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Effects of Government Investment Shocks on Private Investment and Income in India

Jagannath Mallick

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Abstract

This paper evaluates the effect of shocks in government investment on private investment and national income, focusing on “crowding-in” or “crowding-out” effect in India. Recent studies do not deal with this issue by taking account of the heterogeneous effect of public investment as regards to infrastructure. Hence, I divide government investment into infrastructure vs non-infrastructure. The study uses structural vector auto-regressions (SVAR) and impulse-response-functions analysis to evaluate the dynamic change in private investment and income. The study finds evidence of the crowding-out effect of government investment, which is mainly due to the non-infrastructure part of government investment. Private investment has a larger effect on income than both types of public investment. The effect on income due to the infrastructure component of public investment is larger than the non-infrastructure component in both the short-term and medium term. However, government investment in non-infrastructure continued to dominate its infrastructure component during the period of this study. Private investment is vital to achieve higher growth in market-led economies and public investment should play a complementary role. Hence, the Indian government should design policies to attract more investment expenditure in infrastructure and other productive activities such as the development of human capital so as to crowd-in private investment.

Keywords*: private investment; public investment; crowding-out; structural VAR*

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Author’s email: *mallickjagannath@gmail.com*

Effects of Government Investment Shocks on Private Investment and Income in India

Jagannath Mallick*

1. Introduction

Investment is generally considered as the crucial factor for economic growth and development, which is sourced from both the private and public sectors. The allocation mechanisms of private investment differs from public investment in the Indian economy (Mallick, 2014a). Social and discretionary allocations are dominant forms of public investment in India while the increase or inflow of private investment is determined by the rate of returns or profit. Further, marginal productivity of private investment is considered as higher than public investment in developing countries like India (Khan and Kumar, 1997; Khan and Reinhart, 1990, Mallick, 2014a). This makes the contributions of the former to the economic growth and development higher than that of the latter.

Some studied float the theory that government investment may crowd-out private investment directly and through indirect channels (Blinder and Solow 1973; Buiter 1990; Friedman, 1978; Carlson and Spencer, 1975; Spencer and Yohe, 1970). The direct (real) crowding-out occurs when the increase in public investment displaces private capital formation broadly on a unit-for-unit basis irrespective of the mode of financing the fiscal deficit caused by the increase in public expenditure. However, public capital formation, financed by borrowing, reduces loanable funds available to private firms. Consequently, it drives up interest rates and reduces private investment partially, which is termed as "financial crowding-out". The Ricardian Equivalence Theory (Ricardo, 1820) provides another explanation for the crowding-out effect. The increase in government spending financed by taxes, raises the tax rate at present or in the future. Hence, it leaves the private sector with the disposable income, which negatively affects private investment.

Public investment can also create favourable conditions for private investment. For instance, it can provide infrastructure such as roads, highways, sewage systems and harbours. Better facilities may increase the productivity of private investment by reducing the cost of production of the private sector. Hence, it affects positively the profitability of private investment, which is called as crowding-in effect. The crowding-in or crowding-out effects of public investment on private investment have significant impact on economic growth. According to the Keynesian Theory, economic growth will be stimulated if the positive impact of increased government investment outweighs the negative impact of reduced private investment. In the reverse case, which is often called 'net crowding-out', the negative impact of reduced private investment completely cancels the positive impact of increased public investment and economic growth will not be stimulated. The resources consumed by the

* International Research Fellow of Japan Society for Promotion of Science (JSPS) and Visiting Research Fellow at University of Hyogo, Japan

government would have been more effective in the hands of the private sector. Hence, public investment affects economic growth through its relation with private investment and contributes to economic growth as a direct input to production function.

In the context of the above theoretical discussions, there is also mixed findings in the empirical studies (Argimon *et al,* 1995; Ramirez, 1994; Greene and Villanueva, 1990; Everhart and Sumlinski 2001; Sundararajan and Thakur 1980; Atukeeren 2005; Mitra 2006: Odedokum, 1997: Aschauer, 1989a: Blejer and Khan 1984: Serven, 1996). In addition, the extent or magnitude of crowing-out effect of government investment could vary across countries (Afonso and Miguel, 2008). The relationship of public investment with private investment is the most debatable issue in the context of India. A group of studies find crowding-in effect of public investment on private investment, viz., Singh (2005) and Chakraborty (2007), and another group of studies, by the likes of Sundararajan and Thakur (1980), Pradhan *et al.* (1990) and Mitra (2006), have established the crowding-out effect of public investment (for detailed studies and findings see Table 1 in appendices).

Further, the empirical studies mainly focus on aggregate public investment, whereas the effect of government investment by its types is scarce in the Indian economy. As rightly pointed out by Serven (1996), studies dealing with the aggregate of public investment may be adequate for leading industrial countries like USA where the public sector engagement in conventional industrial and commercial activities is minimal. However, this cannot be applied to developing countries where public enterprises are commonly engaged in multiple activities such as manufacturing, banking and commerce. The government acts as two-way player in the developing countries. It serves as a provider of public goods and infrastructure services and is significantly involved in industrial and commercial activities. Hence, it may not be convenient to detect the meaningful relation of aggregate public investment with private investment, as the different types of public investment may have differential impacts on private sector activity (Barro, 1990; Barro, 1991; Mallick, 2013a; Serven, 1996). Public investment in infrastructure tends to raise the productivity of private entrepreneurs and thereby push private investment. However, public investment in other activities, where public enterprises replicate the actions of private firms, is expected to crowd-out private investment by competing in the goods and factor markets and reducing the available funds.

Economic theories suggest that increased investment, whether public or private, should boost growth. In addition, a bulk of the studies suggest that public investment in infrastructure boosts growth (Egert *et al.,* 2009; Canning and Pedroni, 2008; Demetriades, Mamuneas, 2000; Fic and Portes, 2013; Pereira and Pereira, 2015). Fic and Portes (2013) argued that increased infrastructure investment boosts economic growth in both the short-run and long-run and the latter should have larger effect than the former due to the cumulative impact of infrastructure. In this connection, there are some studies on the component of public expenditure and economic growth in the context of developing countries (Devarajan *et al.,* 1996; Easterly and Rebelo, 1993; Barro, 1990; Barro, 1991). Devarajan *et al.,* (1996) used panel data for 43 countries, including India, to estimate the link between the components of public expenditure and growth in 1970-1990 and found surprising results. The impact of current expenditure is positive and capital expenditure (even the infrastructure component of capital expenditure) is negative. This result, they suggested, was due to the misallocation of public expenditure in developing countries and the capital part of government expenditure is over-spending. In contrast, Easterly and Rebelo (1993) found positive impact of infrastructure public capital on economic growth in developing countries. Similarly, Barro (1990; 1991) suggested that infrastructure as the productive components of government expenditure. Aschauer (1989a) used time-series regressions with United States data to consider how public investment in equipment and structures affected private investment and concluded that public investment probably crowds-in private investment. Further, Aschauer (1989b) found that the marginal productivity of infrastructure component was higher than other parts of government expenditure.

A few studies deal with this relationship by categorising public investment into infrastructure and non-infrastructure but they have limitations in terms of coverage of sample periods and methodologies. For instance, Serven (1996) and Chakraborty (2007) examined long-run impact of government investment on private investment by using the vector error correction mechanism (VECM) methods for the periods 1960-1995 and 1970-2002, respectively. Chakraborty considered the only component of the private corporate sector and it has major flaws in the econometric specifications as well. She used the private corporate sector investment as function of public investment, interest rate and non-food credit to represent available credit to the private sector and output gap. She used two different models to replace public investment by infrastructure and non-infrastructure. The specifications of the two models suffer from measurement errors in the variable. The presence of measurement errors causes biased and inconsistent parameter estimates and leads to erroneous conclusions to various degrees in economic analysis (Chen *et al.*, 2007). It would be better to include both the components of public investment in one model. However, the findings of Chakraborty contradict the findings of Serven’s study. Chakraborty finds crowding-in impact effect of public investment and its infrastructure component in the medium and long-run, and there is also positive and insignificant effect of non-infrastructure component of public investment. While, Serven finds crowding-in impact infrastructure and crowding-out effect of non-infrastructure public investment on private investment in the long-run.

Further, some economist including Keating, (1992) criticized VAR and VECM approaches, and argued that dynamic indicators of VAR is obtained by a mechanical technique, which may not be related to economic theory, as it is unable to uncover the information about the actual structural parameters. Sargent (1979, 1984) and Learner (1985) suggested that VAR models could only be used for forecasting purpose and not for policy analysis. These criticisms led to the development of a structural vector auto regression (SVAR) approach. SVAR is also used by Mitra (2006) to examine the effect of shocks in total government investment on private investment and income in India for 1969-2005. Following the argument by Akitoby (2006) for the elasticity of public investment and by Bruckner *et al.*, (2012) for the elasticity of public expenditure, Mitra`s study has limitation with regards to the assumptions of the elasticity of public expenditure due to change in income in order to identify the structural parameter in the estimation of SVAR model.

In fact, FDI has been attracting attention of the policy makers and academicians as the prime driver of export and economic growth in India, which also may affect the private firms' productivity. There are no studies that analyse the contemporary relations between government investment and private investment, FDI, export and income in the Indian economy. Hence, it would be policy imperative to examine the impact of the shocks of government investment by infrastructure and non-infrastructure on private investment and income by taking into account the role of FDI and export in the recent years. In order fill this research gap, the present study focuses on this issue by considering the years from 1970-71 to 2013-14. The findings show that the shocks, in the aggregate, of Government investment has a crowding-out effect on private investment, which is consistent with some of the existing studies. However, the non-infrastructure component of government investment is the main cause for the crowding-out effect on the private investment. The rest of the paper is organized as follows. Section II describes the variables and data sources. Section III outlines the technique of estimation. The core of the empirical analysis and results are presented in Section IV. The robustness of the results is checked in Section V. The result is explained in section VI. Conclusions and policy implications are presented in the last section.

2. Variables and Data

The study includes annual data during the periods from 1970-71 to 2013-14. The variables included in the analysis are public investment in non-infrastructure (NINF), public investment in infrastructure (INF), private investment, gross domestic product (GDP). In addition, the analysis includes export and foreign direct investment (FDI) because it is argued in theoretical literature that they are the crucial factors of economic growth. Generally, investment is measured by the gross capital formation (GCF), which includes GFCF and change in stocks or inventories. However, the inventories in the developing countries are fluctuating in nature (Khan and Reinhart, 1990; Blejer and Khan 1984; Wai and Wong, 1982; Mallick, 2014a; Mallick, 2013b; Mallick, 2012). Hence, this study uses GFCF to measure both the public and private investment. The National Accounts Statistics (NAS) is the basic data source for the macroeconomic indicators in India. However, it does not give information on FDI. Hence, the study makes use of data from the World Development Indicator of the World Bank, which combines with the information from NAS to form the data set for the empirical analysis. Private fixed investment is defined to include the assets created under construction, machinery and equipment by the private sector in the domestic market. The deduction of public investment from the national total investment gives us the series on the private investment. Following Krishnamurty (1984), the infrastructure sector includes electricity, gas and water supply, railways, communications, and transport by other means and storage.

