Role of Public Investment in Infrastructure in Accelerating Growth in India

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Abstract

This paper attempts to build an aggregative, structural, macro-econometric model for India. Output in the model is disaggregated in to four disaggregated sectors, viz., (a) agriculture including forestry & fishing, (b) manufacturing, (c) infrastructure which includes power, transport, communication and construction and (d) services sector covering all other activities. The model emphasizes the inter-relationships between internal and external balances and also the relation between money, output, prices and balance of payments. Annual time series data for the period 1981-82 to 2002-03 are used for this purpose. Three-stage least squares method is used to estimate the model. The model is validated for its in-sample forecasting ability. A few counter factual simulations relating to public investment in infrastructure are undertaken to illustrate the usefulness of the model for analyzing the policy options in a simultaneous equations framework.

The estimated model indicated significant crowding-in effect between private and public sector investment in all the sectors. Counter factual policy simulations of sustained increase in public sector investment in infrastructure, financed through borrowing from commercial banks, shows substantial increase in private investment and thereby output in this sector. Further, due to increase in absorption, real output in the manufacturing and services sectors also seem to increase, which sets-in motion all other macro economic changes. Due to rise in sectoral (and aggregate) output, price level and money supply seem to decline in the short-run. Due to sustained nature of the policy change, the impacts get strengthened over time and benefit the economy. A 10% sustained increase in public sector investment in infrastructure, which is less than 0.5% of GDP, can accelerate the macro economic growth by nearly 2% without causing any inflation. This re-assures the potential for achieving the much debated 8-10% aggregate GDP growth in the Indian economy.

1. Introduction:

A macro econometric model is as a system of simultaneous equations, seeking to explain the behaviour of the key economic variables in the economy at aggregate level, based on the received theories of macroeconomics. Macro econometric modelling, in general, pursues two objectives: forecasting and policy analysis. The latter objective is the focus of this study. Fiscal and monetary policies are the foremost policies that are virtually analysed in macro econometric models from their inception.

This paper attempts to utilise the tool of an aggregative, structural, macro econometric model to analyse the macroeconomic effects of changes in selected exogenous variables for India. Before we give the details of the selected model, its estimation etc., it would be useful to briefly look at the literature on this topic pertaining to India.

2. Literature review:

A detailed review of macro econometric models built for Indian economy is beyond the scope of this paper[2]. Since this study proposes to deal with the monetary sector, it would be worthwhile to look into how the monetary sector was modelled in the Indian context[3]. This will be useful for identifying the research issues pertinent to this study.

Modelling monetary sector and its links with fiscal and external sectors became a challenging task in India after 1970s. Modelling money and monetary policy for the determination of real output and price level has increased considerably in India (Rangarajan and Arif, 1990; Rangarajan and Mohanty 1997). In these models, stock of money varies endogenously through feedback from reserve money, which changes to accommodate fiscal deficit and changes in foreign exchange reserves. The price level is determined by money supply and production. The output supply is determined as a function of real money balances and net capital stock, both with lags. Some models attempt to link the real, monetary and fiscal sectors. Models by Pandit and Krishnamurty (1984), Rangarajan and Arif (1990), Lalitha (1992), Soumya (2004), and Soumya and Murty (2005) exhibit this form of linking.

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[2] A comprehensive review of macro econometric models and policy modelling for India can be found in Krishnamurty (2001), Bhattacharya et.al. (2002) and Pandit and Krishnamurty (2004).
[3] A good review of monetary sector models was provided by Jadhav (1990).

Public capital expenditure adds to real capital stock, which in turn affects the level of real output. The analysis of effect of public investment on private investment indicates crowding-in. (Krishnamurty, 1985). More recent assessment suggests the weakening of this phenomenon in the last decade possibly due to resource constraint and the negative price effect of public sector investment financed by fiscal deficit (Krishnamurty, 2001; IEG-DSE, 1999; Rangarajan and Mohanty, 1997).

Modelling the external sector was not a major concern in the earlier models, because of restrictions on trade. But, in the recent years, several models emerged with detailed emphasis on the external sector and it's interlinks with the monetary and fiscal sectors (e.g. Sunderarajan, 1986; Murty and Asha Prasuna, 1994; Asha Prasuna, 1996). Krishnamurty and Pandit (1996) modelled the merchandise trade flows in supply-demand framework includes disaggregated output, prices and investment behaviour.

Macroeconomic impact of fiscal deficit on balance of payments in India is an emerging issue in recent years since the inception of stabilization program. These issues were modelled by Bhattacharya et.al. (1994) and Rangarajan and Mohanty (1997). It is postulated that fiscal deficit increases the absorption in the economy relative to output and the output effect of deficit follows with a lag. Issues like money supply process in India during the 1990s and the impact of liberalisation on monetary policy and the link between monetary base and money supply for the reform period were discussed in the models by Rath (2001) and Nachane (2001).

3. Methodology:

This paper attempts to fashion the macro econometric model for India following absorption approach of Polak. An important starting point in this direction in this direction for Indian is the work of Rangarajan and Mohanty (1997). We consider Rangarajan and Mohanty (1997) model as a starting point for this study. Some important changes to expand that model and to address the theme of this paper have been made. The basic model is monetarist in focus. The model emphasises the inter-relationships between internal and external balances and also the relation between money, output, prices and balance of payments.

The model strives for a balance between the two polarized approaches of the classicals and the Keynesians. While classicals contend that changes in money supply, ultimately results in changes in the price level, the Keynesians on the other hand

postulate that the changes in money supply eventually leads to changes in output, under conditions of less than full employment. Viewing reality lying somewhere in between these two extremes, one can postulate that changes in money supply affect both the output and the price level. Thus, the model tries to capture the effects of changes in money supply resulting in both output and price level.

This model mainly focuses on the determination of money supply and its links with fiscal operations and on the impact of money stock on output generation. It is postulated that real money balances or credit effects output besides the real capital stock. An increase in real credit results in monetary expansion, which in turn has an effect on aggregate output, and price level. A rise in output through increase in credit neutralizes the rise in price level caused by monetary expansion. Further, RBI credit to finance the resource gap, which is defined as govt. total expenditure less govt. total receipts, causes money supply to increase endogenously with the rise in reserve money. This monetary expansion again affects the price level and output to a lesser extent, and the cycle continues. The model also incorporates the savings-investment identity through current account balance. It also has an interest rate equation, which is in a reduced form. The interest rate determinants are changes in bank credit to commercial sector, current account balance, rate of inflation and equilibrium level of gross domestic savings.

In addition, external sector is also modelled by including supply and demand for exports, demand for imports and BOP identity. Assuming equilibrium in the exports market, the export supply function is specified as a price equation for unit value of exports. It incorporates world real income, relative price and the export price of the rest of the world. The export demand depends on relative export price and the real domestic income, to understand the domestic market for exports. The import demand function is based on the domestic absorption and the relative import price.

4. Trends and changes in Indian macro economy:

It is important to understand the trends and patterns in the observed data before estimating the proposed model. This provides a backdrop for interpreting the empirical results to be obtained. The data were taken mostly from the National Accounts Statistics, published by CSO, and the Handbook of Statistics on Indian Economy, published by the RBI.

The study period is taken as 1980-81 to 2002-03. Most of the variables for the real and external sectors used in the econometric analysis are in real form (constant 1993-94 prices) to avoid inflationary effects. The monetary and fiscal variables are in current prices. All price variables are indices with 1993-94 as unity. To study the macro economic trends, decade-wise annual average compound growth rates for all the variables are computed using semi-logarithmic regressions and are given in Appendix-I, Table-1. To analyse the levels of activity and changes in them, decade-wise descriptive statistics- arithmetic mean and sectoral shares in output and investment variables are also given in Appendix-I, Table-2. A few variables are also plotted to understand the trends and fluctuations visually (Appendix-II).

Output and Prices:

Real gross domestic product at factor cost (YR, at 1993-94 prices), an indicator of total economic activity, grew by a moderate 5.7% p.a. during the entire study period 1980-2003. In fact, the real output growth has accelerated from 5.4% during '80s to 6.2% during '90s. Between 1993-03, the post-liberalization decade, which is also our data period for simulation analysis, the real output has grown at 6% p.a., a slight slowing down in the economy.

The above aggregate growth was made possible through differential sectoral growth: Agricultural output (YAR) grew by 3%, manufacturing (YMNR) by 6.6%, infrastructure (YINFR) by 6.5% and services sector (YSRR) by 7.2%. Clearly, manufacturing sector has slowed-down, while infrastructure and services have accelerated by about 1-1.25% p.a. This is true with the post 1990 reforms as well. The rate of growth in the wholesale price index (P), in other words, rate of inflation, fluctuated between 6.6-7.8%, which declined to 5.5% during 1993-03. The national income deflator (PGDP), shows similar trends but at 0.5-1% higher level.

The GDP share in agriculture fell from 36.4% in '80s to 29.1% in '90s and it stood at 26.5% during the recent decade (1993-02). The non-agriculture exhibits the opposite pattern. Within the non-agriculture, share of the services sector is the largest, accounting for more than one-third of the GDP. The share has gone-up from 32.3% in '80s to 37% in '90s and more recently to 38.8% of the GDP. The GDP share of infrastructure remained stagnant around 14-15%, although the GDP level has roughly doubled. The GDP share of manufacturing sector improved marginally from 17.6% in

'80s to 19.4% in '90s and even subsequently. Thus, there is a structural shift from agriculture to services in the Indian economy.

Investment:

During 1980-03, real public investment in agriculture (PCFAG) and manufacturing (PCFMN) sectors has decelerated by 2.1% and 0.1% respectively, whereas real public investment in infrastructure (PCFINF) and services (PCFSR) sectors grew by 3.9% and 3.7% respectively. The total public investment in all sectors grew by 2.5% in the study period. In fact, the public investment growth has decelerated from 4.5% during '80s to 2.2% during '90s. In the post-liberalization period, it is only 1.1%. This is the result of massive disinvestment of public sector units in the country during post-90s. Private investment in agriculture (PIAG), manufacturing (PIMN), infrastructure (PIINF) and service (PISR) sectors grew by 4.2%, 7%, 5.9% and 6.3% respectively in the entire study period. Private total investment in all sectors grew by 6.3% in the study period. Between '80s and '90s, private investment accelerated in agriculture and manufacturing (substantially), but nearly stagnant or decelerated in the other two sectors. In the post-'93 period, except in agriculture, private investment slowed down in all the three other sectors. The graphs depicting investment shares also confirm this.

