

Dynamic Effects of Energy Sector Public Investment on Sectoral Economic Growth: Experience from Pakistan Economy

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1. INTRODUCTION

The successive economic and financial crisis in recent time has reemphasised the importance of fiscal policy. Modern literature has also revisited the debate regarding the effectiveness of fiscal policy in influencing growth. The issue of the impact of public investment on growth is debated in economic literature since seminal work of 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 to 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 to 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 Shugart (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 effect of government

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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 increase labour 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) analysed the effect of public investment through cointegration model during the period 1961 to 2000 for Canada and found mixed results; 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 U.S 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) analysed 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 used five VAR models, one for aggregate level and remaining four for agriculture, services, manufacturing and construction. The results indicate 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 productivity of output, private investment and employment. The highest output marginal productivity was found in the case of manufacturing being 2.43 indicating one peseta of public investment will generate 2.43 pesetas of output.

Pereira and Andr az (2005) analysed the effect of aggregate public transportation infrastructure investment 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 for output, employment and revenue. Pereira and Sagales (1999) using the VAR model for Spain found a crowding in effect of public capital on private output and employment.

Pina and Aubyn (2006) examined the rate of return of public investment in the case of U.S 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 GDP and found a positive Partial-cost dynamic feedback rate of return of 7.33 percent while the total or Full-cost dynamic feedback came out to be 3.68 percent.

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 has a positive effect on private investment and employment in all countries except Austria, Belgium Luxembourg and Netherland, while public investment has a positive effect on output in all countries 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 has a 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) utilised 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 effects in case of Canada and U.S using quarterly data through a VAR model, using real GDP, real interest rate, and share of public and private investment in 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 elasticities of private investment, employment and output with respect to public investment using 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 U.S. However in the case of employment there is no significant role of public capital.

Pereira (2001) estimated the VAR model using private gross domestic product; private investment, public investment and private employment for U.S economy and both private and public investment are further disaggregated into highways 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 percent. Pereira and Andraz (2003) examined the effect of aggregate public

investment on aggregate private output, employment and investment in the case of U.S using VAR impulse response methodology and found at aggregate level, public investment exerts positive effect on all variables. The study found that an investment of one million dollars 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 of 8.4 percent. Pereira and Andraz (2003) further analysed the effect of aggregate public investment at disaggregate level and found in six out of twelve industries public investment has a positive employment effect; in five industries crowding in prevailed, while in eight out of twelve industries, public investment has a positive effect on output.

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 variables i.e. public investment, employed labour force, GDP and private investment. The study reveals that in agriculture there is crowding in effect while in manufacturing there is crowding out effect and at the aggregate level the evidence 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.

The impact 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 its impact on private investment. This study also indicates which sector of Pakistan's economy is getting most benefit of energy investment. This will be useful information for the policy-makers.

The remaining study is organised as follows: Section 2 illustrates methodological framework, Section 3 gives data and diagnostic test, Section 4 is based on empirical results and finally conclusions and policy implications are presented 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 differs from the one used in the previous studies related to Pakistan, although some studies applied Vector Auto Regressive (VAR/VECM) models, yet their findings are based on error correction term; other studies measured causality among public investment, private investment and output or their 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 and Quarrying, Construction, Electricity and Gas Distribution, Transport Storage and Communication, Finance and Insurance plus Ownership of Dwellings and Public

Administration, Defence and Community Services. Hence, total eight VAR models are estimated; one for each of eight sectors. The VAR model corresponding to each sector is specified as follow:

$$X_t = C + \sum_{i=1}^p A_i X_{t-i} + \varepsilon_t \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (2.1)$$

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 of Public sector energy investment, Private investment, Output and employment for each sector. The linear form of the model is

$$\Delta \log I_{pub}, \Delta \log I_{priv}, \Delta \log Y, \Delta \log Emp \quad \dots \quad \dots \quad \dots \quad (2.2)$$

Where I_{pub} , I_{priv} , Emp and Y are \log of real public investment, \log of real private investment, \log of real output and employment respectively.

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 due 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 due to other variable, these residuals should be uncorrelated. The VAR model is modified in such a way that contemporaneous correlation among the residuals is diagonal, called orthogonalisation. 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 variables 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 where 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 dependent variable 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 of *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.

$$\varepsilon_{IPUB} = \frac{\Delta \log Y_i}{\Delta \log IPub_i} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (2.3)$$

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 i th sector, while the denominator is the accumulated change in growth rate of public investment in the i th sector.

