

Sectoral Effects of Monetary Policy in India

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Abstract

Every economy comprises of different sectors with divergent characteristics. These different sectors respond heterogeneously to identical unanticipated macroeconomic stimuli. Using a Vector Autoregression model this study finds that the impact of a monetary policy shock at the sectoral level is heterogeneous with manufacturing being the most responsive. The sectors such as Manufacturing, Mining and Quarrying, Construction and Trade are the fastest to respond. The differential sectoral effects depend upon factors such as capital intensity, interest sensitivity, export-orientation, production planning strategies among others. The sectors also differ in terms of the most effective channel of monetary transmission. The interest rate channel has emerged as the most efficient channel of the monetary policy transmission in most of the sectors followed by the credit channel. Therefore, the heterogeneous sectoral responses indicate the need for a more sector-specific monetary policy.

Keywords

Transmission mechanism, VAR model, sectoral effect, interest rate channel, credit, exchange rate

JEL Classification: E50, E52, E58, O53

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Introduction

Most studies on transmission mechanism of the monetary policy have traditionally focused on the aggregate economy, specifically on the impact of monetary policy decisions on production and price levels. This approach assumes that the monetary policy affects the entire economy uniformly. However, the fact is that every economy comprises of different sectors with different characteristics. These sectors respond heterogeneously to identical unanticipated macroeconomic stimuli.

Considerable attention is being given to sectoral and regional effects of monetary policy shocks in recent years. The studies have found that different sectors or regions of an economy respond differently to monetary policy shocks. This has important implications for monetary policy makers as the impact of the policy actions in each sector or region will have to be considered separately. While designing an appropriate monetary policy for the economy, it is important for the monetary authority to know the magnitude and duration of the impact to a monetary policy signal on each sector. There are three reasons to care about the differences in sectoral responses to monetary policy. First, different sectors have different interest rate sensitivities; therefore, monetary policy aimed at stabilising aggregate output may fail to stabilize employment in response to a shock in a sector with low interest rate sensitivity when some aspects of human capital are sector specific. Second, the effectiveness of the monetary policy as a policy tool may differ from sector to sector. The ability of an interest rate based monetary policy to have an impact on the economy will depend upon the share of gross domestic product (GDP) associated with the sectors that are highly sensitive to interest rates (Raddatz and Rigobon, 2003). Third, the way monetary policy is transmitted to the various sectors is also different. Depending upon the sectoral characteristics the channel of monetary transmission varies.

Studies on monetary transmission at the aggregate level in India are abounding but the transmission mechanism and the channels of transmission at the sectoral level have been neglected. This study aims to take a more comprehensive measure of real output from a sectoral point of view. It studies the impact of a monetary policy shock on all the sectors of the economy rather than just one sector. Apart from the sectoral disaggregation the paper also analyses the different channels of monetary

transmission affecting each sector which makes this study different from the earlier studies.

In order to study these issues, the article has been structured as follows. The section 'Sources of Heterogeneous Sectoral Response' discusses the factors affecting the heterogeneity of sectoral responses. The section 'Literature Review' provides a brief review of the existing literature on the topic. The section 'Research Methodology, Data and the Model' discusses the research methodology, data and the models used in this study. The section 'Empirical Results' reports and analyzes the aggregate and sectoral results of the study. Search for sector-specific channels of transmission is done in the section 'Search for the Sector-specific Channels of Monetary Transmission' and lastly the conclusion to the study has been presented in the section 'Conclusion'.

Sources of Heterogeneous Sectoral Response

We now discuss the possible sources of heterogeneity among the sectors to a monetary policy shock. An Economic theory suggests a number of channels through which the monetary policy can affect various sectors differently. The credit view of monetary transmission identifies the bank lending and balance sheet channels. The bank lending channel looks at the ability and willingness of the banks to lend (Kashyap and Stein, 1997) and the degree to which firms are dependent on banks for credit (Bernanke and Blinder, 1988; Kashyap et al., 1993). These factors might result in differential sectoral effects to a monetary policy action. The reason is that different sectors can have different levels of capital intensity, input/output demand patterns and production planning strategies; therefore, their patterns of bank credit usage might differ. Sector level differences in the composition and concentration of industry/firm and the sources of credit available to them could also lead to dissimilar responses to monetary policy. Smaller firms are dependent on domestic banks and financial intermediaries for their credit needs, whereas larger firms have easier and greater access to non-bank and external sources. Consequently, a sector dominated by small firms is more likely to be affected by monetary policy. This result is supported by Jansen et al. (2013) who find that larger firms in Manufacturing, Manufacturing of

Non-Durables, Construction, Mining and Service are able to mitigate the impact of monetary policy. However, the small publicly traded firms, despite having access to the financial market, were found to be more sensitive to interest rate changes relative to the large publicly traded firms in certain sectors. One possible explanation could be that the cost of raising funds directly in the financial market may be higher for smaller firms due to greater uncertainty regarding their future prospects.