Fiscal and monetary variables:

In developing countries, the economic policies of the government play an important role in the growth of the economy. Govt. total expenditure consists of current and capital expenditures. The nominal total govt. expenditure (GXP) has decelerated from 16.2% in '80s to 15.4% in '90s. The govt. consumption expenditure, however, accelerated from 15.4% to 16.3%. The trends continue into 1993-03 period as well. Although the govt. direct tax collection has accelerated, the total revenue seems to have decelerated. Some fiscal prudence has led to deceleration in the fiscal deficit over the years. In fact, fiscal deficit decelerated from 18.7% in '80s to 15.8% in '90s. However, it seems to have picked-up momentum again during 1993-03. Money supply (M3) grew more or less steadily at about 17% during the study period. Nominal interest rate (IB) grew marginally during '80s by 0.8% p.a., but dropped significantly since then and the trend continues.

External sector:

Real export (EXPT) growth from the country has accelerated rapidly from 4.2% in '80s to 12% in '90s, with an overall growth of 9.6% p.a. It seems to grow even faster (12.6%) during 1993-03. The unit value of exports (UVIX), proxy for export price, has increased slower between '80s and '90s, and slowed-down even further in the recent decade. The export performance was facilitated by significant depreciation of Indian rupee (9.4%) against the US$, in addition to rise in unit value of exports. Growth in real imports (IMPR) has accelerated very rapidly from 6.3% in '80s to 15.3% in '90s. The import growth seems to have slowed down to 10.7% during 1993-03. The nominal trade balance, as expected, has been negative and highly volatile.

5. Estimated Model:

The proposed model consists of 4 blocks- real, fiscal, monetary and external sectors. It has 52 endogenous variables (28 equations and 24 identities) and 29 exogenous variables and is estimated using 3SLS method. Due to lags and calculation of rate of change in some variables, the actual estimation uses data for 1981-82 to 2002-03.

The 28 equations are grouped into two groups- one main model consisting of 22 equations and another sub-model with six equations. The main model has two broad real sectors, namely agriculture including forestry & fishing and second non-agriculture which covers all the rest of the real sectors. The sub-model tries to disaggregate the non-agricultural sector into three sub-sectors, namely (i) manufacturing, (ii) infrastructure which includes power, transport, communication and construction and (iii) services sector covering all other activities. However, the sub-model specifies output, private investment and depreciation equations for (i) and (ii) only leaving the (iii) sector to be obtained as the residual sector from the non-agricultural sector in the main model and the two estimated sectors in the sub-model. This approach allows more flexibility in the specification and estimation of the main- and sub-models, even for further sectoral disaggregation later.

While estimating the model, a TREND variable is included in some equations to capture the autonomous time related changes in the endogenous variables. Dummy variables are included in the model to separate the pre- and post-liberalization (1991-92 onwards) effects (Dummy1) and also to capture the abnormal

fluctuations in the data for certain variables (Dummy2, Dummy3, Dummy4, and Dummy5). The choice of the equations was guided by expected sign as well as statistical significance for the coefficients and high goodness-of-fit, including absence of serial correlation for residuals. The estimated model is given in the Appendix-III.

A perusal at the estimated model indicates that both the main- and sub-models are estimated quite well. All the regression coefficients, except two, are significant at 5% or less. However, despite our best efforts, some of the equations still seem to suffer from the problem of serial correlation. The estimated partial regression coefficients are given in Table-1.

In this table, the first row is the agriculture production function and the entries are output responses to a unit change in the factor inputs. From the table, ceteris paribus, the real aggregate agricultural output in the economy would increase by (a) Rs. 40 crores for each millimeter increase in annual rainfall (b) Rs. 207730 crores per unit index of gross cropped area, (c) Rs 0.67 crores per Rs. one crore increase of real net capital stock in agriculture and (d) Rs. 0.35 crores per Rs. one crore increase in infrastructural output respectively. The implied incremental capital-output ratio in agriculture is low (1.5). In contrast, the ICOR value in non-agriculture is around 5. It is important to note that there is significant dependence (complementarity) between the outputs of agriculture and infrastructure. The latter commodity acts as an input to the former.

Coming to the investment variables, one rupee increase in public sector real investment in agriculture increases real private investment by Rs. 0.18 in the short run and Rs. 0.16 in the long-run as a crowding-in effect. Likewise, in non-agriculture sector, one rupee increase in public sector real investment increases private sector real investment by Rs. 1.34 as a crowding-in effect. This implies any additional public sector investment encourages private investment in non-agriculture more than proportionately.

Like wise, from the estimated price equation, for every Rs. one crore increase in money stock, the whole sale price index will go up by 0.06 points and the long-run response is even larger. A Rs. one crore increase in real aggregate output, ceteris paribus, will decrease the whole sale price index by 0.2 points in the short-run and 3 points in the long run. Money supply would increase by Rs. 0.44 for each rupee increase in reserve money.

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Coming to government revenue receipts, revenue from direct taxes will increase by Rs. 0.16 with every rupee increase in real income in the non-agriculture sector. Revenue from indirect taxes increases by Rs.0.11 for each rupee of aggregate nominal income and non-tax revenue increases by Rs. 0.04 for every rupee increase in nominal income at market prices. Government consumption expenditure also increases by Rs. 0.04 and Rs. 0.30 with each rupee increase in nominal income in the short run and long run respectively.

In the external sector, export demand decreases by Rs. 1809 thousand crores with unit rise in unit value of exports (relative to world export price) and import demand falls by Rs. 1.8 thousand crores with one unit rise in unit value of imports (relative to domestic whole sale price). Nominal bilateral exchange rate seems to increase rapidly with rise in general price level.

Coming to the sub-model for manufacturing and infrastructure sectors, the real output in manufacturing would increase by Rs. 0.05 for each rupee increase in net capital stock in manufacturing sector, implying a very high incremental capital-output ratio (ICOR of 20). Likewise, real output in infrastructure would increase by Rs.0.41 for one rupee increase in net capital stock in infrastructure (ICOR of 2.4). One rupee increase in public sector investment in manufacturing encourages private investment by Rs.3.23, Rs.4.84 in short- and long-run respectively. Likewise in infrastructure sector, private investment would increase by Rs. 0.24 for each rupee increase in public investment. This shows the contrasting picture between the two sectors- private sector is less enthusiastic in investing in infrastructure and perhaps expects the govt. to invest first. It is interesting to see the complementarity between infrastructure and manufacturing sectors in terms of private investment. Every rupee invested in infrastructure by private investors can stimulate Rs. 3 to 5 investment in the manufacturing sector. This also shows the close interdependence between the two sectors.

Table-1: Estimated partial responses of some important endogenous variables w.r.t. selected determinants.

Endogenous Variable	Determinants			
	Main-Model			
YAR	**RF** 0.04	**AREA** 207.73	**KAGR$_{-1}$** 0.67	**YINFR$_{-1}$** 0.35
YNAR	**ADD** 0.28	**KNAGR$_{-1}$** 0.20	**(M3/P)$_{-1}$** 0.22	
PIAG	**YAR$_{-1}$** 0.03 SR 0.03 LR	**PCFAG** 0.18 SR 0.16 LR	**PIINF$_{-1}$** 0.08 SR 0.07 LR	
PINAG	**D(YR)** 0.26	**(Δ(BCP/P) + CAPB/P))** 0.53	**PCFNAG** 1.34	**IB (real)** -1.88
PC	**PYDR** 0.61	**(CONS/P)** -0.18		
CONS	**YM** 0.04 SR 0.30 LR			
DT	**YNAR** 0.16	**PGDP** -17.63		
DIT	**Y** 0.11			
NTX	**YM** 0.04			
M3	**RM** 0.44			
P	**YR** -0.0002 SR -0.003 LR	**M3** 0.00006# SR .0009 LR	**IB** 0.008 SR 0.13 LR	
IB	**(Δ(BCP/P) + CAPB/P))** 0.02	**P (rate of change)** -4.37	**SAV** -0.02	
EXPT	**WYR** 0.002	**(UVIX/EXR/WPEXP)** -1808.96		
IMPR	**(UVIMP*EXR/P)** -1.80	**AD** 0.12		
EXR	**P** 29.07	**CAB** -0.04	**BOP** 0.07	
	Sub-Model			
YMNR	**ADD** 0.04	**KMNR** 0.05#		
YINFR	**KINFR$_{-1}$** 0.41			
PIMN	**PIINF$_{-1}$** 3.06 SR 4.59 LR	**PCFMN** 3.23 SR 4.84 LR		
PIINF	**PCFINF** 0.24			

SR: Short-run, LR: Long-run. For definitions of variables, see pages 20-22.
Note: All the coefficients, except two with # sign, are statistically significant at 5% or less.

6. Policy Simulations:

To assess the empirical adequacy of the full model in describing the historical data, EViews package was employed to solve the 52 relations together iteratively for each year using commonly required options, namely deterministic simulation and dynamic solving options for the entire sample period, 1981-82 to 2002-03. The simulated values for the above period are also called the 'base simulation' values. Assessment of the full model is done by (a) comparing the time series plots of actual and base simulation values and (b) computing the summary measures, mean absolute percentage error (MAPE) and root mean square percentage error (RMPE). Based on all these three criteria, the base simulation was found to trace the historical data quite well[4](Appendix-IV). Due to limitation of space, these details are omitted here.

The main purpose of this paper is to analyze the impacts of counter factual scenarios about certain exogenous variables, including policy instruments. Hypothetical sustained[5] change(s) in each exogenous variable are incorporated for a specified sample period and the full model is solved for each year, during that sample period. The time path of each endogenous variable of such an exogenous change is compared and contrasted with the base simulation (not the actual series) as a reference path. Such comparison only can facilitate quantification of the impacts of changes in exogenous variable on the endogenous variables, without confounding the effects of the inaccuracies of estimated model.

The exogenous changes considered here include sustained increase in public sector real investment in the infrastructure sector financed either through borrowing from commercial banks or utilization of foreign capital inflows. These changes are envisaged to be implemented, one at a time, starting from the year 1993-94. These counterfactual simulations are undertaken to illustrate the usefulness of the model for

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[4] It may be mentioned that in simulations using multi-equation system, certain endogenous variables are likely to be systematically under/over predicted. The money supply variable got systematically under predicted here. To correct such situations, EViews package has a provision to include 'add-factors' with certain options for type of add-factor (e.g. intercept shift and endogenous variable shift) and initialization of add-factor (e.g. such that the equation has no residuals at actuals etc.). Here, the chosen options are such that the base simulation for money supply variable coincides with its historical series. This, however, will not affect the policy simulations.

[5] Some analysts prefer to hypothesise one-period or shock-type exogenous change. If the estimated underlying model is dynamically stable, the impacts of any one-period exogenous change should decay over time and all the endogenous variables return to base simulation levels. In other words, shock-type simulations are inappropriate for studying long-term policy effects. The present model confirmed this property.

analyzing the changes in these variables in a simultaneous equations framework. The simulation results for a few important variables are plotted in Appendix-V Graphs.