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

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

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 terms based on 1999-2000 prices² and their first differences in log form are 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 results reported in Table 1 show³ that all the variables are non-stationary at levels using a 5 percent confidence interval, except three variables, which are level stationary. However, at first differences, 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 reveal⁴ 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 indicate 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.

²The data is available in real terms at different base years. For this study as suggested by the discussant we have used a common base of 1999-2000, for the conversion of the nominal variables into real variables.

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
LFine_GDP	-0.907251	0.7724	-2.47431	0.3375	-5.001994	0.0003	-4.92316	0.0021
LFine_IPrv	-1.352439	0.5923	-2.562142	0.2987	-5.476395	0.0001	-5.471944	0.0005
LFine_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 communication sector, Lfine 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 and Minor Crops, Livestock, Fishing and Forestry)	1	0.1958	0.1381	0.6523
Mining and 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 and Defense and Ownership of Dwellings)	1	0.0019	0.0017	0.1813

1. Based on VAR residual 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.

Cointegration 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 cointegration results based on Engle-Granger test⁵, in all the models reject the existence of cointegration, while in a 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 findings are similar to other related studies e.g. in the case of Portugal, Pereria and Andraz (2005) and in the case of U.S, Pereria and Andraz (2003) did not find any cointegration.

4. EMPIRICAL RESULTS

This section discusses 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 and Forestry)	+	+	+
Mining and Quarrying	+	+	-
Manufacturing	+	+	-
Construction	+	+	+
Electricity and Gas Distribution	-	+	+
Transport, Storage and Communication	+	+	-
Finance and Insurance	+	-	-
Services (Community Services, Public Administration and Defense, Ownership of Dwellings)	+	+	-

Table 3 gives summary of results of the impact 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 shock effects of public energy investment on output show that public energy investment has a positive effect on the output of all sectors except electricity and gas

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

distribution sector. In case of private investment the impulse response functions indicate that public energy investment also has a positive effect on private investment in all the sectors except finance and 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 dies out after five years, except three sectors.

Measuring the Long-term Accumulated Effect of Public Capital Formation

The Effects of Public Investment on Output

The effect of public investment on sectoral output is presented in Table 4. The results indicate that public investment has positive output effects for all the sectors except electricity and 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 as compared to the relatively advanced countries, such as in Spain; Pereira and Oriol (2001) found the aggregate marginal productivity for output of 5.5, similarly in the case of Portugal; Pereira and Andrzej (2007) found aggregate marginal productivity of output of 8. On the sectoral level, the public investment's highest benefit share goes to manufacturing followed by mining and quarrying, transport and communication, services, agriculture, finance and insurance and then construction. The share distribution is 24 percent, 21 percent, 17 percent, 11 percent, 10 percent and 3 percent 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 a positive impact on private investment supporting the hypothesis of crowding-in; in seven out of eight 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 as compared 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, Pereira and Andrzej (2007) found aggregate marginal productivity is 9.45. On the sectoral level, the highest benefit share of public energy investment goes to manufacturing followed by agriculture, services, transport and communication, mining and quarrying, electricity and gas and then construction. The share distribution is 47 percent, 11.5 percent, 11 percent, 6 percent, 6 percent and 5 percent 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 and gas. The one million rupees public investment will create

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 and 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.

Table 4

highest employment in agriculture sector followed by construction and then electricity and gas. In comparison with other studies such as in the case of Portugal, Pereira and Andraz (2007) found the highest benefit share of infrastructure investment in the case of construction followed by finance, services, and real estate. These results show in many sectors it is negative, however these results are also consistent 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 uses the VAR methodology which allows capturing dynamic feedback effect of public investment on private investment, employment and output.