The balance sheet channel works through net worth and cash flow of the firms and the ease with which banks are able to adjust their balance sheets. Banks' flexibility in adjusting their balance sheets determines the extent of the credit volume available to a specific sector and consequently the impact of monetary policy action on that sector.

Sectors also differ in terms of their sensitivity to interest rate shocks. The type of products and their leverage differs from sector to sector. Investment goods and durable consumer goods which are generally high valued goods are typically financed from credit. Therefore, a tightening of the monetary policy with an interest rate hike will reduce the output of these sectors by increasing the real cost of capital of firms and consumers.

Sectors differ in terms of export orientation and their share of imported inputs. There may be some sectors which are export oriented, while others may be import oriented. Also the composition of the manufactured input and raw material needs of different sectors might be differently allocated between the domestic and the import sources. In other words, not all sectors use the same combination of the imported and domestically produced intermediate products. The exchange rate channel of monetary transmission plays an important role in such sectors. An appreciation of currency due to monetary tightening can thus adversely affects some sectors more than the others.

Another important factor could be the employment composition of productive inputs. Sectors necessarily do not use the same composition of inputs for example; some sectors might be more capital intensive whereas others are more labour intensive. Thus, a capital-intensive sector will be more responsive to an increase in interest rates than a labour-intensive sector.

In emerging economies, like India, informal economic activities are still significant. The informal economic activities (i.e., officially unrecorded

economic activity) should also be considered while accounting for the reasons behind the degree or extent of the same policy shock on different sectors (Berument et al., 2007). In an organized or formal sector firms have an easy access to banks for credit compared to the firms in the informal sector due to better bookkeeping practices. If a sector has a larger concentration of firms of the formal economy then the monetary policy shock will have a greater impact on that sector compared to a less formalized sector.

According to Pellenyi (2012) the large stock of foreign currency debt could also influence the impact of monetary shocks, especially through the credit channel. The financing costs to sectors with large foreign currency debt stocks are less affected by interest rate changes, but they are more exposed to exchange rate movements.

Price rigidities and input–output linkages also cause sectoral heterogeneity. Price stickiness affects the speed of price adjustment. If prices of a sector are slow to adjust then that will be reflected in large changes in sectoral output. Finally, production linkages can also amplify output responses, regardless of their source.

Literature Review

One of the earliest papers to explore monetary transmission at the disaggregated level was the study by Bernanke and Gertler (1995). Using a Vector Autoregression (VAR) model, they showed that in the US economy the responses of the various components of final expenditure (consumer durables, consumer non-durables, residential investment and business fixed investment) to a monetary shock are different. After this a number of studies have been done using disaggregated output data. Raddatz and Rigobon (2003) found a temporary boom in residential investment and durables consumption but had almost no effect on the high-tech sector due to a monetary policy shock induced by a high-tech crisis in the USA. Haimowitz (1996) finds that in the USA durable goods industries exhibit substantially larger output and marginally larger price responses to monetary shocks than non-durable goods industries; industries producing goods for producers exhibit substantially larger output and price responses to monetary shocks than industries producing

goods for consumers; high concentration industries exhibit relatively smaller price responses and larger output responses; and industries with a high inventory-to-sales ratio exhibit relatively smaller price responses.

Ganley and Salmon (1997) found that in the UK construction, distribution and transportation, and manufacturing exhibits the largest output responses to a monetary shock. Government services, financial services and utilities respond relatively little to the shock. The Mining sector's response was somewhat erratic and ambiguous, and the Agricultural sector's response was insignificant. Over all in the sub-sectors, those industries closely linked to the Construction sector react substantially fairly quickly (within a year), those linked to consumer durable and semi-durable goods, such as motor vehicles, react substantially with a lag (within 2 years), and those linked to food show only a modest response. Sectors that are closely linked to industrial demand, such as machinery and chemicals, react substantially with a slight lag, and they reach their maximum decline with a significant delay (over 2 years).

