.38	12.09	43.82	0.0085	0.0640	0.0061	0.3892	0.2107	3.0902	10.79%	13.81%	74.65%
Mining & Quarrying	2.93	4.66	0.17	0.1220	0.0766	-0.1831	0.7666	0.0971	-0.3669	21.25%	6.36%	-----
Manufacturing	18.09	25.55	13.42	0.0227	0.1025	-0.0190	0.8830	0.7132	-2.9306	24.48%	46.73%	-----
Construction	2.35	1.45	6.24	0.0214	0.1884	0.0142	0.1080	0.0746	1.0190	3.00%	4.89%	24.62%
Electricity and Gas Distribution	2.33	2.62	0.7	-0.0074	0.1268	0.0038	-0.0370	0.0903	0.0302	----	5.92%	0..73%
Transport, Storage and Communication	12.67	18.65	5.51	0.0227	0.0325	-0.0219	0.6172	0.1650	-1.3880	17.11%	10.81%	-----
Finance and Insurance	4.48	4.70	0.91	0.0372	-0.1371	-0.0245	0.3576	-0.1756	-0.2560	9.91%	-----	-----
Services	18.02	27.22	14.23	0.0125	0.0237	-0.0356	0.4850	0.1754	-5.8241	13.44%	11.49%	-----
Sum	82.27	96.95	85				3.57	1.35	-6.63			

Source: Authors' own estimation

The effects of public investment on Output:

The effect of sectoral public investment on output is presented in table-4. The results indicate that public investment has positive output effects for all the sectors except electricity & gas distribution. The result shows the sum of marginal productivities across the sectors is 3.57 i.e. one rupee public investment will collectively generate the output of rupees 3.57, which is low compare to the relatively advance countries, such as in Spain; Pereira and Oriol(2001) found the aggregate marginal productivity for output 5.5, similarly in the case of Portugal; Pereia and Andraz (2007) found aggregate marginal productivity of output 8. On the sectoral level the public investment's highest benefit share goes to manufacturing followed by mining & quarrying, transport & communication, services, agriculture, finance & insurance and then construction. The share distribution is 24%, 21%, 17%, 11%, 10% and 3% respectively.

The effects of public investment on Private Investment:

Table-4 also discusses the impact of public investment on private investment. The empirical results show that public investment has positive impact on private investment implies it supports the hypothesis of crowding-in; in 7 out of 8 sectors i.e. except the services sector. The results show the sum of marginal productivities of private investment across the sectors is 1.35 indicating one rupee public investments will increase private investment by Rs.1.35. These results show that overall impact of public investment on private investment is also low in Pakistan compare to the other countries. In the case of Spain Pereira and Oriol(2001) found the aggregate marginal productivity of private investment is 10.18 , similarly in the case of Portugal Pereia and Andraz (2007) found aggregate marginal productivity 9.45. On the sectoral level the highest benefit share of public energy investment goes to manufacturing followed by agriculture, services, transport & communication, mining & quarrying, electricity & gas and then construction. The share distribution is 47%, 11.5%, 11%, 6%, 6% and 5% respectively.

The effects of public investment on Employment:

The employment effect of public investment is presented in Table-4. On the sectoral level public investment has positive employment effect in agriculture, construction and electricity & gas. The sectoral benefit of one million rupees public investment will create highest employment in agriculture sector (3) followed by construction and then electric & gas. In comparison with other studies such as in the case of Portugal Pereia and Andraz (2007) found the highest benefit share of infrastructure investment in the case construction followed by finance, services, and real estate. These results show in many sectors it is negative, however these results are also consistence with other studies. For example Pereira and

Andraz(2007) found negative employment effect of public infrastructure investment in agriculture, food, textile, other manufacturing and real estate sectors in the case of Portugal.

5. Conclusion and Policy Implication

The objective of this study is to find empirical evidence of the effectiveness of public energy investment in Pakistan. In literature, usually the production function approach is applied for such analysis while this study incorporates the VAR methodology which allows capturing dynamic feedback effect of public investment on private investment, employment and output.

