Examining the differential impact of monetary policy in India: a policy simulation approach

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Abstract

Purpose – Though an accumulating body of study has analysed monetary policy transmission in India, there are few studies examining the differential impact of monetary policy action. Against this backdrop, this study aims to analyse the differential impact of monetary policy on aggregate demand, aggregate supply and their components along with the general price level in India.

Design/methodology/approach – The study develops a structural macroeconometric model, which is primarily aggregate and eclectic in nature. The generalized method of movements is used for estimation of behavioural equations, while a Gauss–Seidel algorithm is used for model simulation purposes.

Findings – The paper presents the results of two policy simulations from the estimated model that highlight the differential impact of monetary policy. The first one, hike in the policy rate by 5% and second is a reduction in bank credit to the commercial sector by 10%. The results from the first policy simulation experiment reveal that interest hike has a significant negative impact on aggregate demand, aggregate supply and general price level. However, the maximum impact is borne by investment demand and imports followed by private consumption. While as among the components of aggregate supply maximum impact is born by infrastructure output followed by the manufacturing and services sector with the agriculture sector found to be insensitive in nature. The results from the second policy simulation experiment revealed that pure monetary shocks have a significant negative impact on aggregate demand, aggregate supply and general price level. However, the maximum impact is born by private consumption and imports followed by investment demand. While as among components of aggregate supply maximum impact is borne by infrastructure followed by the manufacturing and services sector with the agriculture sector found to be insensitive in nature. From both policy simulation experiments, the study highlighted the relative importance of the income absorption approach as opposed to the expenditure switching effect.

Practical implications – The results obtained in this study provides a strong framework for design the monetary policy framework. The results are in a view of the differential impact of monetary policy action among the components of both aggregate demand and aggregate supply. This reflection of differential impact has immense significance for the macroeconomic stabilization as the central bank will have to weigh the varying repercussion of its actions on different sectors. For instance, the decline in output after monetary tightening might be conceived as mild from an overall perspective, but it can be appreciable for some sectors. This differential influence will have an implication for policy design to care for distributional aspects, which otherwise could be neglected/disregarded. Similarly, the output decline may be as a result of either consumption postponement or a temporary slowdown in investment. However, the one emanating due to investment decline will have lasting growth implications compared to a decline in consumer demand. In addition, the relative strength of expenditure changing or expenditure switching policies of trade balance stabilization may have varying consequences in the aftermath of monetary policy shock. Accordingly information on the relative sensitiveness/insensitiveness of different sectors/ components of aggregate

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demand towards monetary policy actions furnish valuable insights to monetary authorities in framing appropriate policy.

Originality/value – The work carried out in the present paper is motivated by the fact that although a number of studies have examined the monetary transmission mechanism in India, a very few studies examining the differential impact of monetary policy action. However, to the best of the knowledge, there is no such studies, which have examined the differential impact of monetary policy in the structural macro-econometric framework. The paper will enrich the existing literature by providing a detailed account of the differential impact of monetary policy among the components of both aggregate demand and aggregate supply in response to an interest rate hike, as well as a decrease in the money supply.

Keywords Monetary policy, Structural macro-econometric model, GMM, Policy simulations, India

Paper type Research paper

1. Introduction

A consensus about the "non-neutrality of money" has emerged from a spate of the empirical literature on monetary transmission. Although not permanent, monetary policy actions have a persistent effect on output and prices with some lags/delays (Friedman and Schwartz, 1963; Romar and Romar, 1989; Bernanke and Blinder, 1992; Christiano *et al.*, 1994; Mohanty, 2012; Khundrakpum, 2012) [1]. However, how exactly the monetary policy exerts its influence on real output and prices through different but related channels of transmission is still a contentious issue and is usually referred to as "black box" (Bernanke and Gertler, 1995; Khundrakpum and Jain, 2012). Implying certainty of effect but the uncertainty of how it does is mainly due to the simultaneous operation of different channels and their dynamic behaviour over time (Mohanty, 2012).

Traditionally, four key channels of monetary transmission have been examined and assessed to ponder upon the mechanism of monetary transmission. These include traditional interest rate channel (Taylor, 1995), credit channel (Bernanke and Gertler, 1995), exchange rate channel (Obstfeld and Rogoff, 1995) and the asset price channel (Meltzer, 1995) [2]. Recently another channel, namely, expectation channel has also been introduced to explain the conduct of monetary policy through forward-looking behaviour (Yellen, 2011; Joyce *et al.*, 2011). These various channels have been distinguished in the literature along the lines of neoclassical and non-neoclassical perspective [3]. The functions and interactions of these channels in a given economy are mostly conditioned upon operating procedures and framework of monetary policy, structure and depth of financial system along with the stage of development [4].

Effectiveness of monetary policy transmission in India has been analysed by several studies in the recent period (Nachane *et al.*, 2002; Pandit *et al.*, 2006; Singh and Kalirajan, 2007; Ghosh, 2009; Aleem, 2010; Patra and Kapur, 2012; Bhattacharya *et al.*, 2011; Dhal, 2011; Mohanty, 2012; Khundrakpum, 2012, 2013; Khundrakpum and Jain, 2012; Kapur and Behera, 2012; Sengupta, 2014; Bhoi *et al.*, 2016; Khundrakpum, 2017). These studies encompass a consensus on the real effects of monetary policy with some differences in persistence and lag of effect.

Most of the studies assessing the effectiveness of monetary policy in the existing paradigm, except a few such as (Nachane *et al.*, 2002; Dhal, 2011; Sengupta, 2014; Khundrakpum, 2012, 2013, 2017) connote a uniform effect of monetary policy on the aggregate economy. However, given the heterogeneous nature of an economy, composed of diverse but interlinked sectors, the effect of the monetary policy stance might not be uniform (Nachane *et al.*, 2002). Scarcely literature has now witnessed a shift from the existing paradigm of the uniform impact of monetary policy shocks to whether money matters

differently to different but interlinked sectors or regions (Alam and Waheed, 2006; Sengupta, 2014).

This reflection of differential impact has immense significance for the macroeconomic stabilization as the central bank will have to weigh the varying repercussion of its actions on different sectors (Alam and Waheed, 2006). For instance, the decline in output after monetary tightening might be conceived as mild from an overall perspective, but it can be appreciable for some sectors. This differential influence will imply a policy design to care for distributional aspects that otherwise could be neglected/disregarded. Similarly, the output decline may be a result of either consumption postponement or a temporary slowdown in investment. However, the one emanating due to investment decline will have lasting growth implications compared to a decline in consumer demand. Also, the relative strength of expenditure changing or expenditure switching policies of trade balance stabilization may have varying consequences in the aftermath of monetary policy shock. Accordingly, information on the relative sensitiveness/insensitiveness of different sectors/components of aggregate demand towards monetary policy actions furnishes valuable insights to monetary authorities in framing appropriate policy.