The allocative and dynamic macroeconomic effects due to the above exogenous/policy changes are quantified as percentage changes, also known as multipliers, with reference to base simulation values. They are reported only at four points of time, namely same year of exogenous change (immediate or instantaneous or impact), after one year (short-term), after five years (medium term) and after ten years (long-term). Since the impacts change each year rather slowly, the medium term and the long-term responses are simple averages of the respective years. In the case of rate of inflation, rate of interest and trade balance, the impacts are changes in level, not rates of change. It may be mentioned that these percentage responses are contemporaneous in nature (policy simulation vs. base simulation) and should not be treated as usual percentage rate of change over time. For this reason, these responses are likely to be different from the direct responses (both partial and net) implied by the estimated equations. The ten-year period 1993-94 to 2002-03 is used for the policy simulations. The scenario results are presented in Tables: 2-3.

(a) Sustained 10% increase in public sector real investment in infrastructure sector financed through borrowing from commercial banks:

It is hypothesised that the govt. will raise the necessary investment resources through borrowing from commercial banks. Further, the model assumes that there is liquidity crunch and the bank credit that is available to commercial sector will be lesser by the amount borrowed by the govt. for investment in the infrastructure sector. Such a policy will reduce the reserve bank credit to the govt. and thereby reserve money and money supply. Changes in money supply will trigger several other changes in the economy. A sustained 10% increase in public real investment in infrastructure[6], envisaged as above, has both short- and long-run impacts on all the sectors of the Indian economy.

Usually, due to opposite trends in public and private real investments, certainly during '80s and early '90s, in the agricultural sector, one gets an inverse

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[6] This constitutes Rs. 3463 crores in 1993-94 and Rs. 3747 crores in 2002-03 at 1993-94 prices. These expenditures are 2.8% and 1.6% of tax revenue; 0.4% and 0.3% of GDP in respective years. From the past experience, during 1993-03, both public and private investments in infrastructure have grown at 2% p.a. The average investment growth was higher at 3.9% and 5.9% during 1980-03 in the public and private sectors.

relationship between the two variables. However, after correcting for dynamic relationship and autonomous changes in private investment, there exists a significant complementarity between public and private investments in the Indian agricultural sector (as well as all the three other sectors). Further, agricultural sector exhibits cross-complementarity with the infrastructure sector, with a lag. This latter feature highlights the linkage between the private investment decisions of the two sectors. Thus, any change in public investment in infrastructure will not only affect private investment in that sector but also in agriculture and thereby rest of the economy through macroeconomic linkages.

Thus, a 10% increase in public investment in infrastructure seems to increase real private investment in the infrastructure sector by 4.8% in 1993-94, as an impact. This sets-in many other macroeconomic effects, some small and others as large, in magnitude. Increased public investment in infrastructure will increase net (and gross) capital stock in the infrastructure sector and thereby output only in 1994-95 due to one-period lag for net capital stock in the production function for this sector.

Due to increase in public investment in infrastructure, the aggregate public investment in the non-agricultural sector will increase, which in turn pushes-up private investment in the non-agricultural sector due to crowding-in effect. This increases private investment in services sector, which is treated as a residual sector here. In the present case, in response to a 10% increase in public investment in infrastructure, private investment in non-agriculture and services sectors seems to go-up by 3% and 5.3% respectively. Due to investment lags, private investment in agriculture will change only in 1994-95. However, aggregate private investment will increase by 2.8% in 1993-94 itself. This implies an investment elasticity of 0.28 in private investment vis-à-vis public investment in infrastructure.

Due to increase in investment, aggregate demand (absorption) in the economy will increase, thereby increasing non-agricultural output (0.4%), comprising of growth in manufacturing (0.2%) and services (0.6%). This amounts to an increase of 0.26% in aggregate real income in 1993-94. There will be a small decrease in GDP deflator (0.15%), leaving an increase of 0.1% in nominal income. Increase in income leads to increase in personal disposable income (0.3%) and private consumption (0.2%). Nominal gross investment seems to increase by 3.1%, exceeding the growth in nominal domestic savings (2.2%), necessitating adjustment with current account balance from the external sector.

On the fiscal side, higher public investment will increase govt. expenditure (1.3%). Only part of this could be met from growth in govt. revenue (0.3%), leaving a large uncovered fiscal deficit (3.6%). Since we assume the govt. to borrow the required funds from the commercial banks, the net effect on the growth in money supply is very small[7] and in fact negative (0.1%). As a result, the general price level and inflation will fall (0.14%). Demand for Indian exports will however decline (0.1%) due to rise in relative export price. But, real imports into the country will rise faster (1.2%) due to cheaper import prices and higher absorption. The Indian rupee appreciates marginally (0.3%) against the US$. As expected, nominal trade balance and balance of payments will worsen (1.3%). Nominal interest rate fell marginally (0.1%).

The impacts get stabilised (or consolidated) by 1994-95 and subsequent years. Due to crowding-in effect, Rs. 3463 crores increase in public sector investment in infrastructure in 1993-94 encourages private real investment in infrastructure by 4.6% (nearly the same as in 1993-94), which implies an elasticity of 0.46, a significant positive response of private sector. This increases real gross (and net) capital stock in infrastructure and thereby output (1.4%). It is very interesting to note that private investment responds positively in all the other three sectors of the Indian economy. As can be expected, services sector leads these changes, followed by manufacturing and agriculture. Specifically, private investment in services is expected to grow at a rapid rate of 4.7% in 1994-95, with a modest output growth of 0.6% in this sector.

Through macro economic interactions, the real private investment in the non-agricultural sector is strengthened, which increases at the rate of 3.7% and results in 0.7% increase in output. The over-all real income increases by 0.5%. As a result, the GDP deflator falls by 0.3%. Increase in investment leads to increase in absorption and demand, which increases demand for real imports (1.3%). But, decline in unit value of exports (0.04%) and nominal exchange rate (0.44%), increases relative price of exports and decreases real exports (0.17%) from the country, thereby worsening trade balance (1.6%) and balance of payments. Due to increase in aggregate investment and output, there will be increase in real personal disposable income (0.56%) and hence real private consumption (0.4%). The impacts and the dynamic

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[7] In the absence of this assumption, money supply would have increased by 0.26% in 1993-94, with a marginally lower fiscal deficit.

multipliers are given in Table-1 and graphs comparing the baseline and policy simulated values are given in Figures 1-5.

The fiscal sector is also affected. For example, nominal govt. expenditure increases (1.2%) faster than nominal revenue (0.6%), thereby increasing nominal fiscal deficit (2.6%). To bridge the gap, govt. increases non-market borrowings (0.2%) to supplement borrowing from commercial banks. As expected, all these effects get strengthened further over time (since the policy is a sustained change) and lead to significant and wide spread real benefits to the economy. For example, after ten years (long-term), real gross capital stock in agricultural sector and thereby real agricultural income is expected to increase by a sizeable 1.2%, real aggregate income by 1.9%, with only a marginal increase in money supply (0.14%)[8]. Despite this, the over-all prices are expected to fall by 1.4% and the rate of inflation also declines (0.2%).

Real exports will decline by 0.4% and imports will increase (1.8%), resulting in a significant deterioration in nominal trade balance (6.8%) and balance of payments. The current account balance is also expected to fall by the same extent. The Indian Rupee will appreciate by 1.8% against the US $. However, due to significant fall in prices (and GDP deflator), the nominal income increases by only 0.5%. Thus, in view of the very stagnant economic growth, sustained public investment in infrastructure can provide the necessary push to the higher growth path of the Indian economy.

(b) Sustained 10% increase in public sector real investment in infrastructure sector financed through foreign capital inflows:

In this scenario, we try to compare the earlier simulation results with an alternative policy option that is very much in recent public debate, viz. public investment being financed through the accumulated foreign capital inflows. The simulation results are given in Table-3. It can be seen that the simulation results are quite similar with few differences in monetary and external sectors. Specifically, when the required funds for investment are borrowed from the capital inflows, as expected, the money supply will increase through increased RBI credit to govt. and thereby reserve money.

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[8] In contrast, based on another simulation where the govt. does not borrow from the commercial banks, it is found that the money supply would have increased by 0.26%.

Thus, in 1993-94, the year of the exogenous change, the money supply will rise by 0.27% in this case compared to a decline of 0.1% earlier. Likewise, in the external sector, due to govt. borrowing from net capital inflows, the balance of payments will fall more rapidly than before. This causes the Indian rupee to appreciate more and unit value of exports to decline. Since the fall in nominal exchange rate is higher than the fall in unit value of exports, Indian exports will become relatively more expensive and therefore the real exports from India will tend to decline more rapidly. The opposite is the case with real imports into the country. As a result, the trade balance and balance of payments will decline faster. This pattern is continued into the future as well. Thus, the two scenarios look qualitatively similar with some differences in monetary and external sectors. Since the required legal apparatus for the utilization of foreign capital inflows by the govt. appears not in place yet, probably, it may be easier for the govt. to borrow the required funds from the commercial banks by selling the conventional govt. security bonds.

Thus, **to conclude**, this study has analysed the likely macroeconomic effects of changes in public investment in infrastructure in India. The quantified effects include the allocative and dynamic responses of the chosen policy change on important macroeconomic variables relating to four broad sectors- real, fiscal, monetary and external sectors of the Indian economy. The real sector further decomposed into four sub-sectors, agriculture, manufacturing, infrastructure and services. The sign and magnitude of the effects vary over time- immediate to long-run.

Briefly, the estimated model indicated significant crowding-in effect between private and public sector investment in all the four sub-sectors of the real economy. This has important consequences for investment/disinvestment policies of the govt. in each of these sectors. Sustained increase in public investment in infrastructure was found to stimulate substantial increase in private investment in all the sectors. Such a policy is expected to result in wide spread benefit in the fiscal and monetary sectors of the economy. Thus, public sector investment in infrastructure sector has the potential to provide the much-needed push and accelerate the growth process of the Indian economy. A 10% sustained increase in public sector investment in infrastructure will enable the Indian economy to grow at 8% p.a. from the existing long-run 6% p.a.

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Table-2: Impacts and dynamic multipliers (% p.a.) of 10% sustained increase in real public investment in infrastructure financed by commercial bank credit.