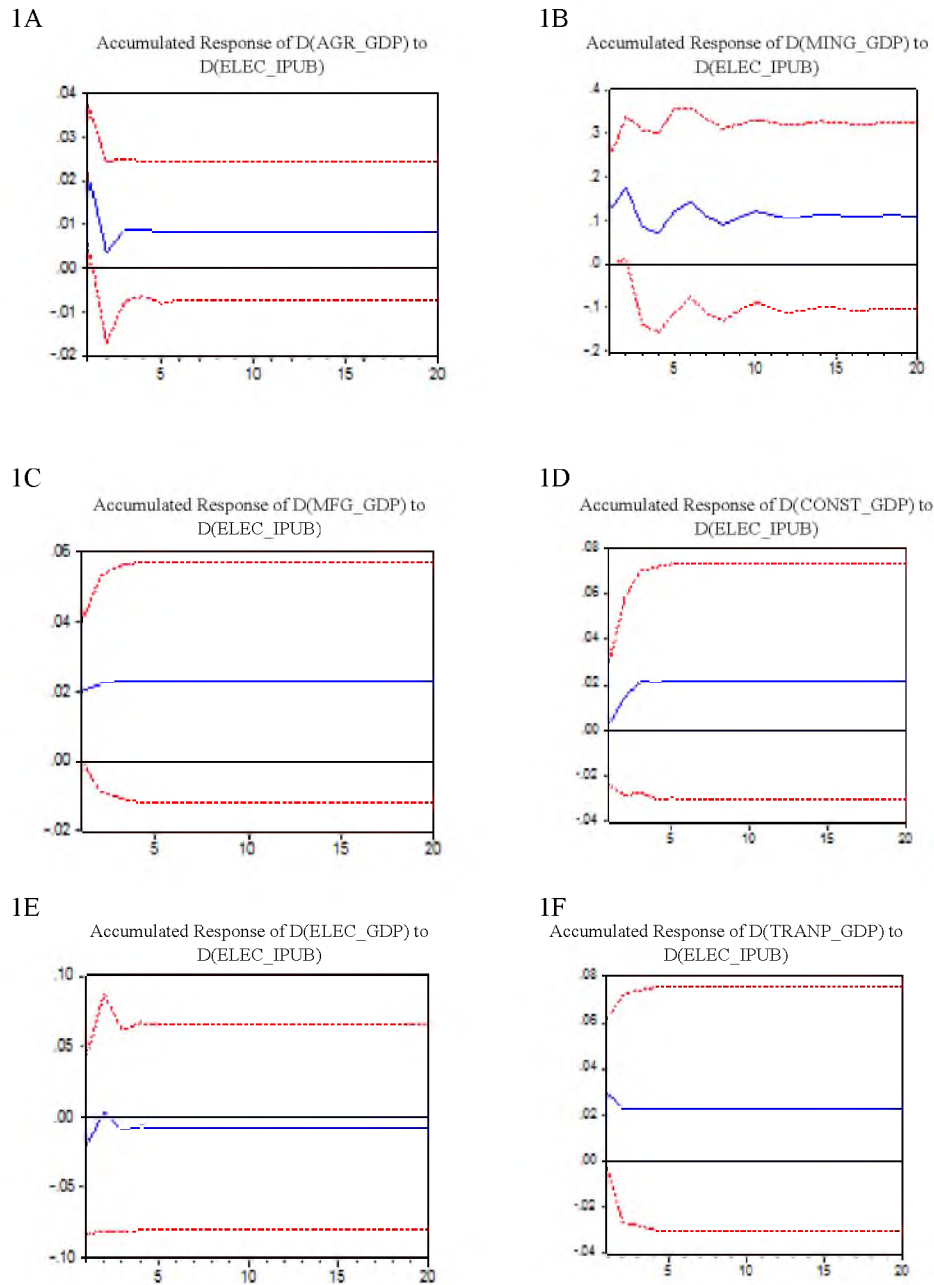
The study is one of the pioneer attempts on the subject by estimating the long term marginal productivities of public investment at sectoral level. The study uses data of eight sectors of Pakistan economy from 1981-2011. The study estimates eight elasticity coefficients to investigate the impact of public investment on sectoral private investment and confirms crowding-in phenomenon in seven out of eight sectors in Pakistan's economy. This overwhelming evidence confirms that public investment has positive effect on private investment. The three out of eight elasticity coefficients show public investment has increased labour absorption and the remaining five show labour 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 0.61 in mining and quarrying and transport and communication sectors. This implies one rupee public investment in these sectors will generate rupees 0.88, 0.766 and 0.61 in these sectors respectively. Generally the marginal productivity is lower as compared to several developed countries like Portugal and Spain where such analysis has been conducted.