It may be noted that the interest rate serves as the main instrument of monetary policy signaling in India under the liquidity adjustment facility, as the beginning of the 2000s with the abandonment of monetary targeting framework by 1998. However, given the cash-intensive nature of the Indian economy, it may be argued that changes in the money supply, whether planned or unplanned, anticipated or unanticipated could have a significant impact on the real economy (Khundrakpum, 2013). In fact, the projection of monetary aggregates by Reserve bank of India (RBI) in its monetary policy review reflects its continued relevance in policy considerations. To fill the gap, the study attempts to answer the flowing questions. First, is the impact of monetary policy shocks as defined by changes in interest rate different from those defined by changes in pure money supply? Second do components of aggregate supply and aggregate demand respond differentially to these shocks?

The rest of the paper is organized as follows: Section 2 provides a brief overview of the existing literature. Section 3 outlines the structural specification of the model. Section 4 provides estimation, data and result in the discussion. Model evaluation and the results of policy simulations are discussed in Section 5. Finally, the paper concludes with a discussion of results and policy implications in Section 6.

2. Literature review

2.1 General literature

The genesis of monetary transmission at a disaggregated level can be traced back to seminal works of Stiglitz and Weiss (1981) on asymmetric information, market imperfection and moral hazards, Bernanke and Gertler (1995) for balance sheet channel and Kashyap *et al.* (1992) and Kashyap and Stein (1995) for bank lending channel [5]. Afterwards on, scholars emphasized on product heterogeneity, capital and labour intensity of input mixture, the financial structure of firms, trade openness and price rigidities in products, and hence, contributed to evolving literature on disaggregated monetary transmission mechanism. Firstly, because of different financial or leverage structure of firms leading to varying external finance premium as postulated by credit channel of monetary transmission mechanism provides an explanation for the heterogeneous impact of monetary policy (Bernanke and Gertler, 1995). Thus, the smaller firms, which are usually dependent on domestic banks for their credit needs are more affected than larger firms, which have easier and greater access to non-bank and external sources of finance (Jansen *et al.*, 2013). The studies conducted by Gertler and Gilchrist (1993), Kashyap *et al.* (1994); Domac (1999), Barth

and Ramey (2000); Dedola and Lippi (2005) and Jansen *et al.* (2013) provided empirical support to the heterogeneous impact of monetary policy shocks in terms of product durability, firm size, financing requirement and borrowing capacity.

Secondly, the nature and leverage of products differ from sector to sector. Generally, investment and capital goods are associated with longer gestation periods, large investment requirements, are usually highly valued and financed through credit, unlike consumer goods. Thus, changing interest rates will lead to more alterations in the real cost of these goods than consumer goods and along with their demand (Sengupta, 2014; Peersman and Smets, 2002; Angeloni *et al.*, 2003; and Jakab *et al.*, 2006). The studies offered an explanation of the differential monetary policy impacts. Thirdly, variation in capital-labor intensity among different production sectors provides yet another possible explanation for the heterogeneity effects (Berument *et al.*, 2007; Hayo and Uhlenbrock, 1999; Ganley and Salmon, 1997). The studies reported the substantial response of capital-intensive than labor-intensive industries, heavy industries than non-durable and manufacturing, construction and transportation than sectors such as financial services and utilities to a monetary policy shock.

Fourthly, product characteristics such as being durable and non-durable provide another important illustration (Mishkin, 1976; Haimowitz, 1996; Kretzmer, 1989; Dedola and Lippi, 2005; Peersman and Smets, 2002; Erceg and Levin, 2002) to the differential impact of monetary policy shocks. Fifthly, a combination of tradable and non-tradable goods and domestic and imported raw material varies across firms. Thus, the sensitiveness of different sectors to exchange rate channels of monetary transmission plays an important role in explaining the heterogeneous effects (Llaudes, 2007).

2.2 Studies specifically for India

A few studies have analysed the disaggregated monetary transmission mechanism in the case of India as well. Nachane *et al.* (2002), Ghosh (2009); Dhal (2011), Khundrakpum (2012); Sengupta (2014) and Khundrakpum (2013) examined the differential effects of policy rate and money supply shocks in India using the data for different periods and of different frequencies. The studies supported the real effects of both the shocks along with differential impact among the components of aggregate demand.

After reviewing the available studies in general and those focussing on India in particular, a common thread running through all is the heterogeneous response to monetary policy shocks emanating from components of aggregate demand and aggregate supply. However, it can be observed from above that this issue has not been studied rigorously in the context of India, especially with due consideration to all intersectoral linkages in the overall macro-econometric framework. Hence, the study is an attempt to fill this gap at an empirical level.

2.3 Specification, estimation and data of the model

The model presented here is theoretically eclectic and primarily belongs to Tinbergen–Klein–Goldberger tradition. The causal structure of the model is simultaneous in nature developed for policy simulations. While most of the early models tend to rely either on Keynesians or Classical framework, the present model, however, takes into consideration both demand and supply-side factors. However, in many developing countries such as India, the supply-side constraint is a major problem (Khan *et al.*, 2011). To gain comprehensive insights of supply-side factors and heterogeneous dynamics in terms of production, price and investment behaviour, we specify production functions, investment function and price

function for agriculture, manufacturing, service and infrastructure sectors separately (Bhattacharya and Kar, 2008).

Regarding the nature of the effectiveness of money supply on prices and output, the model strives a balance between classical and Keynesian approach. The simplicity of the model is a deliberate attempt, to whip out black box causal effect relationships and make them transparent, as it happens in large-scale macro models. Thus, assisting policymakers to see how policy shocks/exogenous variables are affecting the outcome variable. The flexible and adaptable nature of the model gives an eternal way out to change instruments and target variables to answer different policy questions. Further, if policy question desires so, sub-components of the model can be easily expanded, and thus basic nature of the model is so-called "work in progress". The present model has been applied to track the differential impact of policy rate and money supply on various components of aggregate demand and aggregate supply. Finally, the specific equations are – a subset of those with the higher goodness of fit, appropriate theoretical sign and significance of parameters among several tested regression specifications.

The complete structure of the model is centred on four well- known macroeconomic identities "national income identity, fiscal identity, monetary equilibrium and balance of payment identity". Thus, accordingly, a model is divided into five major blocks – demand sector block, price sector block, fiscal sector block, monetary sector block and supply sector block. To ensure internal consistency in macroeconomic analysis, these are considered to be minimum requirements for the macroeconomic model (Easterly, 1989).

The complete model contains 53 equations (27 behavioural equations and 26 identities) and 103 variables, including – dummy variables [6]. The model has been estimated using annual data for the period 1981-1982 to 2015-2016. The data is mainly obtained from the Handbook of Statistics on Indian economy published by RBI and National Account Statistics (NAS) compiled by the Central statistics office (CSO), Government of India [7]. The model is estimated equation by equation using the generalized method of moments (GMM) [8]. All equations have been estimated in conformity with underlying economic theories. The dummy variables have been used to take care of structural shifts and unusual fluctuation in data for certain variables. To correct for autocorrelation AR terms are introduced. Appendix 1 provides the estimates of the behavioural equations along with regression statistics.

2.4 Results and discussion

2.4.1 Consumption demand. The estimated coefficients of real private consumptions equation have all their expected signs and results reveal that the real personal disposable income and general level of prices are the important determinants of it. As pointed out by Hall (1978) and Shaheen (2013), if disposable income turns out to be a major determinant of consumption, then liquidity constraint is binding for a significant portion of households. The coefficient of 0.47 implies that 47% of consumption expenditure are liquidity constrained in nature. The positive and significant coefficient of government consumption signifies the non-Ricardian nature of it, while the positive and significant coefficient of lagged consumption implies ratchet effect or adaptive expectation nature of it. The interest rate was found to be insignificant thus indicating to vary limited or no role in inter-temporal consumption decisions [9].