Variable/Year	Base* Simulation Level, 1993-94	Impact (1993-94)	Short-term (1994-95)	Medium-term (1995-98)	Long-term (1998-2003)
Real Sector					
Nominal Income	819	0.1	0.2	0.5	0.5
GDP Deflator	1	-0.1	-0.3	-0.8	-1.4
Real Income	803.7	0.3	0.5	1.3	1.9
Agriculture	247.6	0	0	0.6	1.2
Non-agriculture	556.1	0.4	0.7	1.5	2.1
Manufacturing	161.7	0.2	0.3	0.7	1
Infrastructure	113.7	0	1.4	4.1	5.3
Services	280.7	0.6	0.6	1	1.5
Real Private Investment	136.6	2.7	3.4	2.9	4.3
Agriculture	11.5	0	0.5	0.7	1
Non-agriculture	125.1	3	3.7	3.1	4.6
Manufacturing	52.9	0	3.1	4.4	5.3
Infrastructure	17	4.9	4.6	4.2	4.2
Services	55.2	5.3	4.7	1.5	4.2
Real Private Consumption	588.3	0.2	0.4	1.1	1.7
Real Personal Disposable Income	731.1	0.3	0.6	1.4	2.1
Gross Domestic Savings (N)	236.7	2.2	2.7	1.4	0.8
Gross Investment (N)	215.5	3.1	3.2	2.3	2.1
Fiscal Sector					
Govt. Consumption (N)	126.7	0	0.1	0.3	0.4
Govt. Total Expenditure(N)	249	1.3	1.2	1	0.9
Govt. Revenue (N)	166.9	0.3	0.6	1.1	1.3
Direct Taxes (N)	32.1	1.2	2.1	3.4	4.3
Indirect Taxes (N)	102.1	0.1	0.2	0.4	0.4
Non-tax Revenue (N)	32.7	0.1	0.2	0.5	0.5
Fiscal Deficit (N)	75.2	3.6	2.6	1	0.2
Govt. Non-market Borrowings (N)	52.3	0.1	0.2	0.5	0.5
Monetary Sector					
Money Supply	431.1	-0.1	0.1	0.2	0.1
Price Level	1	-0.1	-0.3	-0.7	-1.4
Rate of Inflation (%) #	7.2	-0.1	-0.1	-0.2	-0.2
Rate of Interest (%) #	10.4	-0.1	-0.1	-0.1	0
External Sector					
Real Exports Demand	119.1	-0.1	-0.2	-0.3	-0.4
Real Imports Demand	94.6	1.2	1.3	1.5	1.8
Unit Value of Exports	1	0	0	0	-0.1
Exchange Rate (N)	29.2	-0.3	-0.4	-1	-1.8
Trade Balance (N)#	26.1	-1.3	-1.6	-3.5	-6.9
*: Rs. '000 crores, except GDP deflator, Price level, Rate of inflation, Rate of interest, Unit value of exports and Exchange rate. #: Changes in level					

Table-3: Impacts and dynamic multipliers (% p.a.) of 10% sustained increase in real public investment in infrastructure financed through foreign capital inflows.

Variable/Year	Base* Simulation Level, 1993-94	Impact (1993-94)	Short-term (1994-95)	Medium-term (1995-98)	Long-term (1998-2003)
Real Sector					
Nominal Income	819	0.1	0.3	0.6	0.5
GDP Deflator	1	-0.1	-0.2	-0.7	-1.3
Real Income	803.7	0.2	0.5	1.3	1.9
Agriculture	247.6	0	0	0.6	1.2
Non-agriculture	556.1	0.4	0.8	1.5	2.1
Manufacturing	161.7	0.2	0.3	0.7	1
Infrastructure	113.7	0	1.4	4.1	5.3
Services	280.7	0.6	0.7	1	1.4
Real Private Investment	136.6	3.3	3.5	2.8	4.2
Agriculture	11.5	0	0.5	0.7	1
Non-agriculture	125.1	3.6	3.7	3	4.6
Manufacturing	52.9	0	3.1	4.4	5.3
Infrastructure	17	4.9	4.6	4.2	4.2
Services	55.2	6.6	4.8	1.3	3.9
Real Private Consumption	588.3	0.2	0.4	1.1	1.7
Real Personal Disposable Income	731.1	0.3	0.6	1.4	2.1
Gross Domestic Savings (N)	236.7	2	2.3	1.1	0.5
Gross Investment (N)	215.5	3.4	3.3	2.3	2.1
Fiscal Sector					
Govt. Consumption (N)	126.7	0	0.1	0.4	0.5
Govt. Total Expenditure(N)	249	1.3	1.2	1.1	0.9
Govt. Revenue (N)	166.9	0.3	0.6	1.1	1.4
Direct Taxes (N)	32.1	1.1	2.2	3.4	4.3
Indirect Taxes (N)	102.1	0.1	0.3	0.5	0.5
Non-tax Revenue (N)	32.7	0.1	0.3	0.6	0.6
Fiscal Deficit (N)	75.2	3.7	2.5	1	0.3
Govt. Non-market Borrowings (N)	52.3	0.1	0.3	0.6	0.5
Monetary Sector					
Money Supply	431.1	0.3	0.4	0.4	0.3
Price Level	1	-0.1	-0.2	-0.7	-1.3
Rate of Inflation (%) #	7.2	-0.1	-0.1	-0.2	-0.2
Rate of Interest (%) #	10.4	-0.1	-0.1	-0.1	0
External Sector					
Real Exports Demand	119.1	-0.5	-0.5	-0.4	-0.5
Real Imports Demand	94.6	1.7	1.7	1.8	2.1
Unit Value of Exports	1	-0.3	-0.3	-0.2	-0.2
Exchange Rate (N)	29.2	-1.2	-1.3	-1.7	-2.5
Trade Balance (N)#	26.1	-2.6	-2.6	-4.6	-8.3
*: Rs. '000 crores, except GDP deflator, Price level, Rate of inflation, Rate of interest, Unit value of exports and Exchange rate.					
#: Changes in level					

Model equations:

Main model:

1. DT=C(1)+C(2)*YNAR+C(3)*PGDP+[AR(1)=C(4)]
2. DIT=C(6)+C(7)*Y+[AR(1)=C(8)]
3. NTX=C(12)*YM+[AR(1)=C(13)]
4. CONS=C(17)*YM+C(18)*DUMMY1+C(19)*CONS(-1)+[AR(1)=C(20)]
5. DNB=C(21)*Y+[AR(1)=C(22)]
6. P=C(26)*YR+C(27)*M3+C(28)*IB+C(29)*P(-1)+C(30)*TREND
7. PGDP=C(31)+C(32)*P+[AR(1)=C(33)]
8. PGKE=C(37)*P+[AR(1)=C(38)]
9. M3=C(41)+C(42)*RM+[AR(1)=C(43)]+C(44)*TREND
10. PC=C(46)+C(47)*PYDR+C(48)*(CONS/P)+[AR(1)=C(49)]
11. PIAG=C(51)*YAR(-1)+C(52)*PCFAG+C(53)*PIAG(-1)+C(54)*TREND
            +C(55)*PIINF(-1)
12. PINAG=C(56)*D(YR)+C(57)*(D(BCP/P)+CAPB/P)+C(58)*PCFNAG+
            C(59)*(IB-((P-P(-1))/P(-1))*100)+C(60)*DUMMY3+C(61)*DUMMY4
13. YAR=C(65)+C(66)*RAIN+C(67)*AREA+C(68)*KAGR(-1)+C(69)*YINFR(-1)
            + [AR(1)=C(70)]
14. YNAR=C(71)+C(72)*ADD+C(73)*KNAGR(-1)+C(74)*(M3(-1)/P(-1))+
            [AR(1)=C(75)]
15. DEPAG = C(76)+C(77)*KAGR(-1)+[AR(1)=C(78)]
16. DEPNAG = C(81)+C(82)*KNAGR(-1)+[AR(1)=C(83)]
17. EXPT=C(86)+C(87)*(UVIX/EXR/WPEXP)+C(88)*WYR+C(89)*DUMMY1
18. UVIX=C(91)+C(92)*(P/EXR)+C(93)*WYR+C(94)*WPEXP+C(95)*EXPT(-1)+
            [AR(1)=C(96)]
19. IMPT=C(101)*(UVII*EXR/P)+C(102)*AD+C(103)*TREND+
            C(104)*(TREND*TREND)+[AR(1)=C(105)]
20. EXR=C(106)+C(107)*P+C(108)*CAB+C(109)*BOP+[AR(1)=C(110)]
21. PYDR=C(116)+C(117)*YR+[AR(1)=C(118)]
22. IB=C(121)+C(122)*(D(BCP)+CAPB)+C(123)*((P-P(-1))/P(-1))+ C(124)*SAV
        +C(125)*DUMMY1+C(126)*DUMMY4+[AR(1)=C(127)]

Sub-model:

1. YMNR=C(1)*ADD+C(2)*KMNR(-1)+C(3)*(M3(-1)/P(-1)) +[AR(1)=C(4)]
2. YINFR=C(6)+C(7)*KINFR(-1)+C(8)*DUMMY5
3. PIMN=C(11)+C(12)*PCFMN+C(13)*PIINF(-1)+C(14)*PIMN(-1)
4. PIINF=C(16)*PCFINF+C(17)*TREND
5. DEPMN = C(21)+C(22)*KMNR(-1)+[AR(1)=C(23)]
6. DEPINF = C(26)+C(27)*KINFR(-1)

Identities:

1.   PYD = PYDR * P
2.   YR = YAR + YNAR
3.   YSRR = YNAR - YMNR - YINFR
4.   PCFNAG = PCFMN + PCFINF + PCFSR

5. PISR = PINAG - PIMN - PIINF
6. KMNR = KMNR(-1) + PIMN + PCFMN - DEPMN
7. KINFR = KINFR(-1) + PIINF + PCFINF - DEPINF
8. Y = YR * PGDP
9. YM = Y + DIT + YMDIFF
10. KAGR = KAGR(-1) + PIAG + PCFAG - DEPAG + RES1
11. KNAGR = KNAGR(-1) + PINAG + PCFNAG - DEPNAG + RES2
12. ABSP = PC + PIAG + PINAG
13. ADD = ABSP + CONS / P + PCFAG + PCFNAG + EXPT - IMPT
14. AD = ADD + IMPT
15. GXP = CONS + TRP + (PCFAG + PCFNAG) * PGKE
16. TR = DT + DIT + NTX
17. FD = GXP - TR - ORV
18. D(RCG) = FD - D(BCG) - DNB - EB - MISCR
19. BCP = M3 - RCG - BCG - RBFA - GCL + RES
20. RM = RCG + RBCS + RBFA + GCL - RNML + MISL
21. CAB = UVIX * EXPT - UVII * IMPT + ER
22. GCF = GCFDIFF + (PCFAG + PCFNAG + PIAG + PINAG) * PGKE
23. SAV = GCF - CAPTR + CAB
24. BOP = CAB + FDI + NIF