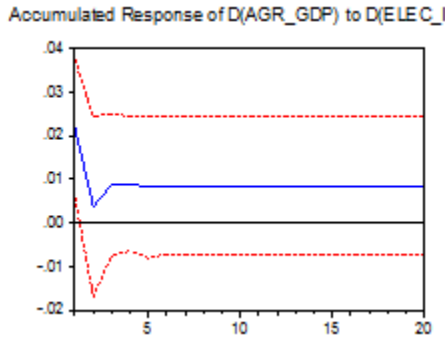
The study is one of the pioneer attempts on the subject by estimating the long term marginal productivities of public investment at sectoral level. The study uses data of eight sectors of Pakistan economy from 1981-2011. The study gives eight elasticity coefficients of private investment from sectoral public investment and conclude 7 out of 8 confirms crowding-in phenomenon in Pakistan economy. This overwhelming majority confirms that public investment has positive effect on private investment. The 3 out 8 elasticity coefficients shows public investment has increased labor absorptions and remaining 5 shows labor is substituted by capital as a result of increased public investment. The highest marginal productivity is 0.88 in manufacturing followed by 0.766 and 0.61in mining and quarrying and transport & communication sectors. This implies one rupee public investment in these sectors will generate rupees 0.88, 0.766 and 0.61in these sectors respectively. Generally the marginal product is lower compare to several developing countries like Portugal and Spain where such analysis is conducted.

The results of this study provide the answers to some important policy questions and also help in formulating future policy. This study is one of the early to calculate the marginal productivity which are useful in project evaluation and investment decisions. The positive output effect indicates that public energy investment is growth stimulating through its direct effect and indirect effects.

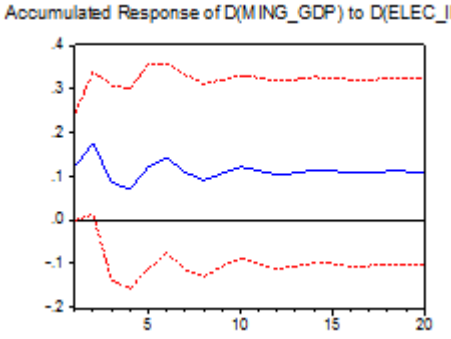
Appendix-A Impulse Response Graphs

Figure 1: Accumulated Impulse Reponses of Sectoral GDP Due to change in Sectoral Public Investment