Table 1: Data sources

Data	Time Period	Sources	Remarks
GDP at constant prices 2011-12 (LCU-local currency unit, which is Rs.)	1970-71 to 2013-14	World Bank	-
GFCF at current and constant prices with base year 2011-12 (LCU)	'do'	'do'	GFCF deflator is calculated
GFCF, private sector (current prices, LCU)	'do'	'do'	Converted using GFCF deflator
GFCF, private sector (current prices, LCU)	'do'	'do'	'do'
FDI in per cent of GDP	'do'	'do'	-
Export of goods and services at constant prices 2011-12 (LCU)	'do'	'do'	-
GCF by industry of use at constant prices with base year 2004-05 (public sector)	1970-71 to 1979-80	NAS (2011)	Infrastructure share is calculated
GFCF by industry of use at constant prices with base year 2004-05 (public sector)	1980-81 to 2012-13	NAS (2011 & 2015)	Infrastructure share is calculated

Data on public investment, private investment, GDP, FDI and export have taken from the World Bank. The disaggregate level information from NAS is used to catagorise the public investment from the World Bank data into infrastructure and non-infrastructure components. The World Bank does not provide information on the components of public investment. Furthermore, NAS provides data on GFCF by industry of use from 1980-81 onwards only. However, it provides data on GCF by the industry of use (See, appendix Table 2 for the detailed availability of NAS data for this study). Hence, the infrastructure shares in GCF from 1970-71 to 1979-80 and in GFCF for the remaining years are used to divide the public GFCF of World Bank data. The used data and construction of variables are presented in Table 1.[1]

All the variables are used in terms of per capita and transferred to their natural logarithms. Further, the study uses dummy variables to capture the effect of Indian economic reform measures in 1991, the Asian financial crisis and the global financial crisis.[2]

3. Empirical Methodology

The study uses the SVAR approach to examine the contemporaneous impact of public investment on private investment. This approach has been used extensively in macroeconomic and finance literatures (Allegret, 2012; Cologni, 2006; Cho, 2012; Moore, 2006; Schenkelberg and Watzka, 2013). SVAR is also used to examine the impact of fiscal

[1] This is a challenging task to research at the disaggregated level in the developing countries including India. The flaws in the data will be reflected in the estimated regression coefficients that makes the results biased and inconsistent, particularly in dealing time series analysis. We need to construct the series consistently to minimise the measurement errors in the estimation.

[2] The dummy for economic reform measures takes 1 for the years from 1991-2013 and 0 other wise. The dummy variables for Asian crisis take 1 for 1997 and 0 otherwise, and for global financial crisis take 1 for 2008 and 2009 and 0 other wise.

policy on private investment and output for various countries (Perotti, 2004; Ramey, 2011; Blanchard and Perotti, 2002). This approach has been adopted in many empirical studies (Mishra and Mishra, 2010; Yadav, *et al.,* 2012; Jain and Kumar, 2013; Jha *et al.,* 2010; Mallick, 2014b; Barnett *et al.,* 2015) in the context of the Indian economy but one study by Mitra (2006) uses this approach to study the crowding-out effect of public investment.

3.1 Structural VAR

The Vector Auto Regression (VAR) model developed by Sims (1980) is a reduced-form time series model, which is estimated by ordinary least square (OLS). The dynamic characteristics of empirical models are illustrated by the impulse response functions and variances decompositions based on the VAR models. Initially it was believed that important dynamic characteristics of the economy could be uncovered by VAR models without imposing restrictions on the structural parameters based on the economic theory. The performance of VAR was criticized Keating (1992), Sargent (1979, 1984) and Learner (1985) and led to the development of the SVAR approach by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986). This approach transforms the reduced-form VAR model into a system of structural equations by imposing short-run restrictions based economic theory to analyse the feedback effects among the variables [3]. The parameters are estimated by imposing contemporaneous structural restrictions. Keating (1992) indicated that impulse responses and variance decompositions yielded from SVARs could be given structural interpretations relating the economic theories. Therefore, the reduced-form VAR residuals are not interpretable in an economic sense, whereas the unobserved structural-form shocks have an economic interpretation. In order to achieve identification of the structural shocks from the estimated variance covariance matrix of the reduced-form residuals, we need to impose contemporaneous (short-run) restrictions.

3.2 Relation between the parameters from reduced form VAR and SVAR

VAR models comprise a system of reduced form equations relating each endogenous variable to lagged endogenous (predetermined) and exogenous variables (Sims, 1980). A reduced form of VAR representation can be written as

$$y_t = \beta + B_1 y_{t-1} + B_2 y_{t-2} + B_3 y_{t-3} + \cdots + B_p y_{t-p} + \varepsilon_t, \qquad \varepsilon_t \sim i.i.d.(0, \Sigma_\varepsilon) \qquad (1)$$

where y_t is an K × 1 vector of endogenous variables at time t; β is an K × 1 vector of constants; B_i are each a K × K matrix of parameters for i = 1, . . . p (lag length); and ε_t is a K × 1 vector of disturbances, which has an independent multivariate normal distribution with zero mean. The variance covariance matrix of ε_t is denoted by $\Sigma_\varepsilon$and non-singular. If B_0 is an identity matrix of order K × K, the equation (1) ca be rewritten as

$$B_0 y_t = \beta + B_1 y_{t-1} + B_2 y_{t-2} + B_3 y_{t-3} + \cdots + B_p y_{t-p} + \varepsilon_t$$

$$\text{or, } B_0 y_t - B_1 y_{t-1} - B_2 y_{t-2} - B_3 y_{t-3} - \cdots - B_p y_{t-p} = \beta + \varepsilon_t$$

[3] An alternative structural VAR method, developed by Shapiro and Watson (1988) and Blanchard and Quah (1989), utilises long-run restrictions to identify the economic structure from the reduced form. Such models also have long-run characteristics that are consistent with the theoretical restrictions used to identify parameters.

or, $B_0 y_t - B_1 L y_t - B_2 L^2 y_t - B_3 L^3 y_t - \cdots - B_p L^p y_t = \quad \beta + \varepsilon_t$
or, $[B_0 - B_1 L - B_2 L^2 - B_3 L^3 - \cdots - B_p L^p] y_t = \quad \beta + \varepsilon_t$
or, $[B_0 - B_1 L - B_2 L^2 - B_3 L^3 - \cdots - B_p L^p] y_t = \quad \beta + \varepsilon_t$
or, $B(L) y_t = \quad \beta + \varepsilon_t,$ where, B(L) = $B_0 - B_1 L - B_2 L^2 - B_3 L^3 - \cdots - B_p L^p$.

The SVAR model with corresponds to the above reduced form VAR is;

$$A_0 y_t = \alpha + A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + \cdots + A_p y_{t-p} + u_t, \quad u_t \sim i.i.d.(0, \cap) \qquad (2)$$

or. A(L)$y_t = \alpha + u_t$, where, A(L) = $A_0 - A_1 L - A_2 L^2 - A_3 L^3 - \cdots - A_p L^p$.

A_0 is a non-singular matrix normalized to have ones on the diagonal. It also summarizes the contemporaneous or instantaneous relationships between the variables in the model contained in the vector y_t. y_t is a vector containing K economic variables and u_t vector is white noise. The variance of u_t is denoted by $\cap$, which is a diagonal matrix with the diagonal elements are the variances of structural disturbances such that the structural disturbances are serially uncorrelated and uncorrelated with each other (see, Hamilton, 1994).

Hence, from equations (1) and (2), $\varepsilon_t = {A_0}^{-1} u_t$ (3)

Further, multiplying ${A_0}^{-1}$ with A (L)
i.e., ${A_0}^{-1} A(L) = [I - {A_0}^{-1}(A_1 L - A_2 L^2 - A_3 L^3 - \cdots - A_p L^p)]$ = B(L)
or, $B(L) = {A_0}^{-1} A(L)$ (4)

Since (1) represents the reduced form, hence the system can be consistently estimated with OLS equation by equation (Sims, 1980; Hamilton, 1994). However, the matrix A_0, which represents the contemporaneous relationships and the structural disturbances in (2) cannot be estimated. They can be recovered from the estimated reduced form coefficients through identifying restriction. Hence, the parameters of the reduced and structural form equations are related by: $\Sigma_\varepsilon = {A_0}^{-1} \cap {A_0}^{-1}$ (5)
and $B(L) = [I - {A_0}^{-1}(A_1 L - A_2 L^2 - A_3 L^3 - \cdots - A_p L^p)$ (6).

Now maximum likelihood estimates of structural parameters A_0 and $\cap$ can be obtained only through sample estimates of Σ_ε . The right hand side of (5) has K(K + 1) free parameters to be estimated. Since $\Sigma_\varepsilon$contains K (K + 1)/2, we need at least K(K + 1)/2 restrictions. By normalizing K diagonal elements of A_0 to ones, we need at least K(K - 1)/2 restrictions on A_0 to achieve identification. Hence, we need to impose the contemporaneous zero-value restrictions on A_0 to achieve identification of the structural parameters. This requires imposing restrictions on the correlation structure of the VAR residuals to make it identified. If we impose more exclusion restrictions, then the VAR model can be estimated by GMM and an over-identifying restrictions test can be performed to judge the validity of the exclusion restrictions (Bernanke and Mihov, 1998).

There are various approaches to solve the identification problem in a system of equations in VAR (Holtemoller, 2002). Since the study focuses on the short run contemporaneous relations, I consider the more general (non-recursive) modelling strategy developed by

Blanchard and Watson (1986), Bernanke (1986) and Sims (1986). This approach looks at the factorization problem by imposing more of an economic structure. The other approach to the factorization problem is the Cholesky decomposition of Sims (1980) by assuming a recursive structure. The Cholesky decomposition of the matrix of covariance of the residuals requires all elements above the principal diagonal to be zero, which provides the necessary additional restrictions to exactly identify the system.

3.3 Identification Scheme

Hence, for a six variable SVAR model, after normalizing six diagonal elements of A_0:

$$A_0 = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ \alpha_{21} & 1 & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix}$$

where each row represent each of the six variables viz. LNINF (ln. of public non-infrastructure investment), LINF (ln. of public infrastructure investment), LPR (ln. of private investment), LX (ln. of export), LFDI (ln. of FDI) and LGDP (ln. of GDP), and their corresponding structural disturbances and reduced form disturbances are ${u_t}^{lninf}$, ${u_t}^{linf}$, ${u_t}^{lpr}$, ${u_t}^{x}$, ${u_t}^{fdi}$ and ${u_t}^{lgdp}$, and ${\varepsilon_t}^{lninf}$, ${\varepsilon_t}^{linf}$, ${\varepsilon_t}^{lpr}$, ${\varepsilon_t}^{x}$, ${\varepsilon_t}^{fdi}$ and ${\varepsilon_t}^{lgdp}$, respectively. I have employed the second method of identification of structural parameters in the results and the recursive structure of Cholesky decomposition for the robustness check. I have extended and modified the contemporaneous relationship between unexpected reduced form shocks and structural shocks as used in Mitra (2006). She assumed that government investment can react to GDP but it is independent of private investment, whereas private investment can respond to lagged GDP but not to current GDP. I have used the following structure for A_0 to identify the parameters:

$$\begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0.54 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0.54 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & 0 & 1 \end{vmatrix}$$

The first two equations relate to real per capita public investment in non-infrastructure and infrastructure. Thus, the first equation states that the unexpected shock to public investment in non-infrastructure is due to an unexpected shock to GDP and its own structural shock. Similarly, the unexpected shock to public investment in infrastructure, as shown in the second equation, is due to an unexpected shock to GDP and its own structural shock. The next four equations relate to private investment, export, FDI and income, respectively. The unexpected shock to private investment is due to the unexpected shocks in public infrastructure investment, public non-infrastructure investment and its own structural shock.