Endogenous variables (in Rs. '000 Crores):

1. DT: Direct taxes of both central and state govts. (Nominal)
2. DIT: Indirect taxes of both central and state govts. (Nominal)
3. NTX: Non-tax revenue of both central and state govts. (Nominal)
4. CONS: Government Consumption Expenditure (Nominal)
5. DNB: Government Non-Market Borrowings of both central and state govts. (Nominal)
6. P: Wholesale Price Index (1993-94=1.0)
7. PGDP: GDP deflator (1993-94=1.0)
8. PGKE: Gross investment deflator (1993-94=1.0)
9. M3: Money Supply
10. PC: Real Private Consumption
11. PIAG: Real Gross Private Investment in Agriculture
12. PINAG: Real Gross Private Investment in Non-Agriculture
13. PIMN: Real Gross Private Investment in Manufacturing
14. PIINF: Real Gross Private Investment in Infrastructure
15. PISR: Real Gross Private Investment in Services
16. YAR: Real Output in Agriculture
17. YNAR: Real Output in Non-Agriculture
18. YMNR: Real Output in Manufacturing
19. YINFR: Real Output in Infrastructure
20. YSR: Real Output in Services
21. DEPAG: Real Depreciation in Agriculture
22. DEPNAG: Real Depreciation in Non-Agriculture
23. DEPMN: Real Depreciation in Manufacturing
24. DEPINF: Real Depreciation in Infrastructure
25. EXPT: Real Exports

26.	UVIX:	Unit Value of Exports (1993-94=1.0)
27.	IMPT:	Real Imports
28.	EXR:	Exchange Rate against US $ (Nominal, Rs./$)
29.	PYDR:	Real Disposable Income
30.	IB:	Nominal Interest Rate (%) on 3-Year bank deposits
31.	PYD:	Personal Disposable Income (Nominal)
32.	YR:	Real Output at factor cost
33.	Y:	Nominal Output at factor cost
34.	YM:	Gross Domestic Product at Market Prices (Nominal)
35.	KAGR:	Real Net Capital Stock in Agriculture
36.	KNAGR:	Real Net Capital Stock in Non-Agriculture
37.	KMNR:	Real Net Capital Stock in Manufacturing
38.	KINFR:	Real Net Capital Stock in Infrastructure
39.	KSRR:	Real Net Capital Stock in Services
40.	ABSP:	Real Private Absorption
41.	ADD:	Real Aggregate Demand
42.	AD:	Real Aggregate Absorption
43.	GXP:	Government Total Expenditure of both central and state govts. (Nominal)
44.	TR:	Government Current Revenue of both central and state govts. (Nominal)
45.	FD:	Fiscal Deficit of both central and state govts. (Nominal)
46.	RCG:	Reserve bank credit to the govt.
47.	BCP:	Bank Credit to Commercial Sector (Nominal)
48.	RM:	Reserve money
49.	CAB:	Current account balance (Nominal)
50.	GCF:	Gross domestic capital formation, adjusted series (Nominal)
51.	SAV:	Gross domestic savings (Nominal)
52.	BOP:	Balance of payments (Nominal)

Exogenous Variables (in Rs. '000 Crores):

1.	RAIN:	Annual Rainfall (mm)
2.	AREA:	Index of Gross Cropped Area (1993-94=1.0)
3.	PCFAG:	Real Gross Public Investment in Agriculture
4.	PCFNAG:	Real Gross Public Investment in Non-Agriculture
5.	RBCS:	RBI credit to the commercial sector (Nominal)
6.	GCL:	Government current liabilities to the public (Nominal)
7.	RNML:	RBI's net non-monitory liabilities (Nominal)
8.	BCG:	Bank Credit to Government (Nominal)
9.	ORV:	Other Revenues (Nominal)
10.	UVII:	Unit Value of Imports (1993-94=1.0)
11.	WYR:	Real World Income
12.	WPEXP:	World Price Index (1993-94=1.0)
13.	FDI:	Foreign Direct Investment (Nominal)
14.	NIF:	Net Capital Inflows (Nominal)
15.	TRP:	Transfer payments
16.	CAPTR:	Capital transfers to govt.
17.	RES:	Residual components of Bank credit to commercial sector
18.	RES1:	Residual for net capital stock in agriculture

19. RES2:   Residual for net capital stock in non-agriculture
20. MISL: Miscellaneous components of Reserve Money
21. MISCR: Other components of RBI credit to govt.
22. ER: Current Account Balance excluding Trade Balance
23. DUMMY1: Dummy for post reform period (1991-92 onwards)
24. DUMMY2: Dummy for sharp decline in Private Investment in Agriculture
25. DUMMY3: Dummy for sharp decline in Private Investment in Non-Agriculture
26. DUMMY4: Dummy for sharp decline in Inflation (post 90s)
27. DUMMY5: Dummy for sharp increase in output of Infrastructure (1993-98)
28. RBFA: Net Foreign Exchange Assets of RBI (Nominal)
29. CAPB: Net capital account in the balance of payments (Nominal)

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Table-1: Annual Compound Growth Rates (%) of variables used in the model.

Variable	Annual Compound Growth Rate (%)			
	(1980-89)	(1990-99)	(1980-03)	(1993-03)
Real Sector				
Nominal Income	13.9	15.2	14.5	12.4
GDP Deflator	8.1	8.5	8.4	6.1
Real Income	5.4	6.2	5.7	6.0
Agriculture	3.0	3.2	3.0	2.2
Non-agriculture	6.8	7.4	6.9	7.4
Manufacturing	7.3	6.9	6.6	5.9
Infrastructure	5.4	6.8	6.5	8.0
Services	7.1	7.9	7.2	7.9
Real Private Consumption	4.1	4.9	4.4	5.1
Real Personal Disposable Income	6.6	7.0	6.5	7.1
Gross Domestic Savings (N)	16.2	15.4	16.2	12.7
Gross Investment (N)	16.8	15.0	15.6	11.7
Fiscal Sector	0.0	0.0	0.0	0.0
Govt. Consumption (N)	15.4	16.3	14.6	16.6
Govt. Total Expenditure(N)	16.2	14.1	14.3	13.8
Govt. Revenue (N)	15.9	13.6	14.1	12.1
Direct Taxes (N)	14.5	18.9	17.2	15.2
Indirect Taxes (N)	16.5	12.1	13.4	11.1
Non-tax Revenue (N)	14.7	14.2	13.8	12.2
Fiscal Deficit (N)	18.7	15.8	15.4	17.2
Govt. Non-market Borrowings (N)	19.1	15.0	14.9	19.3
Monetary Sector	0.0	0.0	0.0	0.0
Money Supply	17.3	17.4	17.2	16.6
Price Level	6.6	7.8	7.7	5.5
Rate of Inflation (%)	-4.9	-12.7	-3.0	-10.3
Rate of Interest (%)	0.8	-1.7	-0.8	-7.5
External Sector	0.0	0.0	0.0	0.0
Real Exports Demand	4.2	12.0	9.6	12.6
Real Imports Demand	6.3	15.3	9.8	10.7
Unit Value of Exports	9.7	7.5	9.2	3.6
Exchange Rate (N)	7.6	9.1	9.4	5.7
Trade Balance (N)#	3.8	79.8	8.7	47.1
Real Private Investment	5.3	8.2	6.3	2.4
Agriculture	2.6	3.5	4.2	4.8
Non-agriculture	5.6	8.7	6.6	2.1
				Contd…….

Manufacturing	6.0	11.7	6.9	1.0
Infrastructure	5.3	5.2	5.9	2.0
Services	5.6	4.8	6.3	4.0
Real Public Investment	4.5	2.2	2.5	1.1
Agriculture	-3.9	-0.1	-2.1	-0.8
Non-agriculture	5.6	2.3	2.9	1.2
Manufacturing	7.3	0.1	-0.1	-4.7
Infrastructure	6.4	1.8	3.9	1.9
Services	3.3	5.1	3.7	3.6
Real Total Investment	4.9	6.0	4.8	1.9
# In absolute values.				

Table-2: Annual average for all the variables.

Variable/Year	Annual Average*			
	(1980-89)	(1980-89)	(1980-89)	(1980-89)
Real Sector				
Nominal Income	253.3	1053.9	839.6	1500.5
GDP Deflator	0.5	1.1	0.9	1.4
Real Income	510.7	886.9	772.2	1052.2
Agriculture	184.2	254.2	228.6	274.1
Non-agriculture	326.5	632.8	543.6	778.0
Manufacturing	90.4	172.9	146.4	206.4
Infrastructure	70.0	128.9	113.3	159.9
Services	166.1	330.9	283.9	411.8
Real Private Investment	71.9	148.1	118.0	168.2
Agriculture	7.8	12.3	10.8	13.6
Non-agriculture	64.1	135.8	107.2	154.6
Manufacturing	35.0	79.6	60.2	89.0
Infrastructure	9.2	17.8	14.6	20.2
Services	19.9	38.4	32.3	45.3
Real Private Consumption	417.0	637.6	570.6	734.0
Real Personal Disposable Income	438.8	812.5	701.6	983.2
Gross Domestic Savings (N)	55.8	269.5	213.8	392.1
Gross Investment (N)	61.6	284.8	221.1	399.6
Fiscal Sector	1.0	1.0	1.0	1.0
Govt. Consumption (N)	40.6	151.5	130.8	235.3
Govt. Total Expenditure(N)	82.7	310.2	256.7	452.5
Govt. Revenue (N)	54.4	208.4	167.9	294.1
Direct Taxes (N)	7.2	38.6	31.4	59.6
Indirect Taxes (N)	36.0	128.9	102.7	175.4
Non-tax Revenue (N)	11.2	40.9	33.7	59.1
Fiscal Deficit (N)	23.5	91.2	78.6	142.1