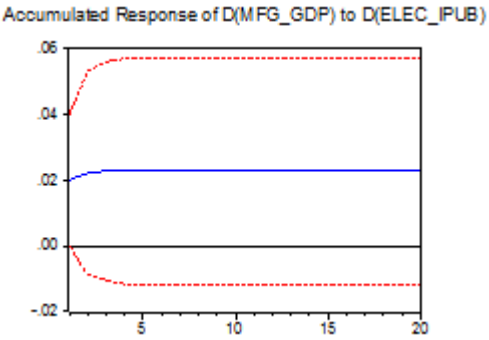
1A



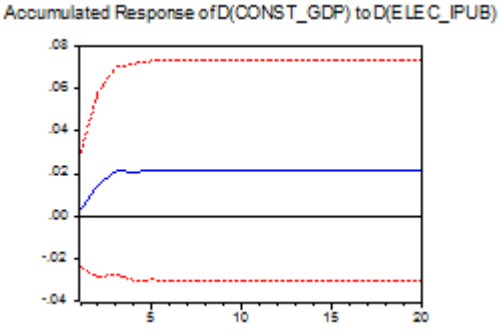
1B



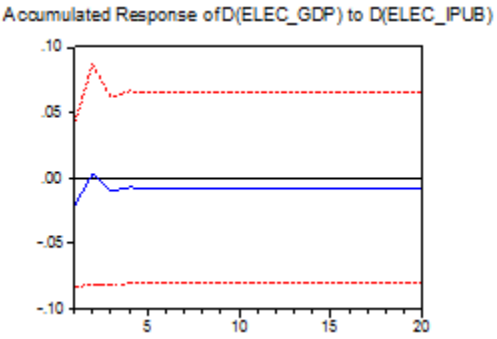
1C



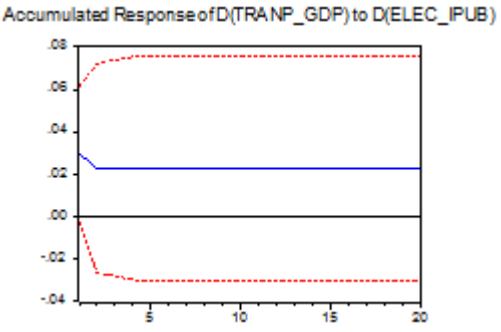
1D



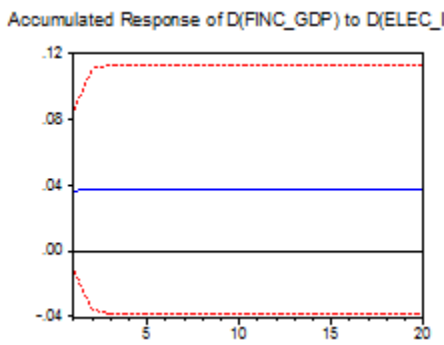
1E



1F



1G



1H

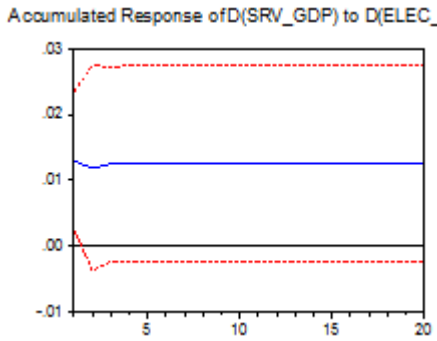
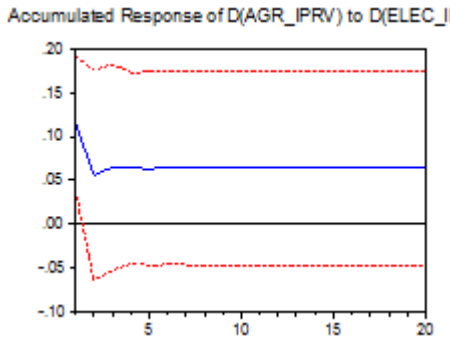
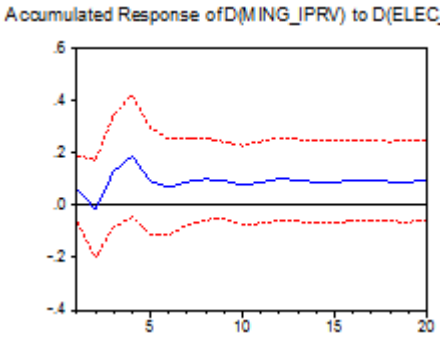


Figure 2: Accumulated Impulse Reponses of Sectoral Private Investment Due to Innovation in Sectoral Public Investment