The fourth equation represents the unexpected shocks in export because of unexpected shocks in LNINF, LINF and LPR, and its own structural shock. The fifth equation stands for the unexpected shocks in FDI are due to unexpected shocks in LNINF, LINF, LPR and X, and its own structural shock. Finally, unexpected shocks in output are a result of unexpected shocks all other four factors excluding FDI [4]and a structural shock to GDP.

Public investment in non-infrastructure and infrastructure is generally independent of private investment. They may have contemporaneous impact on GDP. According to the proposition of 'Wagner's Law of Increasing State Activities', there exists a relationship between economic growth and public expenditure (Wagner, 1883). The fundamental idea behind this relationship is that the growth in public expenditure is a natural consequence of economic growth. This means, that the elasticity of public expenditure due to change in income should be more than 1. However, this law may hold true in the long-run, as it is based on the permanent income. There is serious debate on the validity of this law in the short-run. In this connection, Bruckner and Gradstein (2012) estimate the short-run and long-run elasticities for a panel of 142 countries including India in 1960-2007. They show that the short-run elasticity lie between 0.3 to 0.6 and long-run elasticity is about to 1. Further, the elasticity for investment is more than that of public consumption. As Lane (2003) argued that government consumption varies positively but less than proportionately with output fluctuations. Government consumption expenditure focuses on tracking the growth in the overall size of government via asymmetric fiscal responses to booms and recessions (Hercowitz and Strawczynski, 1999). Government spending is countercyclical during a recession and procyclical during a boom, which is consistent with suggestions from some political economy models (Buchanan and Wagner, 1978). Akitoby *et al.*, (2006) crticised the panel data studies, because they do not utilize the time series properties of data. They estimated the short-run income elasticity of capital expenditure for 51 developing countries in 1970-2002 and showed that for India it is 0.54. However, the use of long-run income elasticity of public expenditure in some of recent studies, including Mitra (2006), in the context of the Indian economy may lead to biased estimates in the SVAR model. Hence, this study uses the income elasticity of public investment in non-infrastructure and infrastructure from Akitoby *et al* (2006) for the estimates of short-run capital expenditure.

3.4 Specification of VAR

Numerous recent studies have suggested estimation of SVAR at the level of variables to understand the actual contemporary relations (Ashley, 2009; Gospodinov *et al.* 2013; Guay and Pelgrin, 2007; Mishra and Mishra, 2010; Raghavan and Silvapulle, 2008; Wiriyawit and Wongy, 2015). Guay and Pelgrin, (2007) argued that it is ideal to proceed with the SVAR in level, even in the case where the variables are not stationary. The estimated coefficients of the

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4 According to Reserve Bank of India, FDI includes equity capital, reinvested earnings and other capital. FDI is not expected to have contemporaneous relations, but it has lag effects. Because, there has to be many administrative works done, before FDI operate and perform the activities. Sometimes, FDI could be just intention or money received, but not actually spent. Also, exports is expected not to affect contemporaneously to public investment and private investment.

VAR with possibly non-stationary variables are consistent and the asymptotic distribution of individual estimated parameters is standard, i.e., a normal distribution (Sims *et al.*, 1990).[5] The impulse-response functions are also consistent estimators of the true impulse-response functions except in long run[6]. Consequently, a VAR can be estimated with non-stationary variables and the resulting impulse responses in the short and medium-run are then reliable estimators of the true impulse responses.

Further, Guay and Pelgrin, (2007) suggested that, this is applicable to the cointegrated variables as well.[7] Nevertheless, the common practice of transforming models into stationary representations by first-differencing or using cointegration operators is often unnecessary even if data appear likely to be integrated (Sims *et al.,* 1990). The critical issue is whether the estimated coefficients or test statistics have a standard distribution and the reliability of the finite sample approximation. More specifically, Sims *et al.,* (1990) show that the OLS estimator is consistent whether or not the VAR contains integrated components, as long as the innovations in the VAR have enough moments and a zero mean conditional on past values of regressand. Guay and Pelgrin, (2007) argued that a two-step cointegrated VAR procedure (Engle and Granger, 1987) may be unnecessary[8], at least asymptotically, because the asymptotic distribution of the VAR coefficients is a singular normal one and is the same as in a model where we assume the cointegration relationships as given.

3.5 Estimation steps

A reduced-form VAR is fitted to the data to estimate the SVAR model, which includes LNINF, LINF, LPR, LX, LFDI and LGDP, and the three dummy variables. The lag length of the VAR is determined based on the lag length criteria. I considered up to two lags as it is the annual frequency data and found that one lag was chosen by the criteria. Then, I used diagnostic test to assess the validity and reliability of VAR estimates, which confirm that the estimated VAR model satisfies these tests. I used an over-identified contemporaneous matrix as illustrated above, which was also tested by using Likelihood Ratio (LR) test. Furthermore, to ensure the robustness of the results, I investigated the results for sensitivity to different specifications, altering the order of identifications or using Cholesky decomposition.

4. Empirical Estimation

The time series properties, including the non-stationarity and stationarity of the variables were examined by applying the Augmented Dickey Fuller (ADF) unit root tests. The unit root test results are presented in Table 2, which show that all the variables under consideration were non-stationary at levels and stationary at first-differences, thus the variables are I(1) process. An important step in the estimation of the VAR model is the lag selection. This matters not only for OLS estimates of the autoregressive coefficients but also in impulse-

5 See also Hamilton (1994, p.557) for a discussion.

6 In the long run, the responses do not converge to the true values with a probability one (Phillips 1996).

7 Because, the VAR in level takes implicitly account of the cointegrated relationships (Sims *et al.,* 1990).

8 Ashley (2009) and Wiriyawit and Wongy (2015) argue that it is also not necessary.

response functions analysis. The number of lags in the VAR is chosen using the lag selection criteria. The majority of the criteria suggest the use of the lag length 1 for the VAR modelling (See, Table 3). Further, the Johansen's co-integration test also provides no evidence of long run relationships among the variables. Given that the variables are non-stationary and non-cointegrated, the use of a VAR model in first differences leads to loss of information contained in the relationships. Since the objective of VAR analysis in this study is to assess the contemporary relations, I concur that the VAR in level remains an appropriate measure to identify the effects of government investment on private investment and national income.

Table 2: Unit root tests using an augmented Dickey-Fuller test.

Variables	ADF	P-value	Intercept, trend, lag selection (N)	Variable type
LGDP	-1.03	0.93	(0,T, 0)	I(1)
dLGDP	-7.73	0.00	(0, T, 1)	I(0)
LPR	-2.47	0.34	(C,T, 0)	I(1)
dLPR	-8.21	0.00	(0, T, 1)	I(0)
LPU	-3.25	0.99	(0,0, 0)	I(1)
dLPU	-5.82	0.00	(0, C, 1)	I(0)
LINF	-2.01	0.58	(C, T, 1)	I(1)
dLINF	-5.80	0.00	(C,0, 1)	I(0)
LNINF	3.07	0.99	(0, 0, 0)	I(1)
dLNINF	-6.20	0.00	(C,0, 1)	I(0)
FDI	-2.88	0.18	(0, T, 0)	I(1)
dFDI	-6.21	0.001	(C, T, 1)	I(0)
X	3.27	0.99	(0, 0, 1)	I(1)
dX	-7.94	0.00	(0, T, 1)	I(0)

Note: C: the intercept; T: trend; N: optimum lag length determined by the Schwartz Information Criterion (SBC).

A six variable unrestricted VAR was estimated at lag order 1 with the variables at their level and the exogenous dummies. The study employed various diagnostic tests for the residuals' of the model viz., LM test, heteroscedastcity test and Jarque-Bera normality test to examine the validity and reliability of the VAR model. The results on the value of diagnostic tests (Table 4) indicate that the estimated model satisfies all diagnostic tests. The LM test examines for null hypothesis of no autocorrelation. The probability value of LM statistics directs not to reject the null hypothesis. Hence, there is no autocorrelation in the system of equations. Similarly, the null hypothesis of LM test and heteroscedasticity are accepted. The estimated VAR model satisfies the diagnostic tests, and hence it is valid and reliable.

Table 3: Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	106.9784	NA	4.56e-10	-4.485319	-3.440400	-4.116936
1	273.9788	243.7303*	4.15e-13*	-11.56642	-8.954124*	-10.64547*
2	315.0474	46.61833	4.18e-13	-11.84040*	-7.660719	-10.36687

Note: * indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

Table 4: Diagnostic tests

Test	H0	Test Statistics	Probability	Conclusion
	No auto correlation at lag 1	46.58	0.12	No aoto correlation
LM	No auto correlation at lag 2	38.76	0.35	"do"
Heteroscedasticity	No heteroscedasticity	781.12	0.256	No heteroscedasticity
Jarque-Bera	Normally distributed	4.5	0.12	Normally distributed

4.1 SVAR results

The order in the six variables VAR are: LNINF, LINF, LPR, LX, LFDI and LGDP. The coefficient of the SVAR model is estimated through the unrestricted VAR model by imposing the short-run restrictions to satisfy the identification conditions of the models. The coefficients of SVAR estimates for the model are presented in Table 5. The results provide the expected signs of the coefficients, which are statistically significant. The test value for the validity of the over identifying restriction is presented below the results. The null hypothesis of this test is that the over identifying restrictions are valid. In the case at hand, we cannot reject this null hypothesis at any of the conventional levels.

Table 5: Estimated coefficients matrix A

	Coefficients	Standard Error
α_{21}	0.36*	0.12
α_{31}	-0.35**	0.16
α_{41}	0.10	0.13
α_{51}	- 1.70	1.23
α_{61}	0.08**	0.09
α_{32}	0.10	0.21
α_{42}	-0.08	0.15
α_{52}	1.95	1.48
α_{62}	0.11**	0.05
α_{43}	0.31*	0.12
α_{53}	1.6	1.27
α_{63}	0.18*	0.04
α_{54}	1.84	1.55
α_{64}	0.07	0.05
LLV	243.9	
LR test of over identified	0.06 (0.80)	

Note: *, ** and *** represents 1 percent, 5 percent and 10 percent level of significant. The value in the parenthesis for LR test represents the probability.

The coefficients of LPR with respect to LNINF and LINF in Table 5 indicate the nature of the impact of public investment on private investment. The coefficient of non-infrastructure components of public investment (α_{31}) has a negative contemporaneous effect on private investment. The estimated coefficient is -0.36 and strongly statistically significant at 1 percent level. This suggest that the elasticity of per capita private investment due to the change in per capita non-infrastructure public investment is 0.36 percent. This means, a one percent increase (decrease) in the per capita non-infrastructure investment leads to decrease (increase) in per capita private investment by 0.36 percent. Thus, this result supports the crowding-out hypothesis of public investment. In contrast, the infrastructure component of public investment does not support the crowding-out hypothesis. The coefficient of elasticity of private investment with respect to LINF (α_{32}) is 0.10 but it is not statistically significant at the convenient level.