Govt. Non-market Borrowings (N)	15.6	56.1	49.4	88.0
Monetary Sector	1.0	1.0	1.0	1.0
Money Supply	123.1	612.7	516.9	971.0
Price Level	0.5	1.1	0.9	1.4
Rate of Inflation (%)	8.0	8.1	7.6	6.1
Rate of Interest (%)	9.9	11.0	10.0	9.8
External Sector	1.0	1.0	1.0	1.0
Real Exports Demand	45.2	112.4	99.2	161.6
Real Imports Demand	45.6	117.1	98.3	161.4
Unit Value of Exports	0.4	1.0	0.8	1.2
Exchange Rate (N)	11.6	31.7	24.9	39.2
Trade Balance (N)	-5.1	-13.4	-10.8	-18.4
Real Public Investment	57.5	74.3	67.7	77.8
Agriculture	6.4	4.8	5.5	4.9
Non-agriculture	51.1	69.4	62.2	72.9
Manufacturing	15.1	16.5	15.1	14.6
Infrastructure	22.0	32.8	28.9	35.5
Services	14.1	20.1	18.2	22.8
Real Total Investment	129.5	222.4	185.7	246.0
Real GDP Share (%)				
Agriculture	36.4	29.1	31.5	26.5
Non-agriculture	63.6	70.9	68.5	73.5
Manufacturing	17.6	19.4	18.6	19.6
Infrastructure	13.7	14.5	14.4	15.1
Services	32.3	37.0	35.5	38.8
Real Private Investment Share (%)				
Agriculture	6.2	5.6	5.9	5.6
Non-agriculture	49.1	60.1	55.6	62.5
Manufacturing	26.6	34.8	30.8	35.9
Infrastructure	7.1	8.0	7.7	8.2
Services	15.4	17.3	17.0	18.4
Real Public Investment Share (%)				
Agriculture	5.2	2.2	3.5	2.0
Non-agriculture	39.6	32.0	35.0	29.9
Manufacturing	11.6	7.6	8.9	5.9
Infrastructure	17.0	15.2	16.0	14.6
Services	11.0	9.2	10.1	9.3

*: Rs. '000 crores, except GDP deflator, Price level, Rate of inflation, Rate of interest, Unit value of exports and Exchange rate.
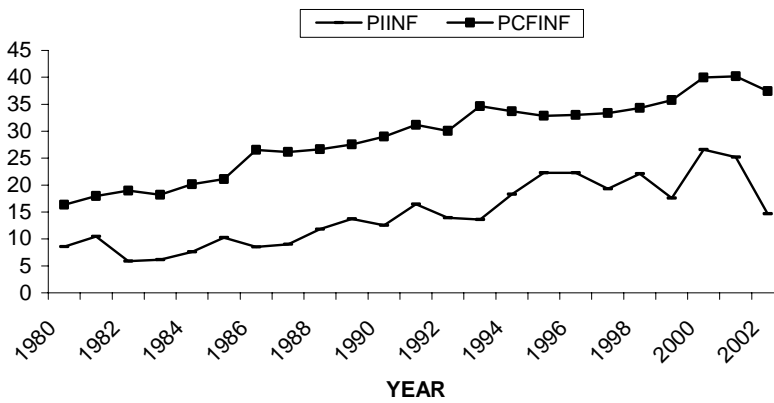
Appendix-II

Trends in observed values of real private and public investment in agriculture sector (Rs. '000 crores)
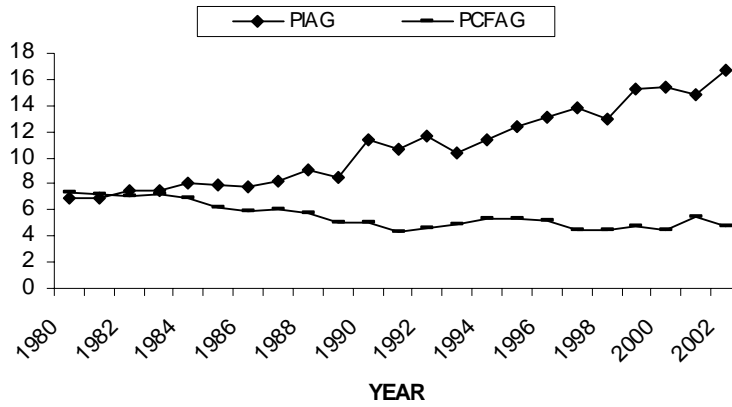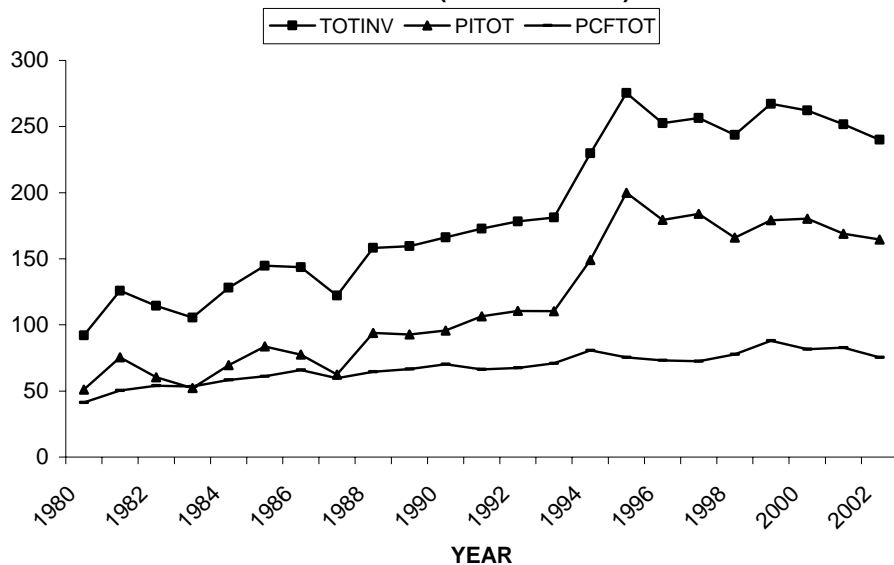

Trends in observed values of real private and public investment in manufacturing sector (Rs. '000 crores)
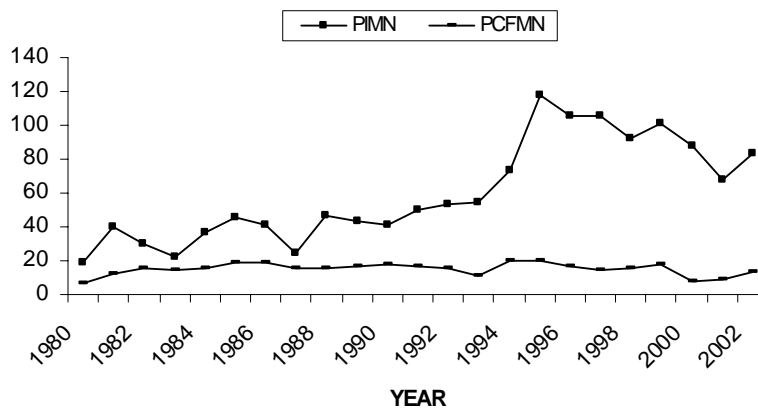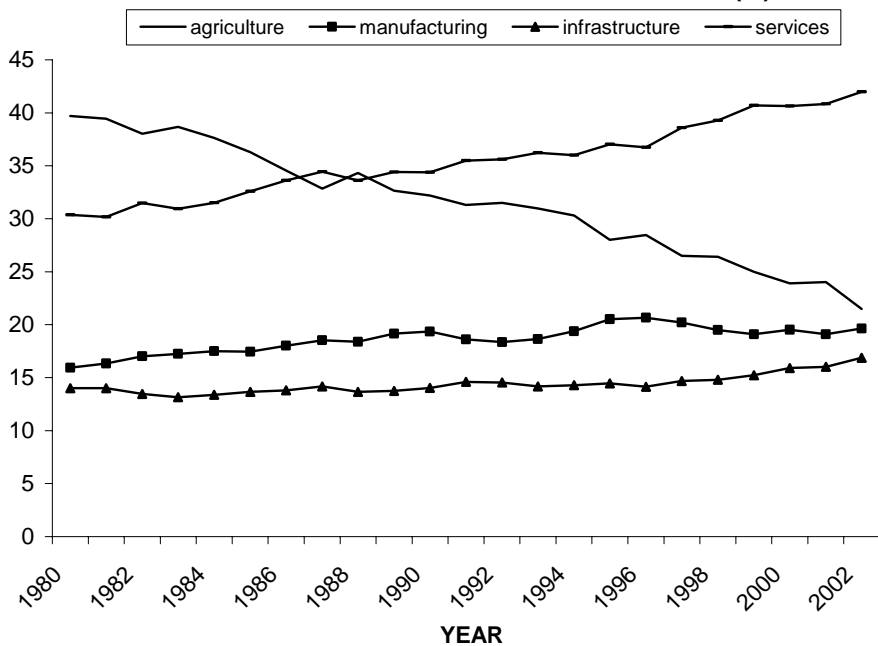

Trends in real private and public investment in infrastructure sector (Rs. '000 crores)
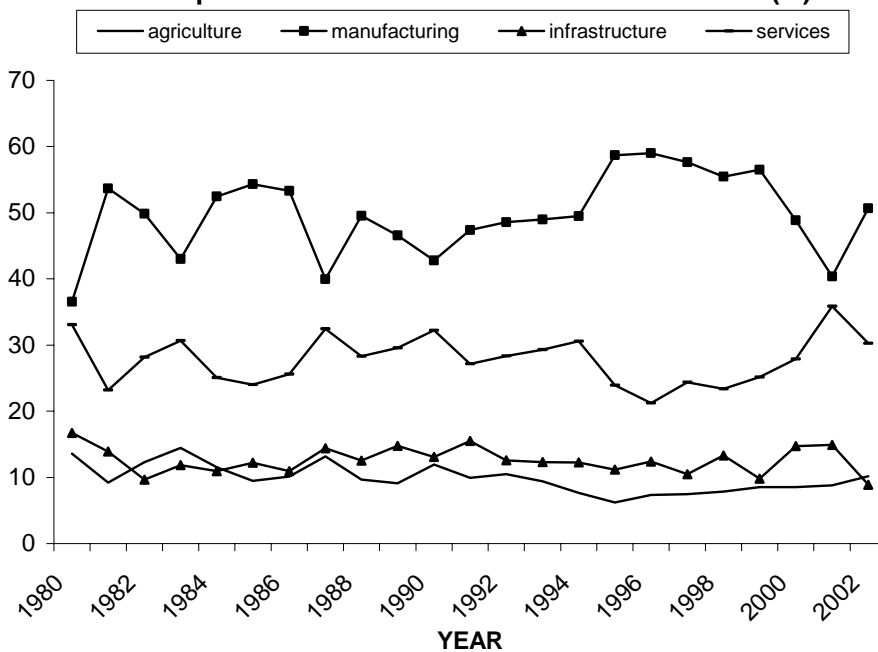
Trends in observed values of private, public and aggregate investment (Rs. '000 crores)
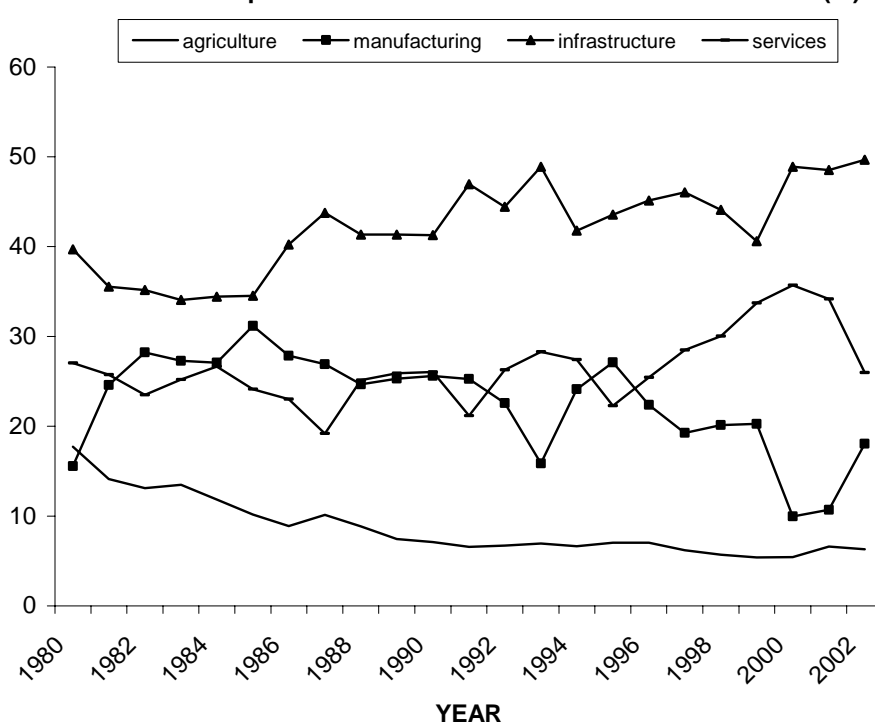