The results of this study provide the answers to some important policy questions and also help in formulating future policy. This study calculates the marginal productivities, 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

Fig. 1. Accumulated Impulse Responses of Sectoral GDP Due to Change in Sectoral Public Investment



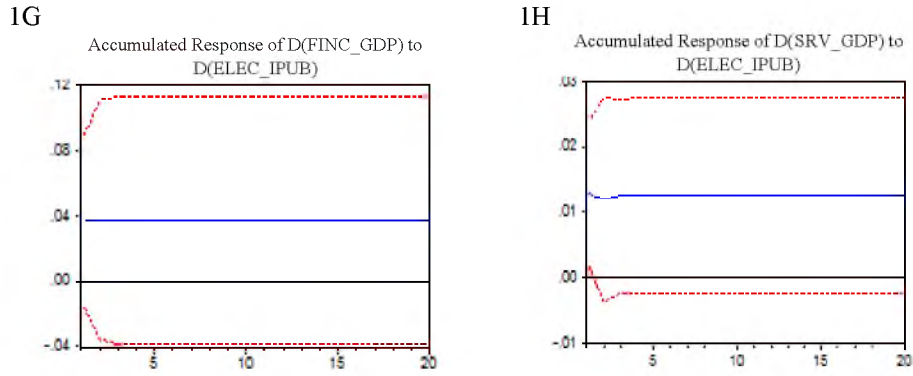
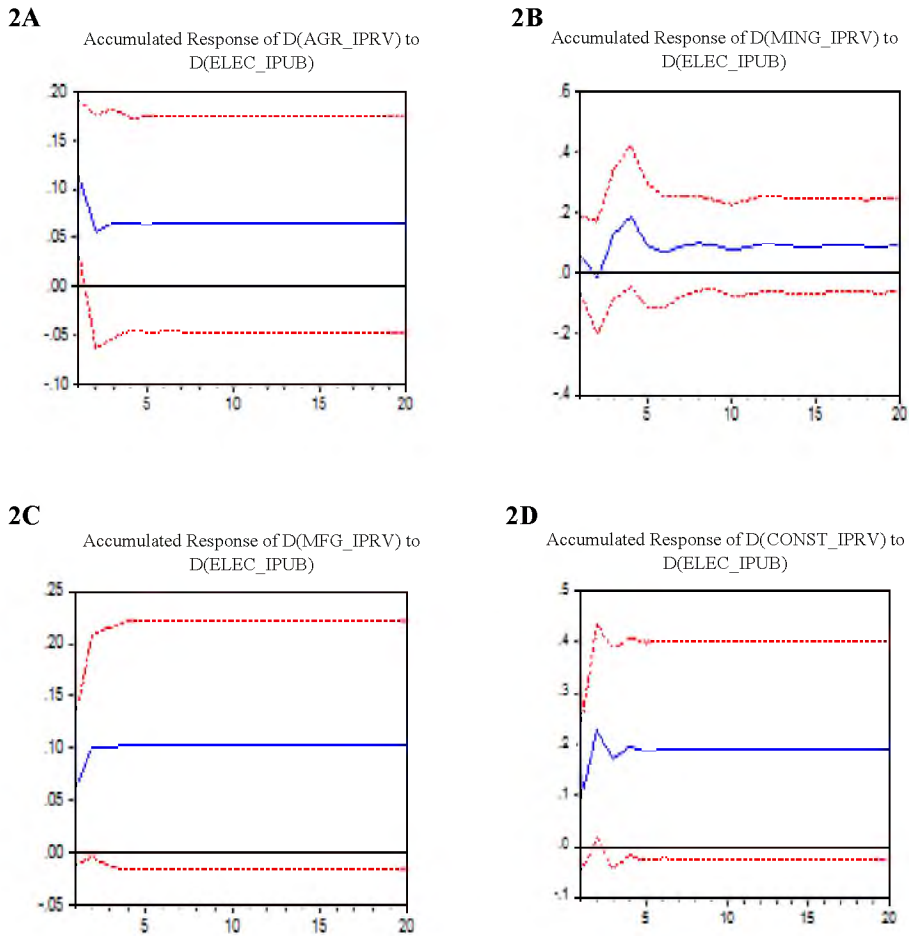


Fig. 2. Accumulated Impulse Responses of Sectoral Private Investment to Innovation in Sectoral Public Investment