The estimated coefficients of LGDP with respect to LNINF (α_{61}), LINF (α_{61}) and LPR (α_{63}) provide the impact of the nature of investment on national income. The coefficients of LGDP with respect to LNINF and LINF are positive and statically significant at the convenient level. The estimated coefficient of LGDP due to change in LNINF is 0.08 and significant at 5 percent level. This indicates that the elasticity of per capita income due to change in non-infrastructure component of public investment is 0.08. The 1 percent increase (decrease) in the non-infrastructure component of public investment leads to increase (decrease) in per capita income by 0.08 percent. Further, the results provide that the estimated coefficient of elasticity of income due to the infrastructure component of public investment is 0.11. This suggests that the 1 percent increase (decrease) in the infrastructure component of public investment leads to increase (decrease) in income by 0.11 percent. The elasticity of income due to change in infrastructure investment is higher than that of the non-infrastructure component of public investment, which justifies the importance of infrastructure investment to the growth and development of Indian economy. Furthermore, the elasticity of income with respect to private investment is 0.18, which is statically significant at 1 percent level. Hence, one percent increase (decrease) in private investment leads to increase (decrease) in income by 0.18 percent. Hence, the significance of private investment for economic growth and development is more than that of public investment in infrastructure and non-infrastructure.

The results provide some additional information on the contemporaneous relationship between the two components of public investment, FDI and export. The statistically significant and positive coefficient α_{21} indicates that there is positive contemporaneous impact of non-infrastructure component of public investment on the public investment in infrastructure. This means that public sector enterprises are favoured by the government in various forms including the development of infrastructure for communication and transport purposes. As a result, non-infrastructure public investment has a crowd-in effect on public investment. Public enterprises get infrastructural support from the government as per their requirement and demand for their entrepreneurial operation and function.

Private investment seems to have a positive contemporaneous effect on export as revealed by the positive sign and statistically significant coefficient α_{43}. Hence, private investment contributes indirectly to the Indian economy by promoting export, in addition to its own direct effect as an input to the production function. In the medium or long-run, the role of infrastructure has been a significant factor for private entrepreneurs during the periods of liberalization in the Indian economy (Mallick, 2013b and Mallick, 2012). The development of infrastructure reduces the cost of production of enterprises and, hence, increases the rate of returns on investment. Hence, infrastructure can have two-way impact on the Indian economy by directly pushing economic growth and by promoting private entrepreneurs. The policy maker should lay emphasis on infrastructure investment by reducing investment in some components of non-infrastructure, which is relatively un-productive in nature.

In sum, private investment and both the component of public investment have statistically significant contemporaneous effect on national income in India, which contradicts to the findings of Mitra (2006). The study also confirms that the contribution of private investment to national income is larger than the public investment. This finding is also in line with the state level study of Mallick (2014a), which evidenced that public investment and private investment are statically significant for explaining income across the Indian states and that the former has larger effect than the latter. Private investment is said to have higher marginal productivity than that of the public investment in developing countries like India (Khan and Kumar, 1997; Khan and Reinhart, 1990). As a result, the contribution or the elasticity of private investment is higher than that of the public investment in Indian economy. Finally, the study shows that the non-infrastructure component of public investment is the cause of the crowding-out effect. Public investment has a crowding-out effect on private investment due to its non-infrastructure component. Public infrastructure investment has positive relation with the private investment, which is not significant. Hence, the crowding-out effect of public investment is mainly sourced from its non-infrastructure component. This finding matches with the aggregate analysis by Mitra (2006), Sundararajan and Thakur (1980), Pradhan *et al* (1990); Mallick (2014a). The study provides another important finding that public investment in infrastructure has larger contemporaneous effect than the non-infrastructure component. The results of the estimates of SIRF and FEVD analysis are depicted in the following sections to support the findings of this study.

4.2 The Impulse response function (IRF)

Since the purpose of the study is to analyze the contemporaneous relationship of type of public investment with private investment and income in the Indian economy, the IRF and variance decomposition analysis is focused on the contemporaneous effect of shocks among them. The crowding-out effect of the types of government investment on private investment and national income is estimated through the structural impulse-response functions based on the estimated SVAR coefficients. The system is perturbed by one standard deviation (S.D) shock (or innovation) on the target variable to examine its dynamic effects on the other variables. The impulse-responses at their corresponding 90 percent confidence intervals are calculated for a time horizon of 10 years and presented in Figure-1.

Figure 1: Structural impulse response of LPR and LGDP

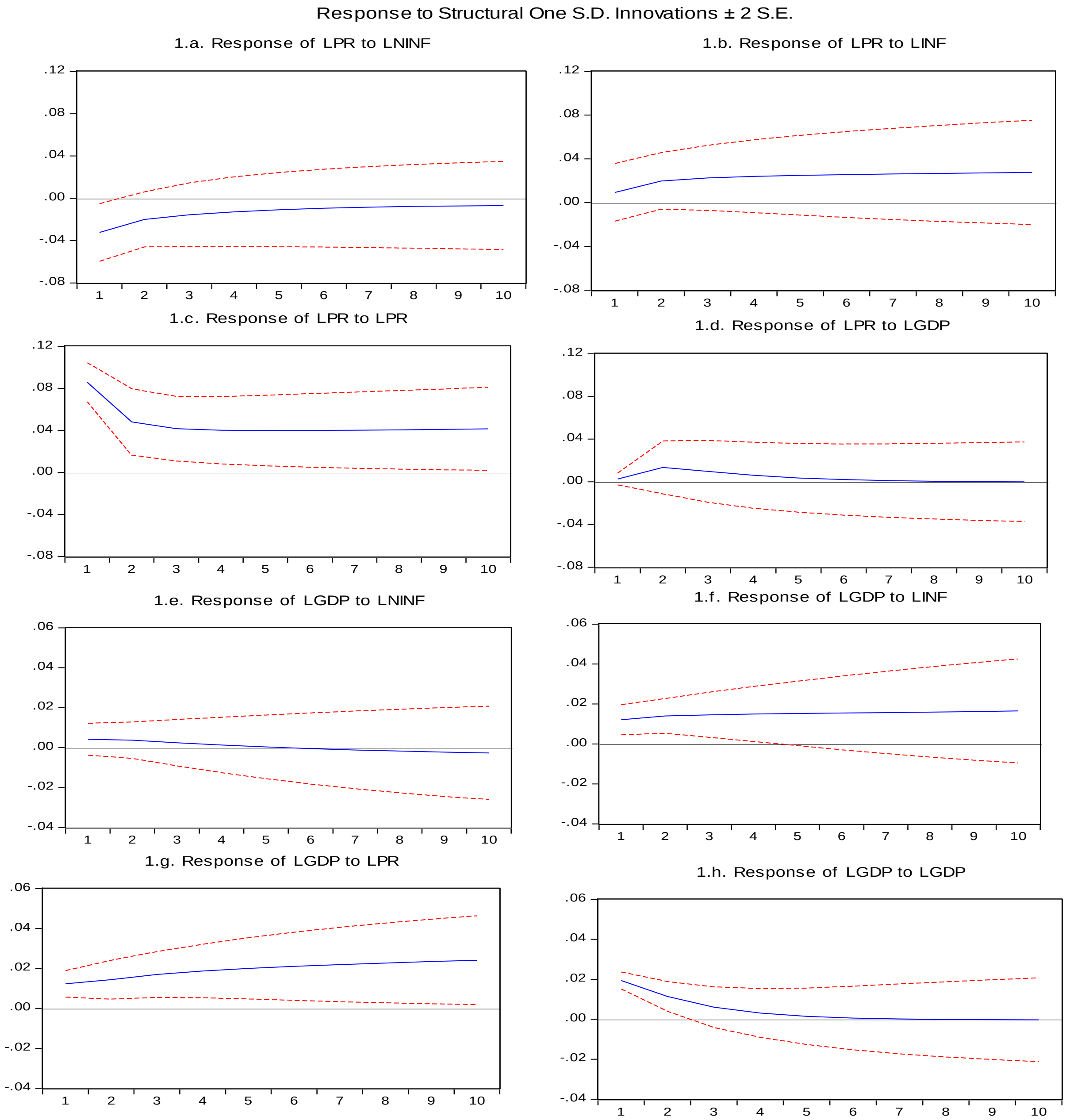


Figure-1.a shows how private investment reacted to a shock in LNINF. It is evident from the figure that one positive standard deviation shock to LNINF has a negative impact on private investment. The impulse response function lies below zero in the period of the structural shock to LNINF is applied as well as in the following periods. Gradually, the impulse response function of private investment rises just above zero after six years. The one s.d., shock causes a series of small decreases in the annualized private investment lasting for six years (then increases from that point). This result provides evidence that the response of private investment to public investment is negative in the short-run and medium-run. However, the accumulated negative impact of shock lasts beyond ten years (see, Table A3 in Appendices for accumulated SIRF). Thus, we may say that the adjustment process of public investment takes six years after the shock. Hence, crowding-out is supported by the initial depression of private investment following a one standard deviation structural shock to non-infrastructure part of government investment.

The impulse response function of LPR due to one positive standard deviation shock to LINF is presented in Figure 1b. This shows that the shock has a positive impact on private investment. The impulse response function lies above zero in the period the structural shock to LINF is applied as well as in the following periods. The one s.d., shock causes a small increase in the annualized private investment in the first year, and then increases. This result supports the statement that public investment in infrastructure does not affect private investment contemporaneously. However, it will have significant positive impact in the short to long-run.

The response of national income to shock in LNINF, LINF and LPR are reflected in Figures 1f, 1g and 1h. The figures show that these shocks affect national income positively in the short, medium and long-run. The one s.d., shock to LNINF and LINF would increase national income by 0.004 and 0.007 points, respectively in the period of the structural shock applied to them. Whereas, the one s.d. shock to LPR would increase national income by 0.012 points in the period of the structural shock. The impulse response functions due to shock in LNINF, LINF and LPR lie above zero in the period of the structural shock and in the following periods. The effect due to these shocks accumulates to 0.04, 0.10 and 0.13 points, respectively in a span of 10 years. Hence, we may conclude that private investment has a larger contemporaneous effect in the short to medium run effect compared to the LNINF and LINF public investment over the entire 10 years. This implies a faster adjustment of private investment compared to the adjustment of public investment. In addition, public investment in infrastructure has a larger effect than the public investment in non-infrastructure.

In sum, the IRF’s analysis confirms that the shock in non-infrastructure public investment affects private investment negatively in the short to medium run and it accumulates in the long run. Public investment in infrastructure has no immediate effect rather it has a positive effect in the short to medium run. This finding is in conformation with certain studies on developing countries including India (Serven, 1996). The shocks in LNINF, LINF and LPR have immediate positive impact on income, and persist from short to medium run. The shocks in LPR have larger effect on income than shocks in LNINF and LINF. Within both components of public investment, the infrastructure has larger effect on income than the non-infrastructure part.