2.4.2 Investment demand. The estimated coefficients of the four investment specifications have all their signs in line with standard theoretical anticipations. All of them except agriculture encompasses the neo-classical principle, which is proxied by a negative and significant coefficient of the interest rate. The positive and significant coefficient of real

output in all equations is consistent with accelerator theories of investment, thereby revealing induced nature of investment expenditure as firms are prone to use profits to finance investment expenditures generated by growing or expanding economies. The estimates of public investment for all the four sectors are positive and statistically significant thus encompassing the real crowding in a phenomenon [10].

2.4.3 Trade block. The estimated coefficients of the export demand function have all their theoretical expected signs and are statistically significant. The positive but low coefficient of world income indicates relatively insensitiveness of export demand to it. The coefficient of the exchange rate is positive and significant suggesting that depreciation of Indian rupee boosts export demand significantly. Further, the positive and significant coefficient of previous years' non-oil imports connotes the view that our imports consist of raw and semi-finished goods, which after processing are exported back (Bhanumurthy and Kumawat, 2009). The estimated coefficients of both non-oil and oil import demand specifications have all their signs in line with standard theoretical anticipations. Under both, specification import demand responds positively to domestic income proxied by aggregate demand and real gross domestic product (GDP) at market price, respectively. Regarding the coefficient of the exchange rate, it is negative but relatively low and insignificant, thereby implying the insensitiveness of import demand to exchange rate movements. On similar lines as in the case of exports, import demand is also positively associated with previous year exports signifying the view that our exports consist of raw and semi-finished goods, which after processing are imported back. Further, it can be inferred from the above results that the income elasticity of imports is higher than the income elasticity of exports.

The estimates of the exchange rate equation have expected signs. The coefficient of current account balance indicates a negative and significant relationship between two, which is consistent with supply and demand theories of exchange rate determination. The positive and significant coefficient of RBFA indicates that lower the absorption of foreign exchange by reserve bank of India from the market local currency would tend to appreciate and vice versa. Thus, implying a significant role of central bank intervention in exchange rate determination. Regarding the coefficient of the general price level, it is positive and significant, which is consistent with the "law of one price". Further, net capital inflows and interest rate differential, which are considered to be other fundamental determinants of exchange rate determination are found to be insignificant. The estimated coefficients of net capital inflows function have all their theoretical expected signs, which are modelled on the line of push and pull factors. The results reveal the relative strength of pull (domestic) factors as compared to push (external) factors. Similar is the case with the unit value index of exports for which theoretical institutions are taken from inverted export supply function with price elasticity equal to 1.19.

2.4.4 Price sector block. The estimated price functions measured by price deflators reveals the eclectic or hybrid approach to price determination. The estimated coefficients of all four price deflators have all their theoretical expected signs and are statistically significant. From the estimated coefficients of agriculture price deflator, the coefficient of supply-side factor proxied by the real output of agriculture is negative, with elasticity equal to 0.27. While a demand-side factor (PYDR) is positive, with elasticity equal to 0.58. Further government intervention (MSP) is found to increase it significantly with elasticity equal to 0.3. The estimated coefficients of the industrial price deflator reveal that it responds positively to the money supply, agriculture price, domestic oil price index and unit value index of imports with a coefficient of elasticity as 0.16, 0.06, 0.037 and 0.11, respectively. Thus, signifying both monetarists and cost pricing approach.

From the estimated coefficients of service price deflator, it can be inferred that it is positively associate with money supply and its own lagged value signifying the price stickiness. Similarly, the infrastructure price deflator is found to be positively associated with industrial price deflator with a coefficient of elasticity equal to 0.43. Thus, signifying the intersectoral linkages and cost-plus pricing as the majority of inputs for this sector are from the industrial sector. The further positive coefficient of its own lagged value with a coefficient of elasticity equal to 0.59 signifies its price stickiness behaviour. The overall price level or the general price level is found to be positively associated with aggregate price deflator and world oil price index with a coefficient of elasticity equal to 0.75 and 0.05, respectively. Also found to be negatively associated with real output with a coefficient of elasticity as 0.11. While a positive coefficient of its own lagged value with elasticity as 0.28 signifies downward price rigid behaviour. The domestic oil price is found to be positively associated with pass-through ratio and international oil price having a coefficient of elasticity as 1.36 and 1.05, respectively.

2.4.5 Fiscal sector block. The estimated coefficients of all the three tax revenue specifications have their signs in line with standard theoretical anticipations and statistically significant. The coefficient of non-agriculture real income and the general price is positive with a coefficient of elasticity equal to 0.54 and 1.94. Thus, signifying that direct tax increases less proportionally with an increase in income and more than proportionally with prices. To account for changes in the tax structure that took place since 1991-1992, the equation has been estimated with a structural dummy. The coefficient of it is positive as expected but insignificant. For both indirect tax and non-tax revenue specification, the coefficient of real GDP at market price is positive with elasticity as 0.93 and 0.98. Thus, signifying a proportional and neither regressive nor progressive relationship with it. To account for structural changes, the equation has been estimated with the structural dummy, the coefficient of both is as per expectations but insignificant.

2.4.6 Monetary sector block. It is clear from the estimated coefficients of bank credit to commercial sector equation that it is positively influenced by a demand-side factor for which real aggregate private investment is taken as a proxy with a coefficient of elasticity as 1.57. While as it is negatively associated with price variable proxied by prime lending rate.

The estimated coefficients of the prime lending rate equation have all their signs in line with standard theoretical anticipations and statistically significant. The positive and relatively low coefficient (0.64) of the policy rate proxied by repo rate signifies the incomplete pass-through from policy rate to lending rate. The money supply proxied for monetary-fiscal interaction [11] and supply-side factor exerts negative influence with a coefficient of elasticity as 1.09. To take cognizance of the shift from administered to a market-determined rate of interest, as the post-reform period. The equation has been estimated with the structural dummy, the coefficient of it is positive and significant.

2.4.7 Supply sector block. The output function is specified in terms of four equation viz. agriculture, manufacturing, service and infrastructure to bring out heterogeneous sectoral characteristics of output generation in the economy. Agriculture output is found to be positively and significantly determined by the index of gross cropped area, rainfall index, previous year capital stock and minimum support price. For the non-agriculture sector, the demand-side factor proxied by real aggregate demand is found to have a dominant effect for all three with a coefficient of elasticity as 0.58, 0.58 and 0.42, respectively. This variable is considered to be important from an interaction point of view between non-agriculture sectors with the rest of the economy such as trade. Similar is the case with previous year capital stock, with a coefficient of elasticity as 0.15, 0.22 and 0.61, respectively. Manufacturing output responds negatively to the domestic oil price index with a coefficient of elasticity as 0.11 and positively by agriculture output with a coefficient of elasticity at 0.17. Thus, signifying intersectoral linkages.