Share of sectoral real GDP in total real GDP (%)

Share of private sector investment in total investmnet(%)

Share of real public sector investmnet in real total investmnet(%)

Appendix-III

Main-Model:

System: SYS01
Estimation Method: Three-Stage Least Squares
Date: 02/22/06   Time: 11:05
Sample: 1981 2002
Included observations: 23
Total system (unbalanced) observations 483
Iterate coefficients after one-step weighting matrix
Convergence achieved after: 1 weight matrix, 185 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-42.88728	4.486259	-9.559698	0.0000
C(2)	0.165666	0.008229	20.13098	0.0000
C(3)	-17.62706	4.954807	-3.557568	0.0004
C(4)	0.812772	0.038733	20.98390	0.0000
C(6)	14.08689	2.658518	5.298776	0.0000
C(7)	0.107438	0.002117	50.76119	0.0000
C(8)	0.485336	0.060927	7.965894	0.0000
C(12)	0.036293	0.000600	60.47889	0.0000
C(13)	0.340657	0.044597	7.638587	0.0000
C(17)	0.040031	0.003917	10.21913	0.0000
C(18)	-7.074873	1.432896	-4.937463	0.0000
C(19)	0.864294	0.026500	32.61512	0.0000
C(20)	-0.367717	0.071258	-5.160322	0.0000
C(21)	0.063914	0.003773	16.93767	0.0000
C(22)	0.591445	0.060366	9.797718	0.0000
C(26)	-0.000189	4.65E-05	-4.071708	0.0001
C(27)	5.73E-05	3.07E-05	1.867189	0.0626
C(28)	0.007641	0.001903	4.016187	0.0001
C(29)	0.939486	0.034639	27.12192	0.0000
C(30)	0.010823	0.001460	7.410299	0.0000
C(31)	-0.067224	0.011617	-5.786659	0.0000
C(32)	1.069649	0.011044	96.85225	0.0000
C(33)	0.551368	0.054864	10.04978	0.0000
C(37)	0.942511	0.014736	63.95986	0.0000
C(38)	0.763108	0.043580	17.51056	0.0000
C(41)	-71.58572	19.92859	-3.592112	0.0004
C(42)	0.438305	0.066559	6.585192	0.0000
C(44)	-16.24986	3.321283	-4.892646	0.0000
C(43)	1.123980	0.005163	217.6936	0.0000
C(46)	168.1541	3.930577	42.78102	0.0000
C(47)	0.605754	0.007475	81.03978	0.0000
C(48)	-0.181803	0.030904	-5.882864	0.0000
C(49)	0.423113	0.041239	10.25991	0.0000
C(51)	0.029173	0.002673	10.91338	0.0000
C(52)	0.180179	0.046113	3.907335	0.0001

C(53)	-0.102180	0.040323	-2.534058	0.0117
C(54)	0.231354	0.031977	7.234994	0.0000
C(55)	0.079893	0.010145	7.875447	0.0000
C(56)	0.255036	0.049570	5.144972	0.0000
C(57)	0.531398	0.072334	7.346417	0.0000
C(58)	1.343105	0.052363	25.65011	0.0000
C(59)	-1.883784	0.371284	-5.073706	0.0000
C(60)	-23.29026	1.714744	-13.58235	0.0000
C(61)	44.61125	2.480908	17.98182	0.0000
C(65)	-250.9925	9.442012	-26.58252	0.0000
C(66)	0.038700	0.003302	11.72151	0.0000
C(67)	207.7334	11.66820	17.80338	0.0000
C(68)	0.671075	0.020992	31.96839	0.0000
C(69)	0.354201	0.019423	18.23615	0.0000
C(70)	-0.435441	0.049709	-8.759888	0.0000
C(71)	-135.5278	10.32277	-13.12901	0.0000
C(72)	0.281424	0.019907	14.13716	0.0000
C(73)	0.195259	0.012091	16.14857	0.0000
C(74)	0.221460	0.028025	7.902220	0.0000
C(75)	0.430076	0.055520	7.746368	0.0000
C(76)	-11.94268	0.791282	-15.09283	0.0000
C(77)	0.076353	0.002458	31.06202	0.0000
C(78)	0.609179	0.033536	18.16494	0.0000
C(81)	-24.80339	1.204512	-20.59206	0.0000
C(82)	0.054834	0.000616	88.94723	0.0000
C(83)	0.482646	0.030692	15.72552	0.0000
C(86)	72.09646	12.87629	5.599162	0.0000
C(87)	-1808.957	323.0807	-5.599087	0.0000
C(88)	0.002145	0.000109	19.68274	0.0000
C(89)	-57.54814	4.832714	-11.90804	0.0000
C(91)	0.218634	0.074048	2.952608	0.0033
C(92)	-8.433785	1.620647	-5.203960	0.0000
C(93)	8.79E-06	4.41E-07	19.93915	0.0000
C(94)	0.485143	0.024298	19.96679	0.0000
C(95)	-0.001008	0.000173	-5.822572	0.0000
C(96)	-0.219547	0.081867	-2.681749	0.0076
C(101)	-1.804003	0.214602	-8.406256	0.0000
C(102)	0.119648	0.011207	10.67632	0.0000
C(103)	-5.032205	0.908208	-5.540809	0.0000
C(104)	0.401050	0.022439	17.87326	0.0000
C(105)	0.502331	0.074872	6.709234	0.0000
C(106)	-3.197032	0.735398	-4.347348	0.0000
C(107)	29.06916	0.735636	39.51567	0.0000
C(108)	-0.044463	0.013716	-3.241771	0.0013
C(109)	0.074051	0.008770	8.443379	0.0000
C(110)	0.379520	0.057400	6.611827	0.0000
C(116)	-98.60966	12.60303	-7.824281	0.0000
C(117)	1.032295	0.014082	73.30769	0.0000
C(118)	0.577396	0.048151	11.99136	0.0000
C(121)	11.95981	0.564970	21.16893	0.0000
C(122)	0.017635	0.001507	11.69917	0.0000

	Coefficient	Std. Error	t-Statistic	Prob.
C(123)	-4.370077	0.762989	-5.727577	0.0000
C(124)	-0.015861	0.001088	-14.57349	0.0000
C(125)	1.508926	0.115404	13.07512	0.0000
C(126)	0.886339	0.091467	9.690286	0.0000
C(127)	0.824856	0.042658	19.33663	0.0000

Sub-model:

System: SYS02
Estimation Method: Three-Stage Least Squares
Date: 02/22/06   Time: 11:28
Sample: 1981 2002
Included observations: 23
Total system (balanced) observations 132
Iterate coefficients after one-step weighting matrix
Convergence achieved after: 1 weight matrix, 16 total coef iterations

|	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.044053	0.018838	2.338470	0.0211
C(2)	0.054989	0.028369	1.938343	0.0551
C(3)	5.163117	1.652987	3.123508	0.0023
C(4)	0.510994	0.199916	2.556038	0.0119
C(6)	-35.07817	4.415674	-7.944013	0.0000
C(7)	0.410728	0.011613	35.36928	0.0000
C(8)	-17.28004	2.926875	-5.903921	0.0000
C(11)	-52.30723	14.91465	-3.507105	0.0006
C(12)	3.233351	0.747661	4.324621	0.0000
C(13)	3.064276	0.814695	3.761254	0.0003
C(14)	0.332329	0.157133	2.114955	0.0366
C(16)	0.238298	0.103107	2.311173	0.0226
C(17)	0.547152	0.196928	2.778432	0.0064
C(21)	14.79042	3.681111	4.017923	0.0001
C(22)	0.037031	0.005447	6.798367	0.0000
C(23)	0.107801	0.066757	1.614816	0.1091
C(26)	-4.063283	1.378871	-2.946818	0.0039
C(27)	0.078612	0.003458	22.73293	0.0000