Hayo and Uhlenbrock (1999) attempt to classify their findings on cross-sector heterogeneity in Germany in terms of certain industry characteristics, such as the intensity of use of capital stock and export orientation. They conclude that heavy industries react more strongly to interest rate shocks than the production of non-durables such as clothing and food.

Dedola and Lippi (2005) studied the effects of an unexpected monetary policy shock on the activity of 21 manufacturing industries in 5 Organisation for Economic Co-operation and Development (OECD) countries (France, Germany, Italy, the UK and the USA). They found significant cross-industry heterogeneity of policy effects and similar cross-industry distribution of policy effects across countries. These patterns were found to be related to the industry output durability, investment intensity and to measures of firms' borrowing capacity, size and interest payment burden. Arnold and Vrugt (2002) found in the Netherlands that sector-specific variation in interest sensitivity was more important than region-specific variation.

Domac (1999) empirically demonstrates that monetary tightening has a larger impact on small- and medium-sized industries (SMIs) than it does on large manufacturing firms (LMFs). The effect of monetary shocks on the production of SMIs was not only more persistent but also

contributed substantially more to the variance of the production than that of LMFs.

Ifeakachukwu and Saibu (2012) investigated the transmission channels of the monetary policy impulses on sectoral output growth in Nigeria for the period 1986–2009. The results showed that the interest rate channel was most effective in transmitting monetary policy to the Agriculture and Manufacturing sectors while exchange rate channel was most effective for transmitting monetary policy to Building/Construction, Mining, Service and Wholesale/Retail sectors. The study concluded that the interest rate and the exchange rate policies were the most effective monetary policy measures in stimulating sectoral output growth in Nigeria.

Alam and Waheed (2006) studied the monetary transmission mechanism in Pakistan at a sectoral level. Using quarterly data spanning from 1973:1 to 2003:4, they examined if monetary policy shocks have different sectoral effects. According to their results Manufacturing, Wholesale and Retail Trade and Finance and Insurance sectors declined more in response to the interest rate shocks whereas the Agriculture, Mining and Quarrying, Construction and Ownership of Dwellings remained insensitive to interest rate changes.

Very few studies have been done on sectoral impact of monetary policy in India. Ghosh (2009) exploits 2-digit level industry data for the period 1981–2004 to ascertain the interlinkage between the monetary policy shock and industry value added. Estimating a VAR model he found that that industries respond quite differently to a monetary tightening. An examination of the observed response across industries indicated that it was possible to classify them into two broad groups: those related primarily to changes in consumer expenditure and those principally selling to other industries.

Palakkeel (2005) found that sectors such as Manufacturing, Electricity, Gas and Water Supply, Trade and Hotels were more sensitive to the monetary policy while considering investment and output in these sectors. But investment and output responses show that monetary policy had minimal impact upon sectors like Agriculture.

A common thread running through all the above mentioned studies is the heterogeneity of sectoral responses to a monetary policy shock. The difference in response of the sectors arises due to different levels of interest sensitivity, trade openness, financial deepening etc.

Research Methodology, Data and the Model

The research methodology followed in this study is the unrestricted VAR model. We first find out the reaction of real output to a monetary policy shock; therefore, we first observe the impulse response functions which trace the reaction of real output to one standard deviation shock to the interest rate. In order to find out the sector specific most efficient channel of monetary policy transmission in each sector we use the Granger causality approach and forecast error variance decomposition (FEVD). We have taken interest rate, bank credit to commercial sector (BCR) and exchange rate variables to test the efficacy of interest rate channel, credit channel and exchange rate channel in India.

The data used in the study are quarterly observations from 1996:Q1 to 2011:Q4. The aggregate output is represented by GDP at factor cost at constant prices. The GDP is arrived at by summing up real production from eight sectors. These are Agriculture (S1), Mining and Quarrying (S2), Manufacturing (S3), Electricity, Gas and Water Supply (S4), Construction (S5), Trade, Transport and Communication (S6), Finance, Insurance, Real Estate, Ownership of Dwellings, Legal and Business Services (S7) and Community, Social and Personal Services (S8) (Figure 1). The base year for the above real output series is 2004–2005.