2.4.8 Model evaluation and simulation analysis. To test the empirical accuracy of the framed model in explaining the historical data and to guide for policy analysis, we performed two sets of simulation exercises using software package Eviews. The first one validates the predictive accuracy of the model while the second delineates the policy simulations' potential of the model [12].

2.5 Predictive accuracy of the model

The model is assessed for both within the sample and out of sample predictive performance. Conventional simulation error statistics such as root mean square percentage error (RMSPE), mean percentage error (MAP) and Theil's inequality coefficient (U) are used for evaluation of the within-sample performance of model while as stochastic simulations are used for out of sample performance. The model has been solved by running the deterministic simulation in both static and dynamic framework for the period 1981-1981 to 2015-2016. The fundamental difference between the two solution options is that in the case of static framework actual lagged values are used in place of lagged forecast values (Pierse, 2001). The RMSPE, MPE and Theil's inequality coefficient (U) of both solutions for key variables within a reasonable range. The trajectories of the static and dynamic simulations along with actual values of key variables capture most of the turning points reasonably well. For assessing the out of sample predictive performance, we applied the stochastic simulations, which add random shocks to each equation during the forecast simulation [13].

2.6 Policy simulations

With a satisfactory within the sample and out of the sample predictive performance of the model, we proceeded to examine the impact of changes in exogenous variables on the endogenously determined macroeconomic variables of the system. Given the basic objective, our study will try to examine differential macroeconomic ramifications of monetary policy shocks like those of repo rate and bank credit to the commercial sector. We proceeded with the following two policy simulations using the model:

(1) *Simulation 1*: sustained a 5% increase in policy rate for which the repo rate is taken as a proxy.

(2) *Simulation 2*: sustained a 10% decrease in bank credit to the commercial sector.

2.6.1 Implications of policy rate shock. To begin with, the model is allowed to work through its dynamic path by running a dynamic deterministic solution to provide estimates of endogenous variables known as control run or baseline solutions. Subsequently, to derive the policy solutions, the policy variables are given a sustained shock and the model is again solved through a dynamic deterministic option under the assumption of *ceteris paribus*. The difference so observed between base run and policy solution is attributed to policy changes under consideration. The quantitative impacts of the above policy simulation on key endogenous variables are presented in Table 1.

The immediate impact of an increase in policy rate is a rise in the prime lending rate by 2.08% from the baseline in the same year. The increase in prime lending rates calls for adjustments in investment decisions and money supply [14]. As a result, both PITOTR and money supply decreased by 1.64% and 2.71%, respectively. At the aggregate level reduction in private investment along with other components leads to a reduction in aggregate demand by 0.55%. Resulting changes in aggregate demand leads to a reduction in real aggregate output by 0.22%. Due to the reductions of both money supply and real output,

Variable name	Deviation of policy simulation from baseline RP# Impact (1994-1995)	Short run (1994-1995 to 1995-1996)	Long run (1994-1995 to 2015-2016)
YMNR	−0.32	−0.36	−0.45
YSRR	−0.32	−0.35	−0.44
YINFR	−0.23	−0.27	−0.64
YR	−0.22	−0.24	−0.40
Y	−0.60	−0.69	−0.95
YM	−0.55	−0.63	−0.87
PIMNR	−1.90	−1.92	−1.45
PISRR	−1.32	−1.34	−1.11
PIINFR	−3.92	−3.96	−3.04
PITOTR	−1.64	−1.64	−1.36
PGDP	−0.38	−0.45	−0.55
P	−0.38	−0.45	−0.54
DT	−0.90	−1.05	−1.31
INDT	−0.51	−0.59	−0.82
NTR	−0.54	−0.62	−0.86
TR	−0.58	−0.67	−0.95
PCR	−0.25	−0.32	−0.49
GFD	0.94	1.12	2.25
M3	−2.72	−2.71	−2.32
BCP	−5.48	−5.49	−4.22
PLR	2.08	2.09	1.90
EXT	0.12	−0.16	−0.53
IMP	−0.53	−0.54	−0.71
UVEXP	−0.45	−0.54	−0.65
*TB**	−2.44	−1.68	−1.05
*EXR***	−0.10	−0.14	−0.28
ABSP	−0.68	−0.72	−0.71
ADD	−0.55	−0.58	−0.58

Notes: *(+) implies an increase in the deficit and (−) decrease in the deficit. ** (+) implies depreciation and (−) implies appreciation. #: [(PS−BS)/BS] * 100, Where PS refers to policy simulated data series and BS refers to baseline simulated data series
Source: Authors' calculation

Table 1. Impact of Simulation 1

GDP deflator and overall price level decreased by about 0.38%. The resultant increase in the price level leads to an appreciation of the currency and a decrease in the unit value index of exports according to outlined theoretical projections.

Due to changes in both real and nominal GDP, total revenue decreased by 0.58% and, thus, fiscal deficit increase by 0.94%. At a disaggregated level, infrastructure investment witnessed a maximum decline of 3.92% followed by manufacturing (1.9%) and the service sector (1.32%). Among the components of aggregate supply manufacturing and service sector bears maximum decline followed by infrastructure. This differential behaviour is mainly due to the working capital ratio of the respective sector, implying the extent it depends on the financing of its current assets or short-term financing requirements. Usually larger dependence is observed in the case of the manufacturing and services sector as compared to infrastructure.

On the external front, the trade balance improves by 2.44%. This is mainly due to the J curve effect of exports and a reduction in imports by 0.53%. Import reduction is mainly attributed to a decrease in aggregate demand.

From the estimated model it can be seen that private investment has a dual role in the model. Firstly, it directly adds to capital stock and generates output with lag. Secondly, being a part of the aggregate demand, it affects real output according to the above-mentioned theoretical projections. Due to the sustained nature of the shock, the prime lending rate rises persistently by 2.09%. Resulting changes in the prime lending rate leads to a reduction in private investment and money supply by 1.64% and 2.71%, respectively. Private investment together with its other components leads to a reduction in aggregate demand by 0.58%. Consequently, due to the combined effect of both aggregate demand and capital stock, aggregate output reduces by 0.24%. Following the above pattern of declined prices, both GDP deflator and overall price level fall by 0.45%. Due to the combined impact of real output and its associated price components, nominal GDP, real GDP and total revenue decreased by about 0.55%, 0.60% and 0.67% respectively. Due to a reduction in total revenue, the gross fiscal deficit increases by 1.12%. At a disaggregated level, components of private investment and aggregate supply follow the above pattern with some changes in magnitudes.

On the external front, even though exports bear a meager decline due to currency appreciation because of the lower level of prices. However, trade balance witnesses an improvement of 1.68%, because of a decrease in imports by 0.54%. The reduction of imports is attributed to the fall in aggregate demand.