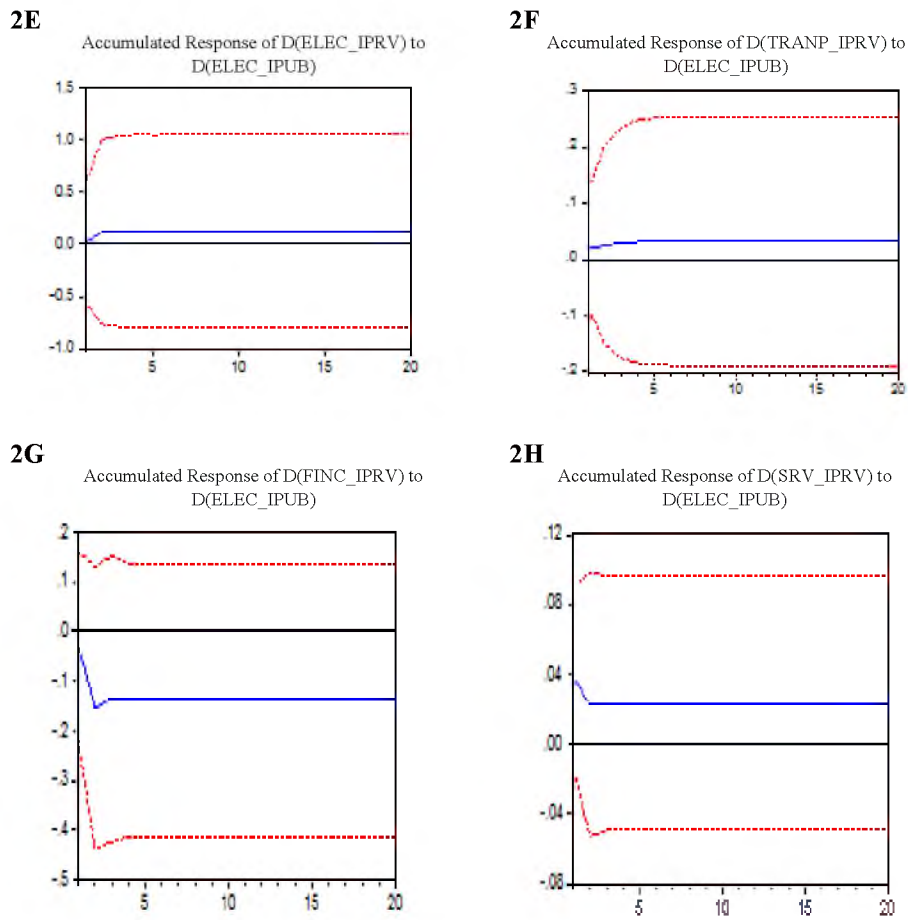
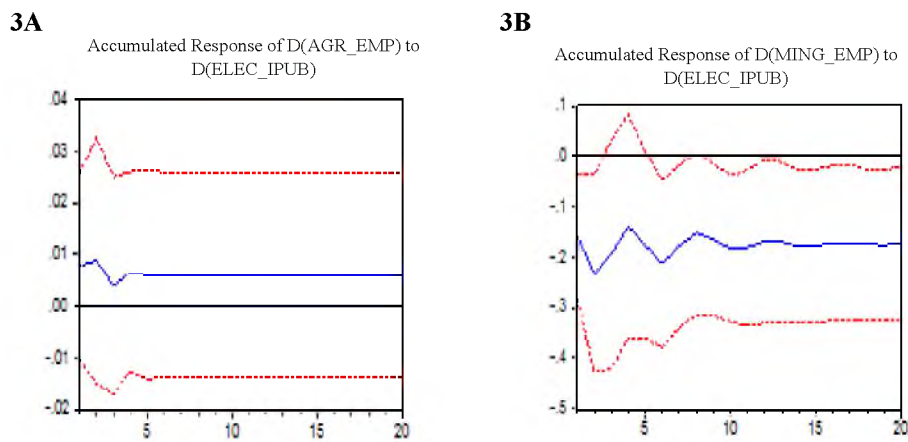
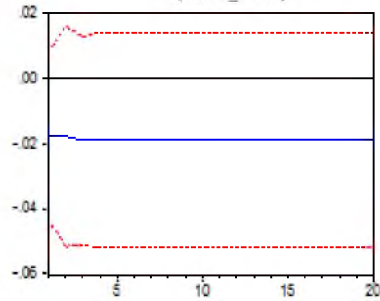