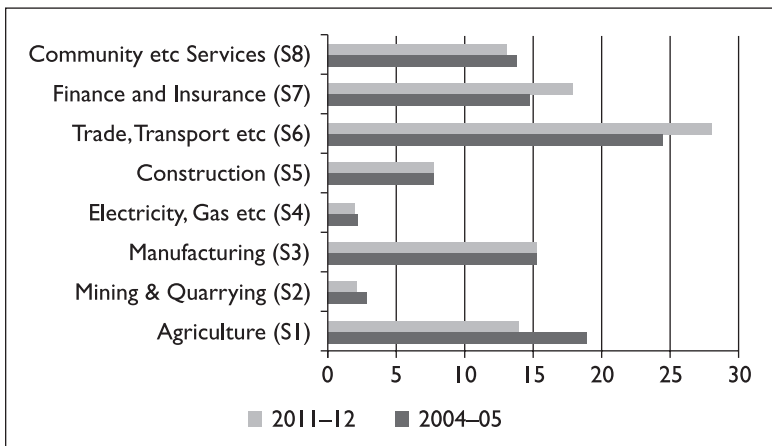


Figure 1. Sector-wise Share in GDP (per cent)

Source: Central Statistical Organisation.

Let us now briefly specify the components of each sector:

1. Agriculture, Forestry and Fishing (S1): Agricultural activity comprises crop production, livestock and livestock products and operation of irrigation system. Forestry includes industrial wood, fuel wood and minor forest products, for example, fodder from forest sources. Fishing includes inland and marine fish production.
2. Mining and Quarrying (S2): This includes output of major and minor minerals. The major minerals cover fuel minerals consisting of coal, lignite, petroleum & natural gas and other major minerals, that is, metallic minerals including atomic minerals and non-metallic minerals. Minor minerals consist of materials like marble, slate, shale etc.
3. Manufacturing (S3): These activities are classified into two broad segments 'registered' and 'unregistered'. The registered manufacturing segment includes all factories employing 10 or more workers using power and those employing 20 or more workers but not using power on any day of the preceding 12 months, and bidi and cigar establishments registered under Bidi and Cigar Workers (conditions of employment) Act 1966 and employing 10 or more workers using power or 20 or more workers not using power. Contribution of activities such as railway workshops, currency coinage and mints and security printing are included in the manufacturing. The output of production units under defence establishments is also included in the manufacturing. The manufacturing units not covered in registered manufacturing, including household industries, form the 'unregistered' manufacturing industry.
4. Electricity, Gas and Water Supply (S4): Electricity includes production of electrical and wind energy. Gas includes biogas output and water supply includes output by public (central, state and local bodies) and private organizations (municipal corporations).
5. Construction Sector (S5): This comprises two components namely (i) accounted construction (pucca construction) and (ii) unaccounted construction (kutchha construction). The overall output of accounted construction includes construction in Public sector, Private corporate sector and Household sector. This is

done on the basis of the availability of five basic construction materials (i) cement and cement products, (ii) iron and steel, (iii) bricks and tiles, (iv) timber and round wood (including imports of timber products and veneer plywood) (v) fixtures and fittings and factor inputs (labour cost, rent/rentals, interest etc.). The unaccounted construction included kutchha construction undertaken in Public sector, Households sector and civilian construction in installing wind energy systems and capital expenditure in cultivating 17 plantation crops.

6. Trade, Transport and Communication (S6): Trade activity includes wholesale and retail trade in all commodities whether produced domestically, imported or exported. It also includes the activities of purchase and selling agents, brokers and auctioneers. Hotels and restaurants activity comprises categories 551 and 552 of NIC, 1998. Transport includes railway transport and transport by means other than railways. Communication activities include (i) courier activities (ii) activities of the cable operators and (iii) other communication which covers the activities of cellular and basic telecom services, and the activities of public call offices (PCOs).
7. Finance, Insurance, Real Estate, Ownership of Dwellings, Legal and Business Services (S7): Finance and Insurance comprises of commercial banks and banking department of Reserve Bank of India (RBI), public non-banking financial corporations, organized and unorganized non-banking financial companies. Some of the other economic activities covered in this sector are ownership of dwellings, real estate services, computer and related activities, accounting, bookkeeping and related activities and legal services.
8. Community, Social and Personal Services (S8): This sector is subdivided into (i) public administration and defence and (ii) other services. Public administration and defence covers services rendered by the administrative departments of the general government, that is, Central and State governments, Union Territories, Municipal Corporations, Municipalities, Housing Boards, Cantonment Boards, Improvement Trusts, Zilla Parishads/District and Local Boards and Panchayati Raj institutions. Public services in the quasi-government bodies are also included under these economic activities.