In the long run, a persistent increase in policy rate leads to a continuous rise in the prime lending rate. The results from Table 1 reveal simultaneously, the differential impact of the interest rate channel and the non-neutrality of money hypothesis. Thus, the long-run impact of the rise in policy rate is a decline of real output and price by 0.4% and 0.54%. The aggregate demand witnesses a decline of 0.58%. At a disaggregated level, among the components of aggregate demand, the maximum impact is born by investment followed by imports, exports and then consumption [15]. The greater sensitiveness of private investment as compared to private consumption in a developing country like India is due to less/insensitivity of consumption towards interest rate along with the lower level of household indebtedness as compared to developed countries (Salam and Kulsum, 2002; and Khundrakpum, 2012). However, the relatively higher sensitivity of private investment to the interest rate can be attributed to both direct effect (rise in the cost of capital) and an indirect effect (accelerator effect via changes in real output along with changes in prices and exchange rate). Among the components of investment maximum impact is born by infrastructure investment followed by the manufacturing and service sector.

In the case of aggregate supply, the maximum impact is born by the infrastructure sector with the manufacturing and service sector responding equally. The reason for this differential impact of monetary policy may be attributed to higher interest and investment costs. As pointed out by Dedola and Lippi (2005), under *ceteris paribus*, the higher investment would imply larger capital stock about output and, hence, more responsive to an increase in the cost of capital.

Second higher investment implies a high proportion of interest cost in total production, and thus, likely to be more affected by the rise in interest rate. The other possible factors may be those that are well disused in literature such as different levels of capital intensity, size of firms, availability of credit, interest sensitivity and export orientation.

On the external side, the higher impact of interest rate on imports than exports may be explained by the decline in total private investment and other components of aggregate demand. The higher impact of the decline in total private investment on imports is mainly due to the high import content in it (Khundrakpum, 2012). In addition, the results portray the relative strength of the income absorption approach as compared to the expenditure

switching approach. This is mainly because of a consistent fall in imports even though there is an appreciation of domestic currency following an interest rate hike.

2.6.2 Implications of monetary shock. The policy simulation under this experiment requires some changes in the framework of the model. The money supply, which was earlier determined by identity is continued to estimate through the same approach but bank credit to the commercial sector is now treated as exogenous, which was earlier endogenized. In this simulation experiment bank credit to the commercial sector, treated as an exogenous variable, is reduced by 10%. A pure monetary shock by way of a decrease in BCP is expected to work through the model in the following way. Being a part of the money supply, any changes in it will trigger changes in money supply and subsequent changes in prices, lending rate and other related variables of the model. The quantitative impacts of the above policy simulation on key endogenous variables are presented in Table 2.

The immediate impact of such a policy change is a decrease in the money supply by 5.55% from the baseline in the same year. The prime lending rate witnesses a hike and price level falls following a decline in the money supply. In addition, we found a decrease in the

	Deviation of policy simulation from baseline BCP#		
Variable name	Impact (1994-1995)	Short run (1994-1995 to 1995-1996)	Long run (1994-1995 to 2015-2016)
YMNR	−0.18	−0.23	−0.45
YSRR	−0.18	−0.23	−0.46
YINFR	−0.13	−0.17	−0.52
YR	−0.12	−0.16	−0.39
Y	−0.88	−1.07	−1.74
YM	−0.80	−0.98	−1.61
PIMNR	−0.41	−0.44	−0.56
PISRR	−0.34	−0.39	−0.59
PIINFR	−1.12	−1.23	−1.60
PITOTR	−0.39	−0.43	−0.65
PGDP	−0.76	−0.92	−1.35
P	−0.77	−0.93	−1.37
DT	−1.58	−1.91	−2.89
INDT	−0.75	−0.91	−1.50
NTR	−0.79	−0.96	−1.58
TR	−0.90	−1.10	−1.87
PCR	−0.38	−0.50	−0.92
GFD	1.54	1.99	4.70
M3	−5.55	−5.65	−5.92
PLR	0.39	0.40	0.55
EXT	0.23	0.13	−0.09
IMP	−0.34	−0.40	−0.78
UVEXP	−0.92	−1.11	−1.64
*TB**	−1.94	−1.93	−1.99
*EXR***	−0.27	−0.34	−0.73
ABSP	−0.38	−0.48	−0.85
ADD	−0.30	−0.39	−0.70

Notes: *(+) implies an increase in the deficit and (−) decrease in the deficit. ** (+) implies depreciation and (−) implies appreciation. #: [(PS−BS)/BS] *100, Where PS refers to policy simulated data series and BS refers to baseline simulated data series
Source: Authors' calculation

Table 2. Impact of Simulation 2

unit value index of exports. At the aggregate level reduction in PITOTR by 0.39% due to an increase in prime lending rate along with other components leads to a reduction in aggregate demand by 0.30%. The resulting reduction in aggregate demand reduces real aggregate output by 0.12%. Due to changes in both real, as well as nominal GDP, total revenue decreased by 0.90% and, thus, fiscal deficit increase by 1.54%. At a disaggregated level, infrastructure investment witnessed a maximum decline by 0.95% followed by manufacturing (0.35%) and service sector (0.29%). Among the components of aggregate supply, manufacturing and service sector witness maximum decline followed by infrastructure.

On the external side of the economy, trade balance improves by 1.94%. This is because of an increase in exports by 0.23% [16] and the reduction of imports by a relatively higher magnitude of 0.34% (to a decrease in aggregate demand). In the short run, the impact on variables is more or less the same on the above lines.

In the long run, due to a sustained decrease in bank credit to the commercial sector, the money supply decreases by 5.92% leading to a continuous increase in prime lending rate by 0.55%. The annual decrease in real output averages to 0.39%. Due to the combined effect of both money supply and aggregate output, aggregate price deflator and general price level declined by 1.35% and 1.37%, respectively. Thus, it connotes the relative strength of liquidity and loanable fund effects over the anticipated inflation effect of monetary shock. The fiscal deficit continues to rise by 4.70%, due to a decline in both real and nominal GDP. At a disaggregated level, among the components of aggregate demand, the maximum impact is born by private consumption (0.92%), followed by imports (0.78%), private investment (0.65%) and exports (0.09%) (Angeloni *et al.*, 2003; Khundrakpum, 2013). The greater sensitivity of private consumption than private investment can be attributed to the following. Firstly, *ex-post* inflexibilities in investment, and hence, production. Secondly, cash in advance or cash-dependent nature of the Indian economy, which makes consumption more sensitive to liquidity and loanable fund effects of monetary shock. Components of investment and aggregate supply observe the same pattern as it was in interest rate shock.

On the external front, the trade balance improves by 1.99% due to the persistent decline in imports. Although exports witness a meager decline due to the appreciation of domestic currency (due to the combined effect of the price level and capital account balance). Here again, the income absorption approach is found to be relatively stronger than the expenditure switching approach because, despite the appreciation of the domestic currency, imports still witness a consistent decline.

3. Conclusion

The objective of the paper is twofold. First, to construct a small and theoretically eclectic structural macro-econometric model for the Indian economy to analize the intersectoral relationships. Second, use estimated structural relationships of the model to perform various policy simulations and thereby to track the differential impact of monetary policy instruments like that of policy rate and money supply on components of aggregate demand and aggregate supply.