4.3 Variance decompositions (VDC)

In this section, we use Forecast Error Variance Decomposition (FEVD) as an analytical tool to assess the relative importance of the types of public investment shocks in explaining fluctuations in private investment and national income. The impulse-response functions provide information on the size and speed of target variable due to shocks on the other variables in the system. They do not give information on the importance of shocks for the variance of target variable on the other variables. We have analyzed the variance decomposition that indicate how much of the forecast error variance of each variable can be explained by exogenous shocks (changes) to the variables in the SVAR model. Innovations/shocks to an individual variable affect the changes in the other variables and its own changes (Ewing *et al.*, 2007). The structural FEVD measures the fraction of the *s*-step ahead of forecast error variance of an endogenous variable that can be attributed to structural shocks itself or to another endogenous variable in the system.[9] The FEDV results are presented in Table 5 over forecast horizons of 10 years.

Table 6: Variance Decompositions analysis

Period	LNINF	LINF	LPR	LX	LFDI	LGDP
Variance Decomposition of LPR:						
1	10.55	0.77	88.63	0.003	0.05	0.05
2	10.66	4.07	78.65	1.85	3.70	1.05
3	9.756	6.97	71.09	4.13	6.20	1.86
4	8.63	9.09	66.06	6.26	7.63	2.32
5	7.63	10.58	62.49	8.260	8.49	2.56
6	6.85	11.58	59.70	10.17	9.00	2.69
7	6.29	12.22	57.39	12.02	9.31	2.77
8	5.88	12.60	55.39	13.83	9.47	2.82
9	5.59	12.79	53.62	15.60	9.55	2.85
10	5.38	12.83	52.03	17.31	9.56	2.88
Variance Decomposition of LGDP:						
1	5.30	12.46	26.46	2.95	0.003	52.83
2	9.62	17.83	22.67	2.76	6.43	40.69
3	11.91	20.11	20.64	6.07	9.26	32.01
4	13.08	20.55	20.14	10.22	10.13	25.88
5	13.51	20.07	20.38	14.34	10.23	21.47
6	13.45	19.18	20.94	18.15	10.05	18.24
7	13.07	18.15	21.60	21.57	9.78	15.82
8	12.52	17.11	22.28	24.61	9.51	13.98
9	11.87	16.13	22.94	27.28	9.25	12.54
10	11.19	15.22	23.55	29.61	9.02	11.40

The upper part of Table 6 describes the variance decomposition of private investment. This is evident that LPR itself explains 89 per cent of forecast error in its own value in the period of shock applied to it. LPR explains the largest proportion of forecast error throughout the 10-year periods. The other proportions of variation in LPR are largely contributed by LNINF in the period of structural shocks. However, the explanatory power of LGDP and LINF has increased in the long-run.

The lower part of the Table 6 presents the variance decomposition of national income. LGDP itself explains 53 per cent of forecast error in its own value in the first year. LPR and LINF are also significant in explaining the variation in national income in the initial years. The remaining variations are contributed due to LPR, LINF and LNINF. They contribute about 27 % (LPR), 13% (LINF) and 6% (LNINF) in the first year. However, the explanatory power of

[9] The forecast error variance is decomposed into components accounted for by shocks in the different endogenous variables, following Lütkepohl (2005).

LFDI and LX has increased in the medium and long-run. Most importantly, the explanatory power of LPR is considerably higher than that of LINF and LNINF in the years of structural shock.

In a nutshell, the most important sources of variability of private investment in the short-run are public investment in infrastructure and non-infrastructure. Further, national income is affected due to the shocks in private investment, non-infrastructure and infrastructure component of public investment in the short-run. The explanatory power of private investment is much larger than that of the both component of public investment in the variation in national income in the short-run.

5. Robustness analysis

In this section, the robustness of the results is checked by using alternatives of identification schemes, ordering variables and specifications.

Table 7: Estimation of coefficients matrix A, for alternative identification

	$\alpha_{61}=\alpha_{62}= 0$	$\alpha_{61}=\alpha_{62}= 0.3$	$\alpha_{61}=\alpha_{62}= 0.6$
α_{21}	0.31 (0.11)*	0.33 (0.12)**	-0.37 (0.12)*
α_{31}	- 0.37 (0.16)**	- 0.36 (0.16)**	0.35 (0.16)**
α_{41}	0.10 (0.13)	0.10 (0.13)	-0.10 (0.13)
α_{51}	- 1.70 (1.2)	- 1.70 (1.23)	1.70 (1.23)
α_{61}	0.07 (0.04)***	0.07 (0.04)**	-0.08 (0.04)**
α_{32}	- 0.03 (0.20)	0.04 (0.20)	-0.11 (0.21)
α_{42}	- 0.04 (0.15)	- 0.06 (0.15)	0.08 (0.15)
α_{52}	1.95 (1.48)	1.95 (1.48)	-1.95 (1.48)
α_{62}	0.07 (0.05)***	0.09 (0.05)**	-0.12 (0.05)**
α_{43}	0.31 (0.12)*	0.311 (0.12)*	-0.31 (0.12)*
α_{53}	1.62 (1.27)	1.62 (1.27)	-1.62 (1.27)
α_{63}	0.18 (0.04)*	0.18 (0.04)*	-0.19 (0.04)*
α_{54}	1.84 (1.55)	1.84 (1.55)	-1.84 (1.55)
α_{64}	0.07 (0.05)	0.07 (0.05)	0.07 (0.05)
α_{65}	0.001 (0.005)	-	-
LLV	243.93	243.90	243.9
LR test	-	0.064	0.06

Note: the figures in parenthesis indicate the standard error of estimates (SEE). *, ** and *** represents 1 percent, 5 percent and 10 percent level of significant.

5.1 The alternative identification scheme and ordering of variables

Short-run SVAR may be sensitive to the identification schemes and ordering of variables. I re-estimated the model by considering three alternative identification schemes. First is the Cholesky identification, which decomposes the matrix of covariance of the residuals by imposing a lower triangular structure to Matrix A. Following Bruckner *et al* (2012) the elasticity of public expenditure due to income ranges from 0.3 to 0.6. Hence, the other two models are estimated by using these elasticities to judge the sensitivity of the results. Further, since this identification including Cholesky's decomposition is sensitive to the ordering of variables, I consider different ordering of the variables. Particularly, I altered the ordering of export and private investment in order to understand the effect of shocks in export to the domestic private investment in India. This confirms that three is a positive relationship between export and domestic private investment in the Indian economy.[10] Briefly, the broad conclusions of the relation between public investment and private investment and their relative impact on income are unchanged (See, Table 7).

Table 8: Estimation of coefficients matrix A for five variables SVAR

	α_{51}= 0	α_{51}= 0.54
α_{21}	- 0.49 (0.18)*	- 0.32 (0.18)***
α_{31}	0.10 (0.15)	0.06 (0.15)
α_{41}	- 0.68 (1.51)	-0.68 (1.51)
α_{51}	0.13 (0.04)*	0.18 (0.05)*
α_{32}	0.29 (0.12)**	0.27 (0.12)**
α_{42}	2.09 (1.31)	2.09 (1.31)
α_{52}	0.18 (0.04)*	0.21(0.04)*
α_{43}	1.40 (1.60)	1.40 (1.60)
α_{53}	0.07 (0.05)	0.07 (0.05)
α_{54}	0.00 (0.00)	-
LLV	203.56	203.56
LR test	-	0.009

Note: the figures in parenthesis indicate the standard error of estimates (SEE). *, ** and *** represents 1 percent, 5 percent and 10 percent level of significant.

5.2 The alternative specifications

To investigate further the sensitivity of the results to the chosen variables, I considered five variables SVAR model by using the aggregate of government investment in the specification. This specification provides scope to compare the results with existing studies on the impact of aggregate of government investment like Mitra (2006). The results in Table 8 confirm the crowding out effect of public investment on private investment by using the approaches of Cholesky's decomposition and restricted contemporaneous matrix. Both private investment and public investment contemporaneously affect national per capita income positively, which is statically significant. This result contradicts the result of Mitra (2006) because it adopts better methodological strategy by using more appropriate restrictions and taking into account the effect of FDI and export, which are the two crucial factors of economic growth and development. The elasticity of private investment is higher than that of public investment, which is expected in the case of developing countries like India.

[10] Also FDI and export variables are introduced into the model in terms of percentage of GDP. Our result remains unchanged. Results are not reported but are available on request.

6. Why Crowding-out effect of Public Investment on Private Investment?

In the post-independence period, India was adopting an import substitution industrialisation (ISI) strategy, which is called by Ragnar Nurkse as an "inward looking growth" strategy involving import substitution and export pessimism. The objective was to be self-reliance and transform an agrarian economy to an industrial one and building domestic capability in crucial sectors, through a state/public sector-led, centrally planned growth strategy of rapid industrialization including capital-intensive industries. India adopted a process of planning that determined the quantity, location and forms of investment. In addition to investing in the traditional areas such as infrastructure development activities viz., transport, telecommunications and electricity, a significant portion of government investment is channelised to industrial and commercial activities such as manufacturing and banking, which are usually undertaken by the private sector (Table 9). Therefore, government is also competing with the private sector in commercial and industrial activities. However, the public sector enterprise may enjoy favouritism from the government in various forms, which is evident from the crowding-in relationship between the public investment in infrastructure and non-infrastructure.

Table 9: Share of Government investment in total investment (in %).

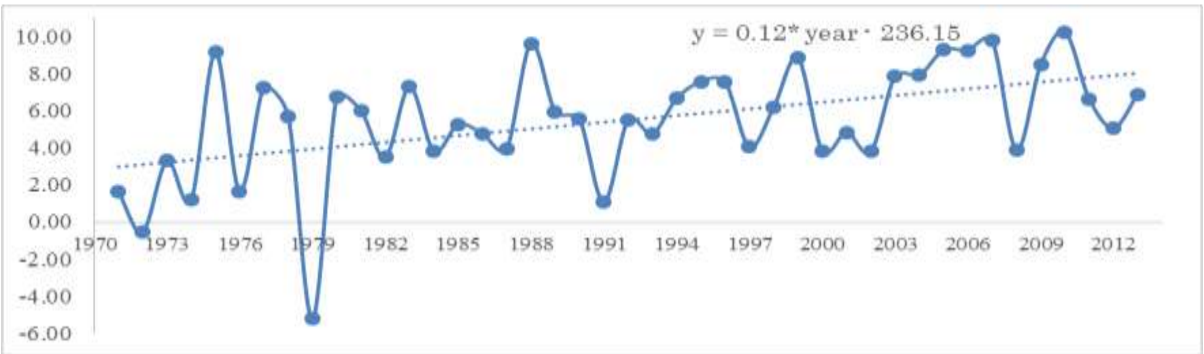
Economic activities	1970	1980	1990	2000	2010
Agriculture, forestry & fishing	33.33	50.20	20.42	15.62	15.46
Agriculture	32.65	49.48	18.99	15.19	16.16
Forestry & logging	98.31	99.01	98.08	95.64	92.76
Fishing	0.00	1.33	0.65	-0.04	0.03
Mining & quarrying	77.31	93.96	97.63	78.01	41.07
Manufacturing	21.69	24.12	20.54	7.91	7.86
Elect. gas & water supply	99.59	96.77	96.85	88.07	74.75
Construction	8.65	21.98	10.47	5.16	13.03
Trade,hotels & restaurants	6.76	3.31	1.69	0.95	0.15
Transport , storage & comm.	85.68	76.24	77.65	61.16	27.84
Railways	100.00	100.00	100.00	100.00	100.00
Transport by other means	58.72	49.04	42.93	18.43	17.00
Storage	94.40	89.93	76.76	81.84	10.22
Communication	100.00	100.00	100.00	87.64	11.04
Financing, insurance, real estate and business services	4.57	7.86	6.30	5.34	5.23
Banking & insurance	53.57	69.26	79.86	63.08	48.78
Real estate, ownership of dwellings and business services	3.41	5.27	3.15	1.57	2.45
Community, social & personal service	91.14	94.05	87.73	76.70	66.04
Public admn.& defence	100.00	100.00	100.00	100.00	100.00
Other services	50.18	57.09	39.86	26.14	19.40
Total :	43.68	53.34	44.16	29.54	24.38

Sources: National accounts statistics, CSO

In contrast, the private firms might be obstructed by administrative roadblocks and procedures as well as restricted approval and forbidding private enterprise to enter some important activities. The private enterprises also faced many obstacles including a complex regulatory system, licensing of firms' entry, expansion and relocation policy, barriers to foreign trade and mandatory credit allocation schemes imposed on the banking system. As a result, the private enterprise activities are crowded-out by public enterprises. On the other hand, public investment in activities that traditionally reserved to the public enterprises can raise the productivity of private firms and thus have a crowding-in effect.