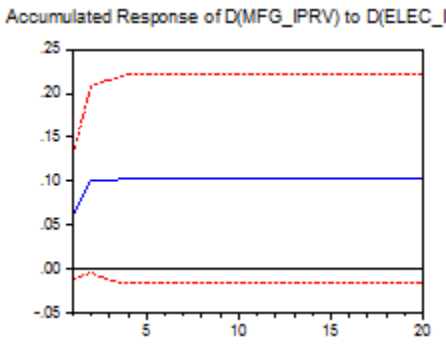
2A



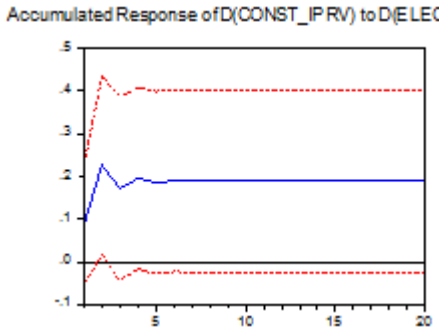
2B



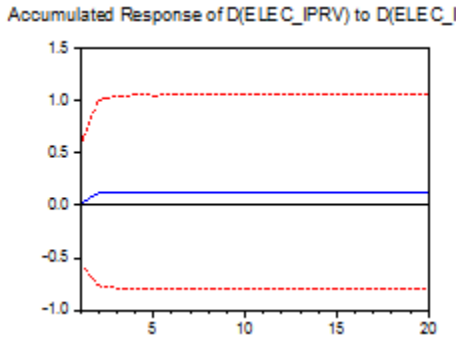
2C



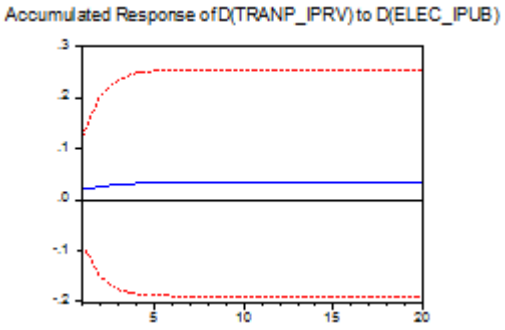
2D



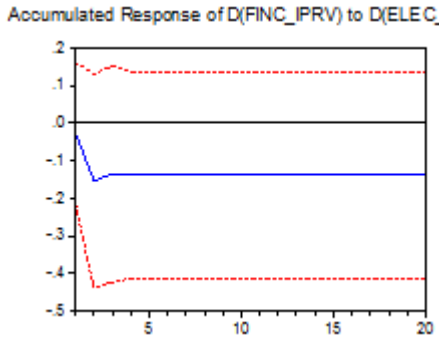
2E



2F



2G



2H

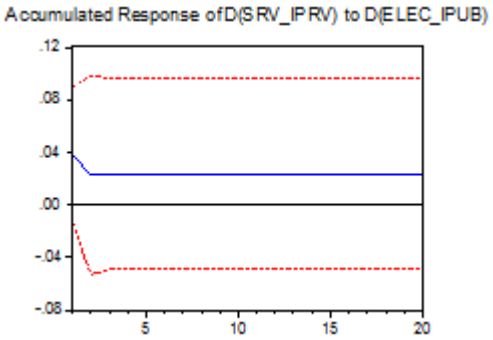
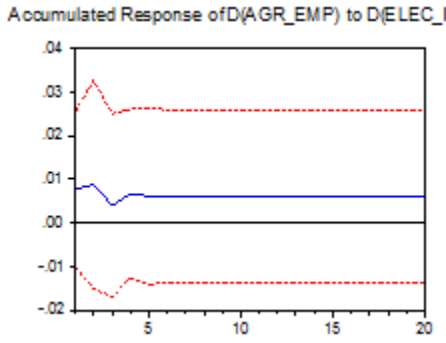
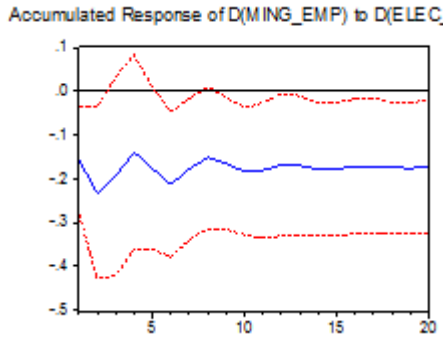


Figure 3: Accumulated Impulse Reponses of Sectoral Employment Due to Innovation in Sectoral Public Investment

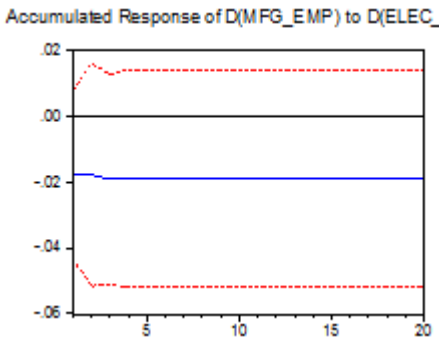
3A



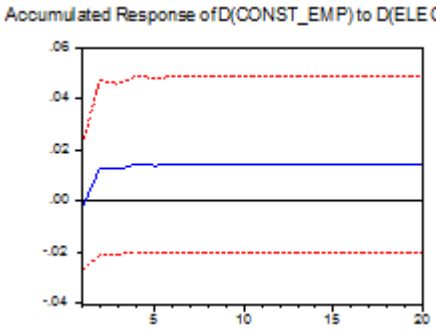
3B



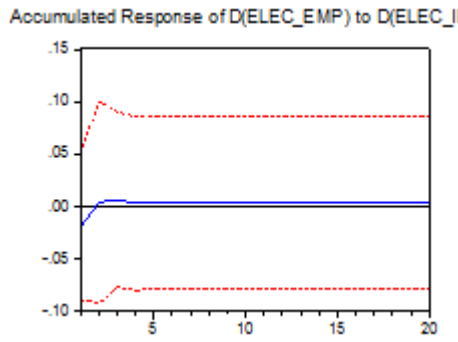
3C



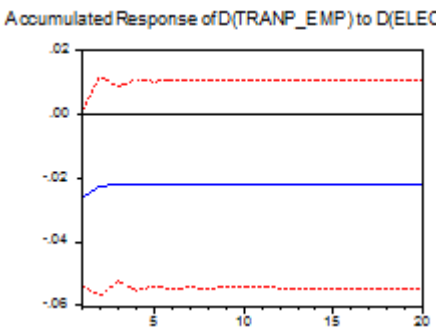
3D



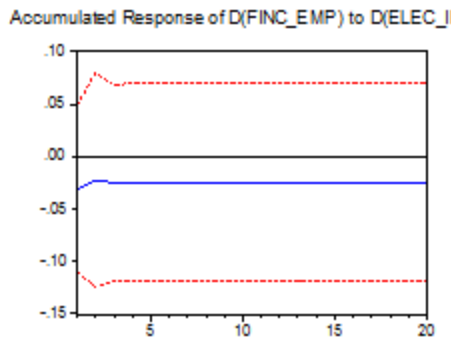
3E



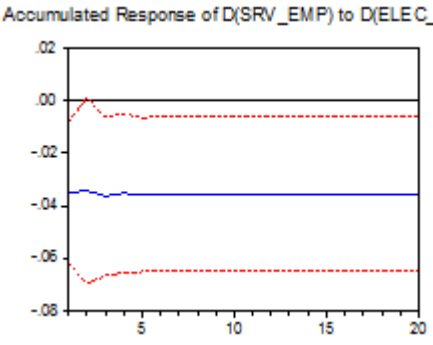
3F



3G



3H



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