Some of the economic activities covered under 'Other services' are coaching and tuition, human health activities including veterinary activities, sewage and refuse disposal, sanitation activities, recreational cultural and sporting activities, extra-territorial organizations and bodies including the activities of international organizations like United Nations and its agencies, regional bodies, International Monetary Fund, World Bank, European Commission, etc.

Figure 1 shows the change in the sectoral shares in GDP over a period of five years (2004–2005 to 2011–2012). The share of the Agriculture sector (S1) has declined from 19 to 14 per cent. The three industrial sectors Mining and Quarrying (S2), Manufacturing (S3), Electricity, Gas and Water Supply (S4) have remained more or less the same. Services which include the remaining sectors have witnessed an increase in sectoral share in GDP to 66.8 per cent in 2011–2012 from 60.7 per cent in 2004–2005. In the services, Construction (S5) has remained unchanged, Trade, Transport and Hotels (S6) has increased from 24.5 to 28 per cent, Finance and Insurance (S7) has increased from 14.7 to 18 per cent whereas share of Community Services (S8) has declined.

The other endogenous variables are: wholesale price index (WPI), call rate (CR), BCR, real effective exchange rate (REER). We have also included two exogenous variables index of fuel, oil and lubricants and federal funds rate (FFR). All the data have been taken from various issues of the *Handbook of Statistics on Indian Economy* and website of Federal Reserve Board.

In this study, nine VAR models for the aggregate and eight sectors of the Indian economy were estimated. Each system consists of five endogenous variables (output, price, interest rate, credit to the commercial sector, exchange rate) and two exogenous variables (oil prices and FFR). The first VAR includes the aggregate output and the subsequent VARs include output from eight different sectors of the economy. A short-term interest rate has been chosen as the monetary policy indicator. This is because India too shifted towards interest rates as the operating procedure for monetary policy transmission in tune with developed economies.

The VAR model of our study is given by:

$$Y_t = R_1(L) Y_{t-1} + R_2(L) X_t + e_t,$$

Where, $Y_t = [\text{GDP, WPI, CR, BCR, REER}]^T$ and $X_t = [\text{OILP, FFR}]^T$

Y_t is the vector of endogenous variables and X_t is the vector of exogenous variables. A VAR model has been set up with five endogenous and two exogenous variables. The endogenous variables are output (measured by GDP/sectoral output), prices (measured by WPI), short-term interest rate (measured by overnight call money market rate), BCR and exchange rate (measured by REER). Oil prices index (OILP) and FFR have been considered as the two exogenous variables.

In order to identify the parameters of the structural form from the parameters in the reduced form we have used lower triangular Choleski decomposition (Sims, 1980). The preferred ordering of each VAR is output, price, interest rate, credit to commercial sector and exchange rate. Since lower triangular Choleski decomposition follows a recursive scheme, it means that the first variable responds only to its own shock, the second variable responds to the first variable plus to a shock to the second variable and the last variable in the system reacts without delay to all shocks, but disturbances have no contemporaneous effect on other variables. As we have five endogenous variables therefore the number of identifying restrictions on the system are $n(n-1)/2 = 5.4/2 = 10$.

The ordering of the variables is done according to the speed of responsiveness of the variables to shocks. The least responsive variable is ordered first. Since output is considered not to be contemporaneously affected by other variables we order it first. The policy rate, that is, CR is set with information about the contemporaneous behaviour of slowly moving output and prices. This seems plausible and consistent with actual behaviour of the economy since changing output and prices are time-consuming processes while monetary authorities set policy with at least some indication about contemporaneous developments in output and prices. Here the credit and exchange rate measures are ordered after the short-term interest rate. The credit to commercial sector and exchange rate reflect the impact of output, prices and rate of interest. Modelling the contemporaneous interaction among credit, exchange rate and rate of interest in this way implies that in this particular model the credit supply and exchange rate are allowed to adjust to changes in the market interest rate.