Appendix-IV
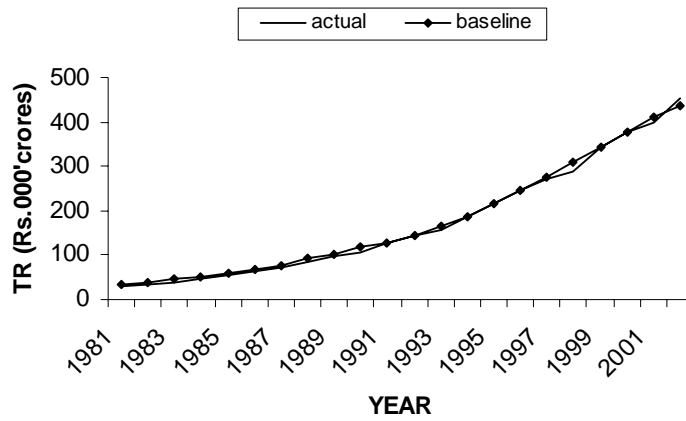
Actual and Baseline values of Real output
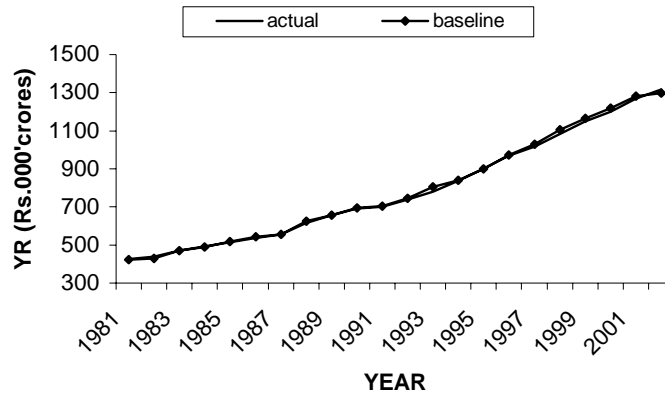
Actual and Baseline values of Price level
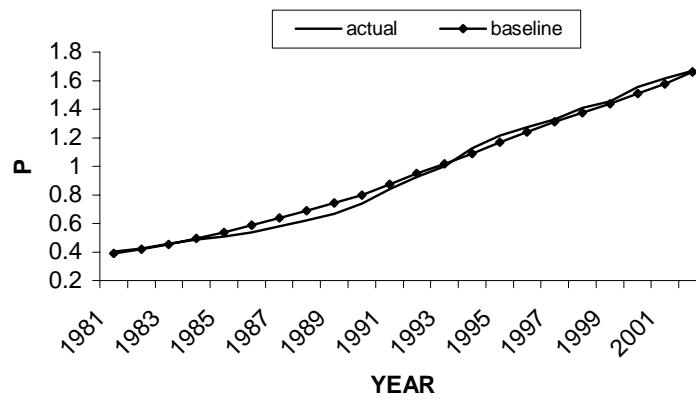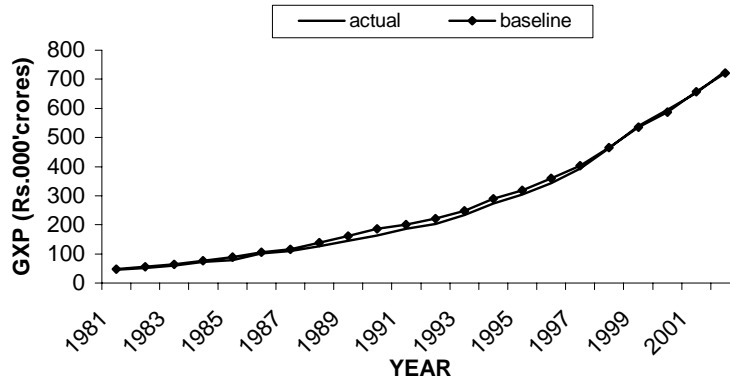

Actual and Baseline values of real private consumption
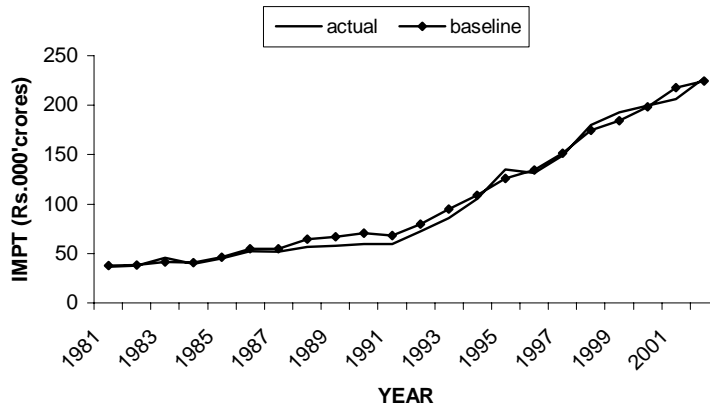

34
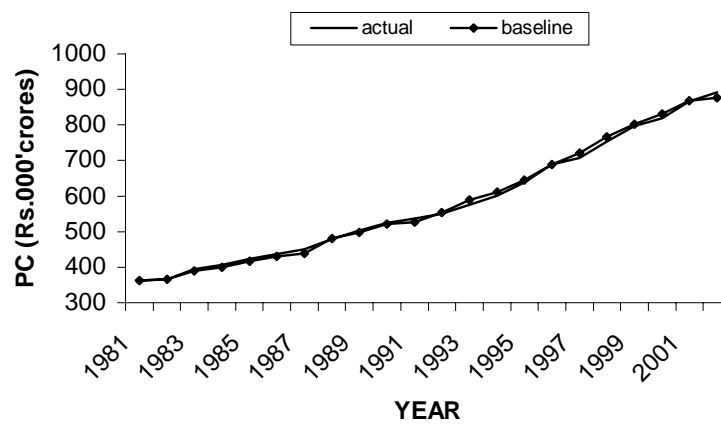
Actual and baseline values of nominal govt. revenue

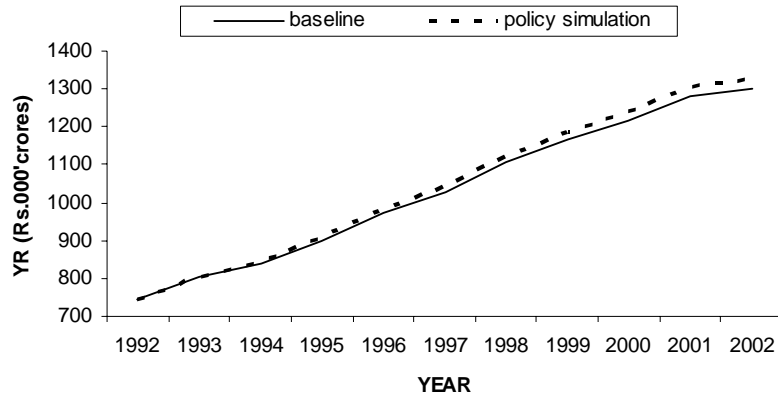**Actual baseline values of nominal govt. total expenditure**
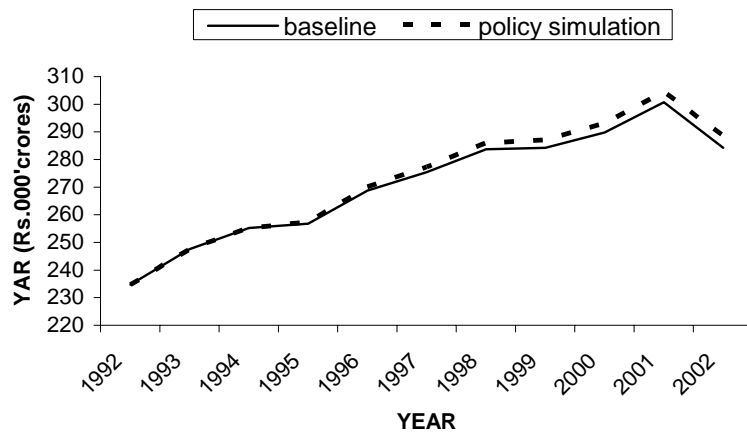

Actual and baseline values of Real imports

Appendix-V

Figure-1: Impact of 10% sustained increase in public investment in infrastructure on real aggregate output

Impact of 10% sustained increase in public investment in infrastructure on agriculture output
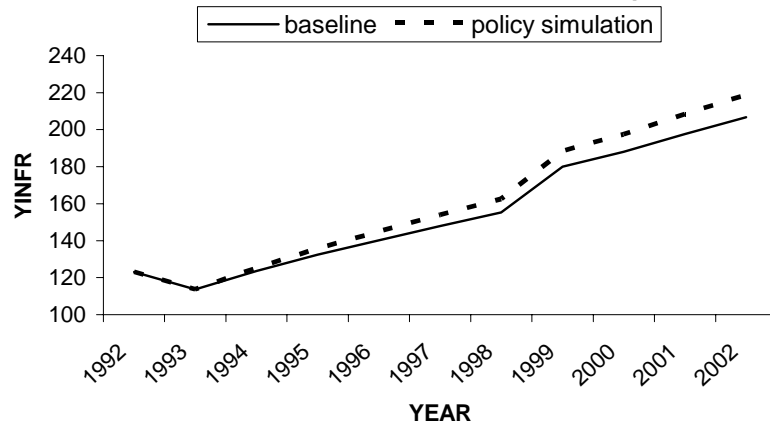

Impact of 10% sustained increase in public investment in infrastructure on infrastructure output

Figure-4: Impact of 10% sustained increase in public investment in infrastructure on real private investment in infrastructure
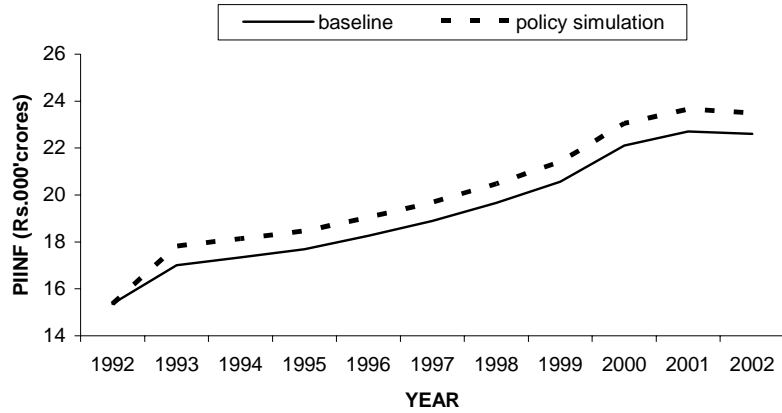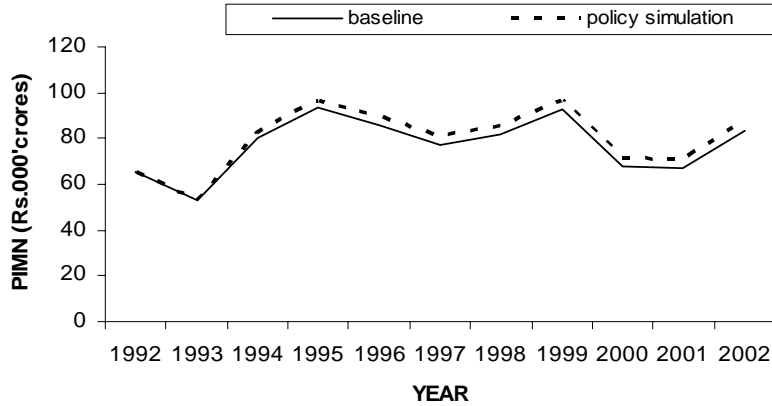

Figure-5:Impact of 10% sustained increase in public investment in infrastructure on real private investment in manufacturing

Impact of 10% sustained increase in public investment in infrastructure on real interest rate