The ineffectiveness of this policy regime forced policy makers to alter the growth strategy by giving scope to the private sector and gradual deregulation of domestic controls in the mid-1980s. This reduces the domestic barriers to entry and expansion of business activities and specifically provides a larger scope to big business groups to participate in the process of industrialisation through promotional policies and incentives. The liberalisation of trade policy was initiated for imports of capital by emphasising on up-gradation of technology in industries. Consequently, higher growth was achieved in the mid-1980s (see, Figures 3 and 4).

Figure 2: Annual Growth of GDP (at constant prices 2011-12)[11]



Source: World Bank

However, the economic crisis in 1990 accompanied by high fiscal deficit and current account deficit, the balance of payment deficit with the foreign currency reserves amounted to only US$1 billion and high inflation forced policy makers to take stabilisation measures and structural reforms in July 1991. The aim of major economic reforms was to accelerate the pace of economic growth through a systemic shift to a more open economy with greater reliance upon market forces, a larger role for the private sector including foreign investment and a restructuring of the role of the government. This reduced the extent of public sector involvement in commercial and industrial activities but its involvement remained an important part of the economy (see, Table 9). As a consequence of the new growth strategy the economy has grown by impressively in terms of annual GDP growth and annual per capita GDP growth from the mid-1980s (as shown in Figures 2 and 3).

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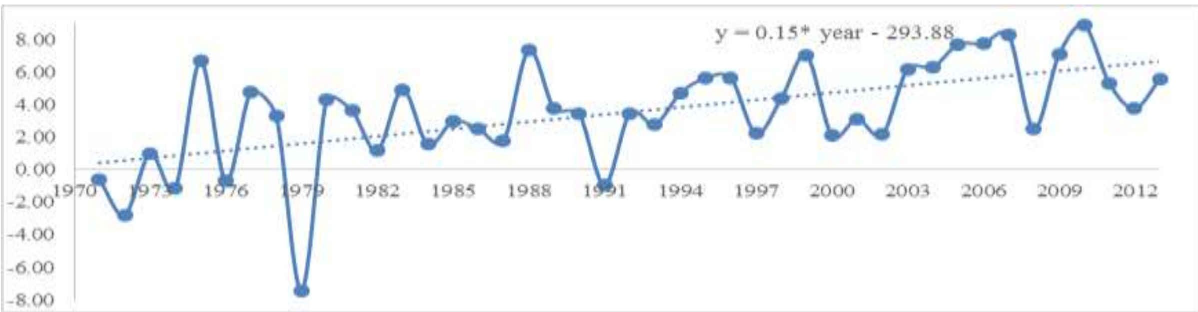
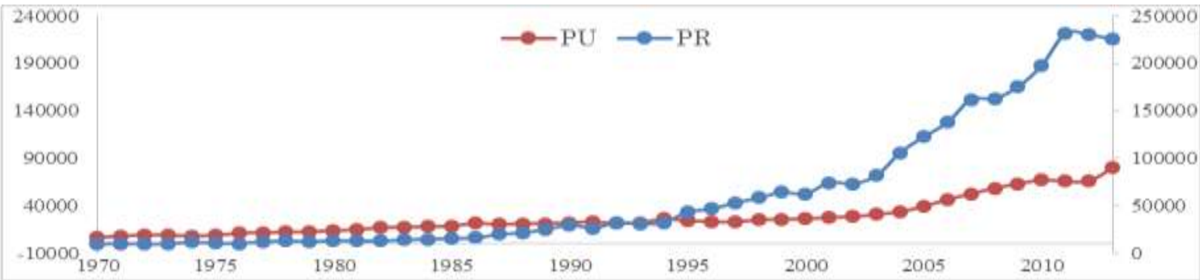
11 In 1972 and 1979 is due to severe drought year (Jha, 2004). For instance, in 1979-80 the rainfall was 20% below the normal level.

Figure 3: Annual Growth of per capita GDP (at constant prices 2011-12)



Source: World Bank

Figure 4: Annual Government and Private Investment (in Billion Rs.)



Source: World Bank

Figure 5: Annual ratio of infrastructure component in total public investment

Sources: National accounts statistics, CSO

However, the public sector led-growth came at the cost of a large budget deficit financed by domestic borrowing. India's budget deficit increased by about 10 percent of GDP in the mid-1980s and from then reduced to about 5 percent thereafter. The increase in public investment along with other spending leads to increase in the fiscal deficit, which is largely financed by domestic borrowings[12]. This reduces the availability of funds and affects private sector investment negatively. Hence, as shown in Figure 4, when public investment increased until mid-1980s, the growth of private investment was stagnant due lower availability of loanable funds to them. The initiation of economic reforms in mid-1980s and the major economic reforms in 1991 (including promotional policies of private investment) benefitted private

[12] IMF data shows these borrowings are mainly from the private sector.

investment significantly relative to the government.

This is also the matter of worry for the policy maker of the Indian government that the government investment in non-infrastructure is continued to dominate its infrastructure component during this period of the study (See, Figure 5). The share of infrastructure in total government investment was about 40 percent in 1970-71, which decreased to 30 percent in 1985-86 and again cumulated to 43 percent in 2000-01. This share has come down to 27 percent in the recent years. Hence, the policy priority should be on increasing investment in physical infrastructure. Adequate infrastructure facilities at reasonable cost are absolutely necessary to achieve and sustain rapid economic growth by encouraging domestic private investment and FDI. However, there is a large gap between the demand for and supply of infrastructure [13]. The Government has embarked on various strategies to upgrade infrastructure services including public private partnership (PPP) but certain factors ranging from corruption to bureaucratic barriers stand in the way of country's growth. Foreign and domestic investors continue to complain about the problems with the current structure of PPP (Singh, 2013). The injection of private capital in key infrastructure sub-sectors has been slower than anticipated and public investment in infrastructure declined significantly from 93 percent in 1970 to 43 percent in the recent years (see, Appendix Figure A1). Consequently, the share of infrastructure in the total investment remained stagnant at about 20 percent (see, Appendix Figure A1). These basic infrastructure services have emerged as major impediments to the growth of private investment and sustainability of high economic growth.

7. Conclusion and policy implication

In this research paper, I have provided empirical evidence on the crowding-out effect of public investment on private investment and the causes. A few studies make the distinction between government investments in infrastructure vs. non-infrastructure, while examining the short-run crowding-out issue in the Indian economy. So, I divided government investment into exclusively in infrastructure and non-infrastructure in India from 1970-71 to 2013-14. I then, examined the relationship between types of government investment with private investment and national income by taking into account the role of FDI and export through a SVAR analysis. The study contributes to the existing literature by assessing the impact of government investment shock by its types on private investment and income in India. This study also contributes by analysing the role of FDI and export on the contemporaneous relationship of government investment with private investment and income.

The coefficients of SVAR estimations show that the government investment shock has a crowding-out effect on private investment, which is mainly due to the non-infrastructure component of government investment. The shock in infrastructure part of government investment has no significant contemporaneous effect on private investment. Though, both the components of public investment have a positive effect on income, the elasticity of infrastructure component of public investment is larger than the non-infrastructure

[13] World Economic Forum (January, 2015) "Infrastructure Investment Policy Blueprint: Country Performance Assessment" at http://www3.weforum.org/docs/WEF_Infrastructure_Investment_Policy_Blueprint.pdf

component in both the short-run and medium-run, as revealed from IRFs. Further, public investment in infrastructure has larger effect in the medium run than the short run. The findings are in conformation with the certain recent studies by Leduc and Wilson (2012), Portes (2013) and Pereira and Pereira (2015)[14]. Further, none of the components of government investment have significant contemporaneous relationship with FDI and export.

I find that the contemporaneous effect of private investment on income is significant. Most importantly, the shocks in private investment are larger than the shocks in both the components of government investment. This findings conform to Mallick (2014a), Khan and Kumar (1997) and Khan and Reinhart (1990). The marginal productivity of private investment is considered as higher than the public investment in developing countries like India and it makes the contributions of the former higher than that of the latter to economic growth and development. Further, the study finds that private investment has a significant positive effect on export. However, the shocks in export have no significant effect on FDI and income. The recent growth of the Indian economy is generally driven by the domestic consumption unlike China. Hence, government has to take major initiatives to boost export. The impulse response function and FEVD analysis also confirm the above findings.

In sum, the positive shocks in government investment in non-infrastructure result in a crowding-out effect and shocks in the infrastructure component provide a neutral effect on private investment in the years of structural shocks. Further, a shock in government investment in infrastructure has a larger positive effect than the other component of government investment on income. The crowding-out effect of the former is due to the competition for investment of the public sector with the private sector. The best course for the government here would be to venture into areas where the private sector has not entered and have implications for future economic growth. This study suggests that for future growth, the Indian Government should reduce investment in sectors that compete directly with the private sector.

Further, the crowding-out effect also arises due to shortage of credit to the private sector. The increase in public investment leads to increase in the fiscal deficit, which is largely financed by domestic borrowings in the Indian economy. This reduces the availability of funds, which affects negatively to the private sector investment. Furthermore, the lower elasticity of the non-infrastructure component suggests that public investment is occurring in the unproductive sectors. This is also a matter of worry for Indian policy makers. Government investment in non-infrastructure continued to dominate its infrastructure component during the period of this study. Private investment is vital to achieve higher growth in market-led economies and public investment should play a complementary role. Hence, the Indian government should design policies to attract more investment expenditure in infrastructure and other productive activities related to the development of human capital.

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[14] Leduc and Wilson (2012) for USA, Fic and Portes (2013) for UK and Pereira and Pereira (2015) for Portugal empirically established that the infrastructure shock boost economic growth in both the short-and long-run, where effect of later is larger than the former. However, Pereira and Pereira (2015) show that effects vary across the types of infrastructure investment.