Following Sims (1974) we have deseasonalized the data, as seasonally unadjusted data over-emphasizes the fit of seasonal frequencies.

In order to take care of the seasonality pattern of the Indian economy output, prices and bank credit data have been deseasonalized using multiplicative X11 method. All the chosen macroeconomic series of this study except CR and REER are non-stationary. However, we choose to estimate the VAR in levels. We follow Sims, Stock and Watson (1990) who showed that a VAR model in levels incurs some loss in estimators' efficiency but not consistency. Ramaswamy and Slok (1998) too provide an economic argument for estimating VAR in levels rather than in first differences. According to their argument the impulse response functions generated from estimating the VAR in first differences tend to imply that monetary shocks have permanent impact on the level of output, while those from the unrestricted VAR allow data to decide on whether the effects of monetary shocks are long-lasting or not. Therefore, we proceed by estimating unrestricted VAR in levels. We have chosen uniform lag lengths for all VARs.

Empirical Results

Aggregate Results

We first examine the response of aggregate output (GDP) to a monetary policy shock. As mentioned earlier the system consists of real output (GDP), WPI, call money rate (CR), BCR and REER and two exogenous variables oil prices (OILP) and FFR. Figure A1 in appendix shows the response of real GDP to one standard deviation shock to interest rate. The response of real output is negative which conforms to the real effect of monetary policy tightening. As the interest rate is increased the real output immediately declines and reaches its lowest point of 0.27 per cent below the baseline by the second quarter.

Sectoral Results

In this section we estimate a VAR for each sector. Similar to Ganley and Salmon (1997) and Sahinoz and Cosar (2010) we will first focus on the

Table 1. The Magnitude and Duration of Output Responses

Sector	Maximum Output Reduction	
	%	Quarter
S1	-0.20	8
S2	-0.50	3
S3	-1.00	3
S4	-0.31*	12
S5	-0.52	3
S6	-0.24	2
S7	-0.60	7
S8	-0.20*	10

Source: Author's own work.

Note: *Does not show the maximum output reduction.

size and timing of the maximum impact of a monetary shock on the various sectors. The maximum decrease in output in each sector indicates how the size of the impact is distributed across the economy. The timing of these responses shows how long the real effects of monetary policy innovations may persist. Figure A2 in appendix shows the impulse responses of sectoral output to monetary policy shock and Table 1 shows the size and the timing of the maximum reduction in output in each sector.

Table 1 and Figure A2 in appendix show that the sector which responds the most is Manufacturing (S3). A monetary policy shock causes the real output to fall by 1.0 per cent in the third quarter. Finance, Insurance, Real Estate and Business Services (S7) too responds well with a fall in real output by 0.60 per cent. The other two sectors which respond strongly are Construction (S5) and Mining and Quarrying (S2) which fall by 0.52 and 0.50 per cent respectively.

The two sectors which respond moderately are the Electricity, Gas and Water Supply (S4) and the Trade, Transport and Communication (S6). A monetary policy shock reduces the output in both the sectors but the impulse responses do not reach the lowest point for the observed period (12 quarters). One possible reason for moderate responsiveness of Trade, Transport and Communication (S6) could be that the output

activity of this sector is based on foreign demand. A monetary policy shock causes a decrease in the REER in the short run, implying depreciation. Thus, depreciation suppresses the recessionary effects of a contractionary monetary policy by stimulating exports.

The response of a monetary policy shock in case of the Agriculture (S1) is slightly positive initially. The real output falls maximum by 0.20 per cent after a lag of 8 quarters. The reason for a sluggish response could be that the goods produced in agriculture are non-durable and especially in India this sector is still less capital intensive. The response of real output of Community Social and Personal Services (S8) is highly positive initially but similar to the Agriculture sector (S1) becomes negative with a lag. This sector mainly include services rendered by the administrative departments of the general government, therefore, the influence of a monetary policy shock is less. This conforms to the findings of Ganley and Salmon (1997) and Arnold and Vrugt (2002) too. Thus, these two sectors are the least responsive sectors.

Analyzing the duration of the responses (Table 1) we find that the Mining and Quarrying (S2), Manufacturing (S3) and Construction (S5) and Trade, Transport and Communication (S6) sectors respond very fast to a monetary policy shock.