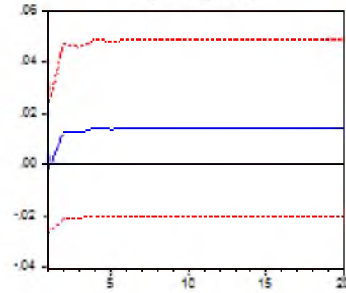
Fig. 3. Accumulated Impulse Responses of Sectoral Employment to Innovation in Sectoral Public Investment



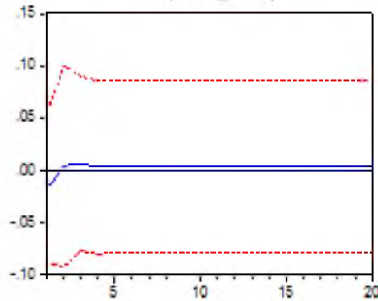
3C Accumulated Response of D(MFG_EMP) to D(ELEC_IPUB)



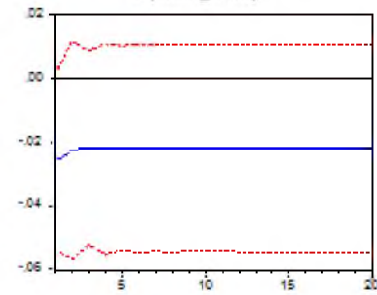
3D Accumulated Response of D(CONST_EMP) to D(ELEC_IPUB)



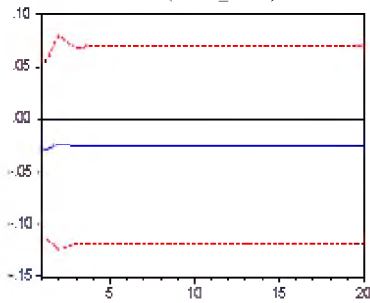
3E Accumulated Response of D(ELEC_EMP) to D(ELEC_IPUB)



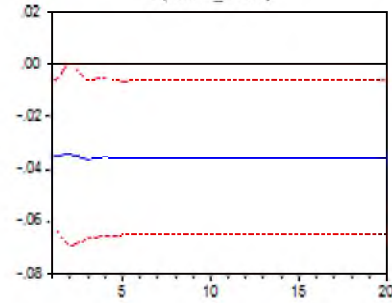
3F Accumulated Response of D(TRANP_EMP) to D(ELEC_IPUB)



3G Accumulated Response of D(FINC_EMP) to D(ELEC_IPUB)



3H Accumulated Response of D(SRV_EMP) to D(ELEC_IPUB)



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Comments

It is an awesome topic to work on in the current scenario because the country is facing acute problem of energy which is among the major input in industrial as well as agriculture production. While reading the paper I felt that if authors can incorporate the following comments, it would enhance the quality of their paper.

Authors have used Growth model. Mankiw, Romer Weil (1991) already showed that human capital is extremely important in case of growth modeling, therefore, human capital is extremely important to include in the growth equation.

Since not all the sectors need energy such as finance and insurance thus all the sectors do not need to regress on energy. Therefore, I would recommend to exclude irrelevant variables from the analysis. Moreover, investment in public sector energy ventures are the investment in the manufacturing sector by the public sector, but rest of the investment is missing in the model. The variable is extremely important and should be included in the model to get correct partial association with the main variables.

Paper did not explain procedure adopted to fill the gaps in employment data. As a reader it is a useful information which is missing.

Cointegration in case of growth equation may not be a feasible technique because there are significant chances that labour, capital, human capital and growth are interlinked to each other and there is a problem of endogeneity. Therefore, proper technique should be applied to get the parameters.

The exercise done in Tale 4 is a very good exercise. However, the magnitude and signs of few variables seems to be incorrect. I believe that by including the human capital variables, inclusion and exclusion of relevant and irrelevant variables and adopting proper estimation technique may help in getting correct signs.

As much as I am not convinced with the estimation technique applied in the paper, I am also not convinced with the application of impulse response function on annual data. Impulse response function gives us the response of shock in any variable within the system. By using this technique we know the divergent or converging behavior of the variables. However, it also tells us the duration of period in which shock is either absorbed or tells. Using the technique on annual data, mostly, do not give meaningful results. Therefore, in my view either this technique is not used on annual data or the results should be interpret with caution because “variable will adjust after 8 periods implies 8 years”, which in most of the cases is not a meaningful result.

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