Appendices

Table A.1: Selected studies about the effects of public investment on private investment in India

Study	Period and country	Method	Results
Mallick (2013a)	1993-2004 (State level in India)	Panel data	Negative
Furceri and Sousa (2011)	1960-2007 (145 countries)	Panel data model	‘do'
Mitra (2006)	1969-2005 (India)	SVAR	‘do'
Chakraborty (2007)	1970-71 to 2002-03 (India)	VECM	There is no real crowding-out effect of public investment on private investment; rather they complement each other.
Atukeren (2006)	1970-2000 (25 developing countries including India)	Cointegration test, Granger causality test, probit analysis	Public investment may crowd-out private investments. 10 out of 11 cases of crowding-out and 13 out of 14 cases of no crowding-out were observed.
Ahmed and Miller (1999)	1975-1984 (39 developed and developing countries)	Lagrange-multiplier test, random-effect model, and OLS model	Spending on transport and communication crowds-in private investment in developing countries, whereas spending on social security and welfare crowds-out investment in both developed and developing countries.
Servén (1996)	1960-1995 (India)	Cointegration test, VAR analysis, error correction model	The non-infrastructure public capital crowds-out the private capital in both the long-run and short-run. The infrastructure component of public capital crowds-in private capital after two years.
Parker (1995)	1974-1994 (India)	Accelerator model	Public investment crowds-out private investment whereas public infrastructure crowds-in private investment
Easterly and Rebelo (1993)	1970-1988 (Developed and developing countries)	Cross section analysis	Positive effect of public expenditure.
Pradhan *et. al.*, (1990)	1960-1990 (India)	Computable general equilibrium (CGE) model	Public investment crowds-out private investment. However, the extent of crowding-out varies with the different modes of financing the public investment (Mixed impact)
Blejer and Khan (1984)	1971–1979 (24 developing countries)	Flexible accelerator Model	It is not the level, but the change in public investment that crowds
Krishnamurty (1984)	1975–1990 India	Sectoral model	Though public investment crowds out private investment in some sectors and for some years, the immediate and ultimate impact favours growth of output. Infrastructure investment crowds in private investment in almost all sectors.
Greene and Villanueva (1990)	1975–1987 23 developing countries	Neoclassical model	Gross public capital formation crowds in private investment.
Sundararajan and Thakur (1980)	1960–1978 India and Korea	Neoclassical (Jorgenson)	Evidence of crowding out in India.
Sankar (1997)	1960–1994 India	Accelerator model	Infrastructure investment crowds in private corporate investment.
Tun Wai and Wong (1982)	1965–1975 five countries of same development pattern	Flexible accelerator model	Public investment crowds out private investment. Quantity of credit is also a significant factor.

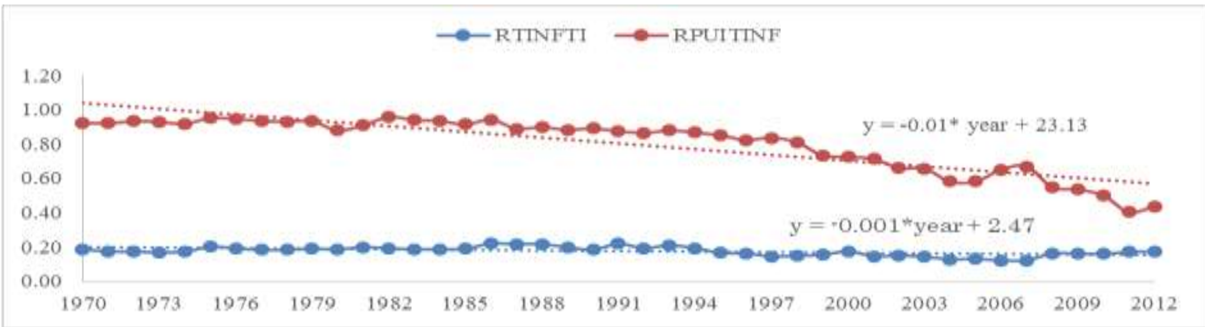
Table A. 2: Data availability in NAS

Data	Time period		Sources
	Aggregated	Dis-aggregated	
GDP at constant prices 2004-05 (Economy)	1970-71 to 2013-14		NAS (2011 & 2015)
GFCF at current prices by institution (i.e., public sector, private corporate sector and household sector) at current prices	1970-71 to 1979-80		NAS (2011)
GFCF at constant prices by industry of use at 2004-05 (Economy)		1970-71 to 2013-14	NAS (2011 & 2015)
GCF by industry of use at constant prices with base year 2004-05 (public sector)		1970-71 to 1979-80	NAS (2011)
GFCF by industry of use at constant prices with base year 2004-05 (public sector)		1980-81 to 2013-14	NAS (2011 & 2015)

Table A3: Accumulated SIRFs of private investment and national income

Shock in	LNINF	LINF	LPR	LNINF	LINF	LPR
Period	Accumulated Response of LPR:			Accumulated Response of LGDP		
1	-0.029587	0.008002	0.085765	0.004512	0.008456	0.012320
	(0.01420)	(0.01380)	(0.00972)	(0.00378)	(0.00363)	(0.00323)
2	-0.050702	0.029000	0.134673	0.014408	0.019925	0.022635
	(0.02618)	(0.02479)	(0.02248)	(0.00781)	(0.00719)	(0.00706)
3	-0.064741	0.053087	0.170969	0.024309	0.032062	0.032711
	(0.04165)	(0.03860)	(0.04002)	(0.01330)	(0.01198)	(0.01280)
4	-0.072536	0.077141	0.202952	0.034511	0.043865	0.043673
	(0.05986)	(0.05489)	(0.05911)	(0.02028)	(0.01813)	(0.01998)
5	-0.075316	0.100275	0.233035	0.044611	0.055040	0.055685
	(0.08003)	(0.07310)	(0.07903)	(0.02862)	(0.02558)	(0.02834)
6	-0.074296	0.122260	0.262008	0.054346	0.065557	0.068630
	(0.10157)	(0.09278)	(0.09938)	(0.03819)	(0.03424)	(0.03768)
7	-0.070494	0.143077	0.290263	0.063566	0.075489	0.082372
	(0.12405)	(0.11359)	(0.11994)	(0.04885)	(0.04400)	(0.04784)
8	-0.064717	0.162792	0.318084	0.072206	0.084936	0.096808
	(0.14722)	(0.13528)	(0.14059)	(0.06047)	(0.05475)	(0.05870)
9	-0.057578	0.181515	0.345704	0.080258	0.094011	0.111869
	(0.17093)	(0.15771)	(0.16132)	(0.07294)	(0.06641)	(0.07016)
10	-0.049541	0.199377	0.373314	0.087752	0.102818	0.127503
	(0.19509)	(0.18079)	(0.18214)	(0.08619)	(0.07889)	(0.08215)

Figure A 1; Trends of total and public investment in infrastructure



Note; *RTINFTI refers to the ratio of infrastructure investment to total GFCF and RPUITINF stands for the ratio of public investment in infrastructure to total investment in infrastructure.*
Sources: National accounts statistics, CSO

References

Afonso, A., and M. St Aubyn. 2008. Macroeconomic Rates of Return of Public and Private Investment: Crowding-in and Crowding-out Effects. Working paper, University of Lisbon.

Ahmed, H. and Miller, S.M. "Crowding-Out and Crowding-In Effects of the Components of Government Expenditure ." Contemporary Economic Policy, 2000, 18(1), 124-133

Akitoby, B., B. Clements, S. Gupta and G. Inchauste (2006), "Public Spending, Voracity, and Wagner's Law in Developing Countries," *European Journal of Political Economy* 22(4), 908–924.

Allegret, J. P., Couharde, C., & Guillaumin, C. (2012). The impact of external shocks in East Asia: Lessons from a structural VAR model with block exogeneity. International Economics, 132, 35–89.

Ardagna, S., C., Frank and L., Timothy. (2004) "Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries." National Bureau of Economic Research, NBER Working Paper: No. 10788.

Argimon, I., G. P., Jose M. and R., Jose M. (1995) "Does Public Investment Crowd-Out Private Investment? Evidence from a Panel of 14 OECD Countries." Bank of Spain, Working Paper: No. 9523.

Aschauer, D. A. (1989a), "Does Public Capital Crowd Out Private Capital?" Journal of Monetary Economics 24 (2): 171–188.

Aschauer, D. A. (1989b), " Is public expenditure productive? " Journal of Monetary Economics, 23, 177-200.

Ashley. R. A. (2009), To difference or not to difference: a Montecarlo investigation of inference in vector autoregression models, Int. J. Data Analysis Techniqus and Strategies, 1(3), 242-274.

Atukeren, E. (2006), Politico-Economic Determinants of the Crowding-in Effects of Public Investments in Developing Countries. Working paper, Swiss Institute for Business Cycle Research.

Baily, M. (1971), National Income and Price Level. New York: McGraw-Hill.

Barro, R. J. (1991), "Economic Growth in a Cross Section of Countries," Quarterly Journal of Economics, CVI (1991), 407-43.

Barro, R. J. (1990) "Government Spending in a Simple Model of Endogenous Growth." Journal of Political Economy 98 (5): S103–S125.

Barro, R. J. (1981), “Output Effects of Government Purchases.” Journal of Political Economy 89 (6): 1086–1121.

Bernanke, B. S. (1986) "Alternative Explanations of the Money-Income Correlation," in K. Brunner and A. Meltzer, eds., Real Business Cycles, Real Exchange Rates, and Actual Policies, Carnegie-Rochester Series on Public Policy No. 25, Amsterdam: NorthHolland, 1986, pp. 49-99.

Blanchard, O.J. and D. Quah (1989), The Dynamic Effects of Aggregate Demand and Supply Disturbances, *American Economic Review*, 79(4), pp. 655-673.

Blanchard, O. and R. Perotti (2002) An Empirical Characterisation of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics* 117:4, 1329–1368.

Blanchard, O. J.. and M. W. Watson. “Are Business Cycles All Alike?” in Robert J. Gordon, ed., The American Business Cyc/e (University of Chicago Press, 1986).

Blejer, M. I., and M.S. Khan, (1984). “Government policy and private investment in developing countries”, IMF Staff Papers, 31(2): 379-403.

Bruckner, M., A. Chong, and M. Gradstein (2012). "Estimating the Permanent Income Elasticity of Government Spending: Evidence on Wagner's Law Based on Oil Price Shocks." Journal of Public Economics 96: 1025-1034.

Buchanan, J., Wagner, R., 1978. Fiscal responsibility in constitutional democracy. Studies in Public Choice 1, 79–97.

Caballero, R. J. (1999), “Aggregate Investment.” Handbook of Macroeconomics, Chapter 12, Volume 1. Edited by. J. B. Taylor and M. Woodford. Elsevier Science B.V.

Canning, D. and P. Pedroni (2008), Infrastructure, Long-run Economic Growth and Causality Tests for Cointegrated Panels, Manchester School, vol. 76(5).

Chakraborty, L.S. (2007). “Fiscal deficit, capital formation, and crowding out in India: Evidence from an Asymmetric VAR”, The Levy Economics Institute and National Institute of Public Finance & Policy, Working Paper no. 518.

Chakraborty, L.S. (2012). Interest Rate Determination in India: Empirical Evidence on Fiscal Deficit-- Interest Rate Linkages and Financial Crowding Out," Economics Working Paper Archive wp_744, The Levy Economics Institute, New York.

Cho, D (2012), Aggregate demand gap based on a simple structural VAR model, Economic Letters, 114, 228–234.