The model has been estimated using the annual data for the period 1981-1982 to 2015-2016. It contains 55 equations, which are explained by 29 stochastic equations and 26 identities. The individual equations of the model were estimated using GMM. Most of the estimated parameters were found statistically significant and theoretically correct. The with-in sample performance of the model, evaluated by using conventional simulation error statistic measures i.e. RMSPE, MAP and U and out-of-sample evaluations of the model, tested by using stochastic simulation are found satisfactory. With satisfactory in and out

sample performance of the model, we proceeded to conduct the dynamic simulations to determine the responsiveness of various endogenous variables to sustained changes in policy rate (repo rate) and reserve bank foreign exchange assets. Two simulation schemes were executed. The first experiment involved a sustained 5% increase in the policy rate and the second involved a sustained 10% decrease in reserve bank foreign exchange assets.

The results from the first policy simulation experiment reveal that interest rate hike has a significant negative impact on aggregate demand, aggregate supply and general price level. However, the maximum impact is borne by investment demand and imports followed by private consumption. Among the components of aggregate supply, maximum impact is born by infrastructure output followed by the manufacturing and services sector with the agriculture sector found to be insensitive. The results, thus, corroborate the differential impact of policy rate shock and findings of Khundrakpum (2012).

The results from the second policy simulation experiment revealed that pure monetary shocks have a significant negative impact on aggregate demand, aggregate supply and general price level. However, the maximum impact is born by private consumption and imports followed by investment demand. Among components of aggregate supply maximum impact is borne by infrastructure followed by the manufacturing and services sector with the agriculture sector found to be insensitive. From both policy simulation experiments, the study highlighted the relative importance of the income absorption approach as opposed to the expenditure switching effect. Thus, in the case of India, both interest rate shock and money supply shocks have a differential impact on components of aggregate demand and aggregate supply, signifying the importance of both as policy instruments. Further, to avoid potential unequal distribution of income across the sectors, the one-for-all policy will be inefficient in achieving its targets. Therefore, the need of the hour is to impart specific sector/component focussed monetary policy.

Notes

1. Accept few studies like Ulhig (2005) could not reject neutrality of monetary policy even in the short run.
2. A concise overview of the channels of monetary transmission is given by Mishkin (1996).
3. Neoclassical channels focus on how interest rate changes operating through investment, consumption and trade affect the ultimate target, whereas non-neoclassical channel operate primary through changes in behaviour of banks and their balance sheets (Mohanty, 2012).
4. See Bhoi *et al.* (2016) for extensive review for development of monetary policy framework in India.
5. For detail see Dhal (2011) and Sengupta (2014).
6. The overall model has not been mentioned in the paper due to space constraints. However, the same can be available upon request.
7. Complete description of variable data source along with definition is provided in Appendix 2.
8. All the variables except rate are transformed into nature logarithms. All real and nominal variables are used in the 2004-2005 base year. GMM is considered to be superior to the alternatives in handling many econometric problems including endogeneity, heteroskedasticity and serial correlation. The number of instruments in each equation is greater than the number of parameters to be estimated, hence, all the equations are over-identified and GMM gives unique estimates of parameters in over-identified equations (Akbar and Jamil, 2012).

9. Which is mainly due to liquidity constraints that affect the ability to substitute consumption intertemporally.
10. As far as financial crowding in/out is concerned it would be determined by the relationship between fiscal deficit and interest rate.
11. As the money-supply is determined through identity and among various determinants reserve bank credit to government is one of them. This is one of the major sources of financing the fiscal deficit. Thus, fiscal policy action, which alters reserve bank credit to government, and hence money supply and thereby by interest rate.
12. After estimation, the model is deterministically solved as a system of equations by using Gauss–Seidel algorithm to get dynamic solutions for different simulation experiments. Historical simulations are conduction by solving the model for the period 1981-1982 to 2015-2016 and the results are used to check the validity of the model.
13. The results portraying the predictive accuracy and forecasting performance of the model are available with the authors and can be provided on request.
14. To account for the inflationary effect of policy rate shock, by way of changing money supply bank credit to the commercial sector has been endogenized.
15. This result of the impact of policy rate shock on aggregate demand mainly through investment has also been found by Barran, Coudert and Mojon (1996) for the European Union countries, Angeloni *et al.* (2003) for Euro countries, Disyatat and Vongsinsirikul (2003) for Thailand, Jakab *et al.* (2006) for Hungary and Khundrakpum (2012) for India.
16. The increase in exports despite exchange rate appreciation can be attributed to the J curve effect. The exchange rate appreciation by 0.27% is because of the combined effect of price level and trade balance effect.

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Appendix 1

List of equation and identities:

$$LOG(PCR) = \underset{(0.00)}{-0.99} + \underset{(0.00)}{0.47} *LOG(PYDR) + \underset{(0.00)}{0.2} *LOG(CONS) + \underset{(0.00)}{0.49} *LOG(P) + \underset{(0.00)}{0.25} *LOG(PCR(-1)) \quad (1)$$

$$LOG(PIAGR) = \underset{(0.00)}{-8.66} + \underset{(0.002)}{.91} *LOG(YAR(-1)) + \underset{(0.05)}{0.1} LOG(PCFAGR) + \underset{(.000)}{0.34} *D02 - \underset{(.01)}{0.45} *D03 + \underset{0.00}{0.6} *LOG(PIAGR(-1)) + \left[\underset{(0.01)}{AR(1) = -.25}\right] \quad (2)$$

$$LOG(PIMNR) = \underset{(0.03)}{0.46} *LOG(YMNR) + \underset{(0.000)}{0.71} *LOG(PCFMNR) - \underset{(.10)}{0.05} *PLR - \underset{(.14)}{0.042} *LOG(OTEXP) + \underset{(0.1)}{0.06} *D04 + \left[\underset{(0.00)}{AR(1) = -.89}\right] \quad (3)$$

$$LOG(PISRR) = \underset{(.14)}{0.23} + \underset{(0.00)}{0.86} *LOG(YSRR) + \underset{(0.09)}{0.09} *LOG(PCFSRR + PCFINFR) - \underset{(.02)}{0.03} *PLR \quad (4)$$

$$LOG(PIINFR) = \underset{(0.00)}{-9.5} + \underset{(0.00)}{0.5} *LOG(Y) + \underset{(0.00)}{1.26} *LOG(PCFINFR) - \underset{(0.00)}{0.1} *PLR \quad (5)$$

$$LOG(EXT) = \underset{(0.00)}{-0.86} + \underset{(0.00)}{0.98} *LOG(WGDP) - \underset{(0.00)}{0.12} *(UVEXP/EXR) + \underset{(0.00)}{0.62} *LOG(NOIMP(-1)) \quad (6)$$

$$LOG(NOIMP) = \underset{(0.00)}{-6.62} + \underset{(0.00)}{1.02}*LOG(ADD) - \underset{(0.15)}{0.006}*(EXR) + \underset{(0.01)}{0.35}*LOG(EXT(-1)) - \underset{(0.1)}{0.023}*LOG(UVIMP) + \underset{(0.00)}{0.23}*D05 + \left[\underset{(0.00)}{AR(1) = 0.82}\right] \quad (7)$$

$$LOG(OIMP) = \underset{(0.00)}{-5.6} + \underset{(0.01)}{0.88}*LOG(YM) - \underset{(0.00)}{0.87}*LOG(WIOLP) + \left[\underset{(0.00)}{AR(1) = 0.84}\right] \quad (8)$$

$$EXR = \underset{(0.02)}{16.54} + \underset{(0.00)}{0.23}*P - \underset{(0.04)}{2.03}*\left(\frac{CAB}{RBFA}\right) + \underset{(0.08)}{4.90}*D08 - \underset{(0.20)}{1.10}*DEXR + \left[\underset{(0.00)}{AR(1) = 0.85}\right] \quad (9)$$

$$LOG(NCIAB) = \underset{(0.00)}{-6.72} + \underset{(0.00)}{1.19}*LOG(Y) + \underset{(0.04)}{0.13}*WGDP - \underset{(0.04)}{0.75}*DNCIAB \quad (10)$$

$$LOG(UVEXP) = \underset{(0.00)}{-0.75} + \underset{(0.00)}{1.19}*LOG(P) + \left[\underset{(0.00)}{AR(1) = 0.73}\right] \quad (11)$$

$$LOG(PRAG) = \underset{(0.15)}{0.46} - \underset{(0.03)}{0.27}*LOG(YAR) + \underset{(0.00)}{0.58}*LOG(PYDR) + \underset{(0.00)}{0.30}*LOG(MSP) + \left[\underset{0.00}{AR(1) = .94}\right] \quad (12)$$

$$LOG(PRMN) = \underset{(0.1)}{1.44} + \underset{(0.05)}{0.16}*LOG(M3) + \underset{(0.05)}{0.06}*LOG(PRAG) + \underset{(0.06)}{0.037}*LOG(DOILP) + \underset{(0.08)}{0.11}*LOG(UVIMP) + \left[\underset{0.00}{AR(1) = .96}\right] \quad (13)$$

$$LOG(PRSR) = \underset{(0.07)}{-0.54} + \underset{(0.00)}{0.23}*LOG(M3) + \underset{(0.01)}{0.48}*LOG(PRSR(-1)) + \left[\underset{0.00}{AR(1) = .86}\right] \quad (14)$$

$$LOG(PRINF) = \underset{(0.15)}{-0.09} + \underset{(0.06)}{0.43}*LOG(PRMN) + \underset{(0.003)}{0.59}*LOG(PRINF(-1)) \quad (15)$$

$$PGDP = 0.19*PRAG + 0.18*PRMN + 0.44*PRSR + 0.18*PRINF \quad (16)$$

$$LOG(P) = \underset{(0.00)}{1.34} + \underset{(0.00)}{0.75} * LOG(PGDP) - \underset{(0.00)}{0.11} * LOG(YR) + \underset{(0.00)}{0.05} * LOG(WOILP) + \underset{(0.00)}{0.28} * LOG(P(-1))] \quad (17)$$

$$LOG(DOILP) = - \underset{(0.00)}{1.61} + \underset{(0.00)}{1.36} * OILPRATIO + \underset{(0.00)}{1.05} * LOG(WIOLP) \quad (18)$$

$$LOG(DT) = - \underset{(0.00)}{5.06} + \underset{(0.00)}{0.54} * LOG(YNAR) + \underset{(0.57)}{0.03} * D06 + \underset{(0.00)}{1.94} LOG(P) + \left[\underset{0.00}{AR(1) = 0.85}\right] \quad (19)$$

$$LOG(INDT) = - \underset{(0.03)}{1.25} + \underset{(0.00)}{0.93} * LOG(YM) + \underset{(0.2)}{0.11} * D07 + \left[\underset{(0.01)}{AR(1) = 0.75}\right] \quad (20)$$

$$LOG(NTR) = - \underset{(0.00)}{3.11} + \underset{(0.00)}{0.98} * LOG(YM) - \underset{(0.15)}{0.033} * DNTR \quad (21)$$

$$LOG(BCP) = \underset{(0.00)}{-6.01} + \underset{(0.00)}{1.57} * LOG(PITOTR) - \underset{(0.00)}{0.09} * PLR \quad (22)$$

$$PLR = \underset{(0.00)}{22.47} + \underset{(0.00)}{0.64} * RP - \underset{(0.00)}{1.30} * LOG(M3) + \underset{(0.00)}{4.02} * D01 \quad (23)$$

$$LOG(YAR) = \underset{(0.001)}{6.99} + \underset{(0.005)}{0.24} * LOG(RFI) + \underset{(0.00)}{0.21} * \mathrm{LOG(KAGR(-1))} + \underset{(0.00)}{0.25} * LOG(MSP) \quad (24)$$

$$LOG(YMNR) = \underset{(0.1)}{0.72} + \underset{(0.00)}{.68} * LOG(ADD) + \underset{(0.00)}{.26} * LOG(KMNR(-1)) - \underset{(0.00)}{.11} * LOG(DOILP) + \underset{(0.00)}{0.17} * \mathrm{LOG(YAR)} + \left[\underset{(0.00)}{AR(1) = .5}\right] \quad (25)$$

$$LOG(YSRR) = \underset{(0.00)}{2.01} + \underset{(0.002)}{.22} * LOG(KSRR(-1)) + \underset{(0.00)}{.58} LOG(ADD) - \underset{(.0023)}{.02} DYSRR + \left[\underset{(0.00)}{AR(1) = .58}\right] \quad (26)$$

$$LOG(YINFR) = \underset{(0.1)}{-1.86} + \underset{(0.02)}{0.61} * LOG(KINFR(-1)) + \underset{(0.01)}{0.42} * LOG(ADD) + \left[\underset{(0.00)}{AR(1)} = .75\right] \quad (27)$$

Identities:

$$ABSP = PCR + PIAGR + PIMNR + PIINFR$$

$$ADD = ABSP + CONS + PCFTOTR + REXP - RIMP$$

$$AD = ADD + RIMP$$

$$PYD = YM - TR + TP$$

$$PYDR = PYD/PGDP$$

$$INFL = \big((P - P(-1)/P\big)*100$$

$$KAGR = KAGR(-1) + PIAGR + PCFAGR - DEPAG$$

$$KMNR = KMNR\,(-1) + PIMNR + PCFMNR - DEPMN$$

$$KINFR = KINFR(-1) + PIINFR + PCFINFR - DEPINFR$$

$$KSRR = KSRR(-1) + PISRR + PCFSRR - DEPSR$$

$$PITOTR = PIAGR + PIMNR + PIINFR + PISRR$$

$$PCFTOTR = PCFAGR + PCFMNR + PCFINFR + PCFSRR$$

$$GXP = CONS + PCFTOTR + TP$$

$$TR = DT + INDT + NTR$$

$$GFD = GXP - TR$$

$$IMP = NOIMP + OIMP$$

$$TB = EXT - IMP$$

$$REXP = EXT/UVEXP$$

$$RIMP = IMP/UVIMP$$

$$YR = YAR + YMNR + YINFR + YSRR$$

$$CAB = EXT - IMP + INVSB$$

$$Y = (PGDP{*}YR)/100$$

$$YNAR = YMNR + YINFR + YSRR$$

$$YM = Y + IDLS$$

$$M3 = NBCG + BCP + NFEAB + GCL - NNMLB$$

$$RBFA = \text{CAB} + \text{NCIAB} + \text{RBFA}(-1)$$

Appendix 2

Table A1.
List of variables

Variable	Description	Source
ABSP	Real private absorption	NAS CSO,GOI
DEPAG	Real depreciation in agriculture, forestry and fishing (Industry Group 1 of NAS), called "agriculture" for simplicity	NAS CSO,GOI
DEPINF	Real depreciation in infrastructure includes electricity, gas and water supply; construction; transport, storage and communication (Industry Groups 4, 5 and 7 of NAS), called "infrastructure" for simplicity	NAS CSO,GOI
DEPMN	Real depreciation in manufacturing includes mining and quarrying (Industry Groups 2 and 3 of NAS), called "manufacturing" for simplicity	NAS CSO,GOI
DEPSR	Real depreciation in services includes all others (Industry Groups 6, 8 and 9 of NAS), called "services" for simplicity	NAS CSO,GOI
DT	Direct tax revenue	NAS CSO,GOI
GXP	Govt. total expenditure combined centre and state	NAS CSO,GOI
CONS	Govt. final consumption expenditure	NAS CSO,GOI
IDT	Indirect tax revenues	NAS CSO,GOI
KAGR	Real net capital stock in agriculture	NAS CSO,GOI
KINFR	Real net capital stock in infrastructure	NAS CSO,GOI
KMNR	Real net capital stock in manufacturing	NAS CSO,GOI
KSRR	Real net capital stock in services	NAS CSO,GOI
NTX	Non-tax revenue (incl. income from entrepreneurship, property and miscellaneous current receipts)	NAS CSO,GOI
PCFTOTR	Real aggregate public investment	NAS CSO,GOI
PCFTOT	Aggregate public investment	NAS CSO,GOI
PCR	Real private consumption	NAS CSO,GOI
PGDP	GDP deflator (2004-2005 = 100)	NAS CSO,GOI
PGKE	Implicit price deflator for public sector investment	NAS CSO,GOI
PIAGR	Real gross private investment in agriculture	NAS CSO,GOI
PIINFR	Real gross private investment in infrastructure	NAS CSO,GOI
PIMNR	Real gross private investment in manufacturing	NAS CSO,GOI
PISRR	Real gross private investment in services	NAS CSO,GOI
PITOTR	Real aggregate private investment	NAS CSO,GOI
PNA	Price deflator for non-agriculture sector	NAS CSO,GOI
PPIE	Implicit price deflator for public sector investment	NAS CSO,GOI
PRAG	Price deflator for agriculture	NAS CSO,GOI
PRINF	Price deflator for infrastructure	NAS CSO,GOI
PRMN	Price deflator for manufacturing	NAS CSO,GOI
PRSR	Price deflator for services	NAS CSO,GOI
PYD	Personal disposable income	NAS CSO,GOI
PYDR	Real personal disposable income	NAS CSO,GOI
TR	Govt. current revenues combined	NAS CSO,GOI
Y	Aggregate output at factor cost	NAS CSO,GOI
YAR	Real output in agriculture	NAS CSO,GOI
YINFR	Real output in infrastructure	NAS CSO,GOI
YM	GDP at market prices	NAS CSO,GOI
YMNR	Real output in manufacturing	NAS CSO,GOI

(*continued*)

Variable	Description	Source
YNAR	Real output in non-agriculture sector	NAS CSO,GOI
YSRR	Real output in services	NAS CSO,GOI
YR	Real output at factor cost	NAS CSO,GOI
TP	Other transfer payments (including IPD, CTS, etc.)	NAS CSO,GOI
PCFAGR	Real gross public investment in agriculture	NAS CSO,GOI
PCFINFR	Real gross public investment in infrastructure	NAS CSO,GOI
PCFMNR	Real gross public investment in manufacturing	NAS CSO,GOI
PCFSRR	Real gross public investment in services	NAS CSO,GOI
RFI	Percentage deviation between actual and normal rainfall	IITM
AD	Real aggregate absorption	NAS CSO,GOI
ADD	Real aggregate demand for domestically produced goods	NAS CSO,GOI
BCP	Bank credit to the commercial sector	RBI
CAB	Current account balance	RBI
EXT	Exports (merchandize)	RBI
EXTR	Real exports (DGCI and S)	RBI
GFD	Gross fiscal deficit of both central and state govt	RBI
IMP	Imports (merchandize)	RBI
IMPR	Real imports (DGCI and S)	RBI
NOIMP	Non-oil imports	RBI
OIMP	Oil imports	RBI
DOILP	Domestic oil price index (index of mineral oil in WPI basket (2004-2005=100)	OEA, GOI
OILPRATIO	Domestic oil price index upon world oil price index	Calculated
M3	Money supply	RBI
RP	policy rate, bank rate up to 2000-2001 and repo rate after that	RBI
P	Wholesale price index (2004-2005 = 100)	OEA, GOI
INFL	Rate of inflation	Calculated
PLR	Prime lending rate	RBI
RBFA	Net foreign exchange assets of RBI	RBI
RCG	Reserve bank credit to the govt	RBI
RM	Reserve money	RBI
TB	Trade balance	RBI
CAB	Current account balance	RBI
UVEXP	Unit value of exports	RBI
AREA	Index of gross cropped area	RBI
BCG	Commercial bank credit to the government	RBI
CRR	Cash reserve ratio	RBI
DNB	Non-market borrowings of both central and state govts	RBI
EXR	Exchange rate of Indian rupee against US$ (Nominal, Rs./$)	RBI
EB	External borrowings by the govt	RBI
GCL	Government's currency liabilities to the public	RBI
INVSB	Invisibles in a current account balance	RBI
MSP	Average of minimum support price of fair average quality	RBI
MISCR	Other capital receipts of the govt	RBI
NCIAB	Net capital inflows including a net capital account in the balance of payments and errors and omissions	RBI
NBCG	Net bank credit to the government	RBI
NFEAB	Net foreign exchange assets of the banking sector	RBI
NNMLB	Net non-monetary liabilities of the banking sector	RBI
RBCS	RBI credit to the commercial sector	RBI
RGCB	RBI's claim on banks	RBI
RNML	RBI's net non-monetary liabilities	RBI

(*continued*)

Table A1.

Variable	Description	Source
UVIMP	Unit value of imports	RBI
WGDP	index number of world exports (2004-2005 = 100)	IMF
WOILP	World oil Price Index	WDI
D01	Dummy for post-reform period	Authors calculated
D02	Unusual increase in agriculture investment	Authors calculated
D03	Unusual decrease in agriculture investment	Authors calculated
D04	Irregular dummy for manufacturing (2007-2008) for a sharp increase	Authors calculated
D05	Dummy crisis,1 for 2008-2009 and 0 for others	Authors calculated
D06	Dummy for 1991-1992 for change in the structure of the direct tax	Authors calculated
D07	Dummy for 1992-1993 and 1993-1994 for a sharp change in indirect tax rates	Authors calculated
D08	Dummy representing a large depreciation of exchange rate of rupee in 1992-1993, 1 for that and 0 for others	Authors calculated
DYSRR	Outlier dummy in the service sector	Authors calculated
DEXP	Outlier dummy in exports	Authors calculated
DEXR	Outlier dummy in the exchange rate	Authors calculated
DNCIAB	Outlier dummy in a net capital account balance	Authors calculated

Table A1. **Source:** Authors' calculation

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