Cologni A., and Manera M. (2006). Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries. Energy Economics. doi:

10.1016/j.eneco.2006.11.001.

Chrinko, R. S. (1993), "Business Fixed Investment Spending: Modelling Strategies, Empirical Results, and Policy Implications." *Journal of Economic Literature*, Vol. 31, No. 4, pp.1875–1911.

Demetriades, P.O. and T., P. Mamuneas, (2000) Intertemporal Output and Employment Effects of Public Infrastructure Capital: Evidence from 12 OECD Economies, Economic Journal, 110(465).

Devarajan, S., V. Swaroop and H. Zou (1996), "The Composition of Public Expenditure and Economic Growth," Journal of Monetary Economics, 37, pp. 313B344.

Dungey, M. and A. Pagan (2000), A Structural VAR Model of the Australian Economy, *The Economic Record*, 76, pp. 321-43.

Eduardo, C., and C., Daude. (2011), "Public Investment in Developing Countries: A Blessing or a Curse?" Journal of Comparative Economics 39 (1): 65–81.

Egert B. and T. Kozluk, and D. Sutherland, (2009), Infrastructure and growth: empirical evidence, OECD Economics Department Working Paper No. 685.

Easterly, W., and S. Rebelo. (1993) "Fiscal policy and economic growth: An empirical investigation." Journal of Monetary Economics, 32, pp.417-458.

Evans, P. (1985), "Do Large Deficits Produce High Interest Rates?" American Economic Review, 75(1), pp.68-87.

Everhart. S. S., M. A. Sumlinski. (2001),"Trends in private investment in developing countries, statistics for 1970-2000 and the impact on private investment of corruption and the quality of public investment." *International Finance Corporation*, Discussion paper No. 44, The World Bank, Washington D. C.

Fic, T. and J. Portes (2013), Macroeconomic Impacts of Infrastructure spending, National Institute of Economic Research, UK.

Fisher, W. H., and S. J. Turnovsky (1998), "Public Investment, Congestion, and Private Capital Accumulation." The Economic Journal 108 (447): 399–413.

Greene, J. and D. Villanueva (1990), "Private Investment in Developing Countries: An Empirical Analysis." IMF Staff Papers 38 (1): 33–58.

Gospodinov, N., Herrera, A.M., Pesavento, E., 2013. Unit roots, cointegration and pre-testing in VAR models. Mimeo, Concordia University.

Guay, A. and F. Pelgrin, (2007), SVAR Models and the Short-Run Resilience Effect, mimeo.

Hamilton, J.D., 1994. Time Series Analysis, Princeton University Press.

Hercowitz, Z., M. Strawczynski (2004). Cyclical ratcheting in government spending: evidence from the OECD. The Review of Economics and Statistics 86, 353–361.

Hicks, J. R. (1937), "Mr. Keynes and the 'Classics'; A Suggested Interpretation." Econometrica 5: 147–159.

Holtemoller, O. (2002), Structural vector autoregressive models and monetary policy analysis. ¨ Working Paper 2002-7, SFB 373, Humboldt-Universitat zu Berlin.

Jha, R. (2004), "Reducing poverty and inequality in India: has liberalization helped", in Giovanni Andrea Cornia (ed.) Inequality, growth and poverty in an era of liberalization, Oxford, U.K. and New York: Oxford University Press. Also available at https://crawford.anu.edu.au/acde/publications/publish/papers/wp2002/wp-econ-2002-04.pdf

Jha, S, S. Mallick, D. Park, and P. Quising, (2010), 'Effectiveness of Countercyclical Fiscal Policy: Time-Series Evidence from Developing Asia', ADB Economics Working Paper Series, 211.

Jain, Rajeev and Prabhat Kumar (2013) Size of Government Expenditure Multipliers in India: A Structural VAR Analysis" RBI Working Paper Series, Reserve Bank of India, 18th September.

Keating, J. (1992), "Structural Approaches to Vector Autoregressions," Federal Reserve Bank of St. Louis Review, 37-57.

Khan, M. S. and M. S. Kumar (1997) *Public and Private Investment and the Growth Process in Developing Countries*, Oxford Bulletin of Economics and Statistics, 59(1): 69-88.

Khan, M.S., C. M. Reinhart (1990), "Private Investment and Economic Growth in Developing Countries." *World Development*, Vol. 18, No. 1, pp. 19-27.

Knot, K., and J. de Haan. (1999), "Deficit Announcements and Interest Rates." Journal of Policy Modeling 21 (5): 559–577.

Knot, K., and J. de Haan. (1995), "Fiscal Policy and Interest Rates in the European Community." European Journal of Political Economy 11 (1): 171–187.

Krishnamurty, K. (1984) "Inflation and Growth: A Model for India." India Economic Review, 19(1), 6-111.

Kulkarni, K. G. and E., E. L. (1995) "Is Crowding Out Hypothesis Evident in LDCS? A Case of India." Indian Economic Journal, 43, 116-126.

Leamer, E.E. (1985). "Vector auto regressions for causal inference?". Carnegie–Rochester Conference Series on Public Policy 22, 255–303 (Spring).

Lane, P (2003) The Cyclical Behaviour of Fiscal Policy: Evidence from the OECD, Journal of Public Economics, 87, 2661-2675.

Leduc, S., and D. J. Wilson (2012). "Roads to Prosperity or Bridges to Nowhere? The ory and Evidence on the Impact of Public Infrastructure Investment." National Bureau of Economic Research (NBER) Working paper 18042.

Lutkepohl, H. (2005). New introduction to multiple time series analysis. Springer-Verlag.

Mallick, J. (2014a), "Regional Convergence of Economic Growth during Post-Reform Period in India", The Singapore Economic Review**,** 59 (2): 1450012-1-1450012-18.

Mallick, J. (2013.a), "Public expenditure, private Investment and states income in India," *Journal of Developing Areas*, Vol. 47(1), 181-205.

Mallick, J. (2013b), Private Investment in India: regional patterns and determinants, The Annals of Regional Science**,** 51 (2): 515-536.

Mallick, J. (2012). 'Private investment in ICT sector of Indian states' India Economic Review, 47(1), 33-56.

Mallick, S. K., (2014b) "Disentangling the Poverty Effects of Sectoral Output, Prices, and Policies in India," Review of Income and Wealth 60 :773–801.

Mishra, A., and Mishra, V. (2010). A VAR model of monetary policy and hypothetical case of inflation targeting in India. Discussion Paper No 15/10. Department of Economics: Monash University. ISSN 1441-5429.

Mitra. P. (2006), "Has Government Investment Crowded out Private Investment in India?" The American Economic Review. 96 (2): 337–341.

Moore, T., Pentecost, E. J., 2006. An investigation into the sources of fluctuation in real and nominal wage rates in eight EU countries: A structural VAR approach. Journal of Comparative Economics 34, 357-276.

Narayan, P, S. Narayan and A. Prasad (2008) "A Structural VAR Analysis of Electricity Consumption and Real GDP: Evidence from the G7 Countries" Energy Policy 36(7), 2765 - 2769.

Pereira A. M. and Pereira, R. (2015) "Is All Infrastructure Investment Created Equal? The Case of Portugal" College of William and Mary Department of Economics Working Paper no. 156

Parker, K. 1995. "The Behaviour of Private Investment." IMF Occasional Paper No. 134.

Washington, D.C.: International Monetary Fund.

Perotti, R. (2004). "Estimating the Effects of Fiscal Policy in OECD Countries." Working paper, IGIER at Milan.

Pradhan, B. K., D. K. Ratha, and Atul Sarma. (1990). "Complementarity between Public and Private Investment in India." Journal of Development Economics 33 (1): 101–116.

Phillips, P.C.B. (1996) Impulse Response and Forecast Error Variance Asymptotics in Nonstationary VAR's", *Journal of Econometrics*, 83, pp. 21-56.

Raghavan, M., & Silvapulle, P. (2008). Structural VAR approach to Malaysian monetary policy framework: Evidence from the pre- and post-Asian crisis periods. New Zealand Association of Economics, NZAE Conference 2008, Paper No. 30.1, 1–32.

Raissi, M. and V. Tulin (2015) "Price and Income Elasticity of Indian Exports — The Role of Supply-Side Bottlenecks" IMF Working Paper, WP/15/161, International Monetary Fund.

Ramey, V.A. (2011). Identifying Government Spending Shocks: It's All in the Timing, Quarterly Journal of Economics, 126, 1-50.

Ramirez, M. D. (1994). "Public and Private Investment in Mexico, 1950–90: An Empirical Analysis." Southern Economic Journal 61 (1): 1–17.

Ricardo, D. (1820). Essay on the Funding System. The Works of David Ricardo. McCulloch ed, 1888. London: John Murray.

Sargent, T. J. "A Note on Maximum Likelihood Estimation of the Rational Expectations Model of the Term Structure," Journal of Monetary Economics (January 1979),5: pp.133-43.

Sargent, T. J., 1984, "Vector autoregressions, expectations, and advice," American Economic Review 74, May, 408-415.

Schenkelberg, H. and S. Watzka (2013): "Real effects of quantitative easing at the zero lower bound: Structural VAR-based evidence from Japan", Journal of International Money and Finance, Vol. 33(C), pp. 327-357

Serven, L. (1996). Does Public Capital Crowd Out Private Capital? Evidence from India. Working paper, No. 1613, The World Bank.

Sims, C. A. (1986). Are forecasting models usable for policy analysis? Federal Reserve Bank of Minneapolis Quarterly Review 10(1):2-16.

Sims, C. A. (1980), "Macroeconomics and Reality." Econometrica 48: 1–48.

Sims, C.A., J.H. Stock and M.W. Watson (1990), Inference in Linear Time Series Models with Some Unit Roots". *Econometrica*, 58, pp. 113-144.

Singh, B., (2005). "A forecasting and policy simulation oriented small macro-model for the Indian economy", Journal of Policy Modeling, 27(9): 1025-1049.

Singh, P. S. (2013) "What is wrong with PPP in India?", Business Standard, July 6.

Sundararajan, V., and S. Thakur, (1980). "Public investment, crowding out and growth: A dynamic model applied to India and Korea", IMF Staff Papers, 27(4): 814-855.

Vijverberg, W. P. M., and Chu-Ping C.Vijverberg. (1997), "Public Capital and Private Productivity." Review of Economics and Statistics 79 (2): 267–278.

Voss, G. M. (2002), "Public and Private Investment in the United States and Canada." Economic Modelling 19 (4): 641–664.

Yadav S., V. Upadhyay, Seema Sharma (2012). "Impact of Fiscal Policy Shocks on the Indian Economy," *Margin: The Journal of Applied Economic Research*, Vol.6 No.4. pp. 415-444.

Tun, W.U., and C. Wong. 1982. "Determinants of Private Investment in Developing Countries." Journal of Development Studies 19(1): 19–36.

Wagner, A. (1883), Three Extracts on Public Finance, in R.A. Musgrave and A.T. Peacock (eds) (1958), Classics in the Theory of Public Finance, London: Macmillan.

William A. B., S. Bhadury and T. Ghosh (2015), An SVAR Approach to Evaluation of Monetary Policy in India: Solution to the Exchange Rate Puzzles in an Open Economy, MPRA Working Paper, 19th September.

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