The decline in output bottoms out after 8 quarters for Agriculture (S1), more than 12 quarters for Electricity, Gas and Water Supply (S4) and more than 10 quarters for Community Social and Personal Services (S8). This shows that the monetary policy has the slowest influence on these three sectors.

The above results suggest that for the period under consideration there are potential disparities in the effects of monetary shocks on sectoral output. As discussed before, there are various possible sources of heterogeneity among sectors to a monetary policy shock. These could be different levels of capital intensity, concentration of firms, size of firms, availability of credit, interest sensitivity, export-orientation etc. Table 2 shows the behaviour of one such indicator, credit-output ratio, in two of the major sectors namely, Agriculture and Industry. We find that the credit output ratio in case of Industry is much higher than for Agriculture. Therefore, a monetary policy shock will definitely affect the Industrial sector more than the Agricultural sector.

Table 2. Credit Output Ratio

Financial Year	Agriculture	Industry
2005–2006	0.08	0.19
2006–2007	0.09	0.20
2007–2008	0.07	0.21
2008–2009	0.10	0.22
2009–2010	0.12	0.28
2010–2011	0.06	0.32
2011–2012	0.09	0.35

Source: Annual Report, various issues and *Handbook of Statistics on Indian Economy*, 2011–2012.

Search for the Sector-specific Channels of Monetary Transmission

We now move on to the next set of tests which aims at finding out the relevant channel of transmission of monetary policy for every sector. We start the empirical analysis by conducting the Granger causality test following the study by Ifeakachukwu and Saibu (2012) and Yue and Shuanghong (2007). The Granger causality approach is employed to examine the one-to-one possible link between the sectors' output and monetary variables. The result is used to find out the possible channel/channels of monetary policy transmission between the monetary variables and the various sectors of the Indian economy. The Granger causality result is presented on Table 3.

The results show that both the interest rate and the credit channels are the potential channels through which monetary policy impulses were transmitted to Mining and Quarrying (S2), Manufacturing (S3) and Finance, Insurance, Real Estate and Business Services (S7). Trade, Transport and Communication (S6) was affected by both the credit and the exchange rate channels. Construction (S5) is affected by the interest rate channel. Agriculture (S1) and Community Social and Personal Services (S8) are affected by the credit channel. Electricity, Gas and Water Supply (S4) does not show a clear dominance of any channel.

At this point we make three important observations. First, there are few sectors which are clearly affected by any one channel of monetary policy transmission. Second, there are some sectors which are being

Table 3. Granger Causality between the Real Output and the Monetary Policy Variables

Null Hypothesis:	F-Statistic	Prob.
CR does not Granger Cause S1	0.057	0.811
LBCR does not Granger Cause S1	8.770	0.004*
LREER does not Granger Cause S1	0.006	0.970
CR does not Granger Cause S2	4.400	0.039*
LBCR does not Granger Cause S2	3.179	0.079**
LREER does not Granger Cause S2	0.631	0.429
CR does not Granger Cause S3	11.050	0.002*
LBCR does not Granger Cause S3	4.780	0.032*
LREER does not Granger Cause S3	0.278	0.599
CR does not Granger Cause S4	0.095	0.750
LBCR does not Granger Cause S4	0.274	0.602
LREER does not Granger Cause S4	0.303	0.583
CR does not Granger Cause S5	3.290	0.070**
LBCR does not Granger Cause S5	0.480	0.480
LREER does not Granger Cause S5	0.039	0.840
CR does not Granger Cause S6	0.099	0.750
LBCR does not Granger Cause S6	2.970	0.080**
LREER does not Granger Cause S6	5.490	0.022*
CR does not Granger Cause S7	7.150	0.009*
LBCR does not Granger Cause S7	5.720	0.019*
LREER does not Granger Cause S7	0.694	0.408
CR does not Granger Cause S8	0.043	0.830
LBCR does not Granger Cause S8	7.160	0.009*
LREER does not Granger Cause S8	0.001	0.970

Source: Author's own work.

Note: ***/** Significant at 5/10 per cent level.

affected by more than one potential channels. Third, one sector does not show clear dominance of any channel. Therefore, we need to isolate the most relevant channel of transmission for each sector. In order to meet this objective we will now look at the results of the variance decomposition which will help to determine the most significant channel in each sector of the economy. The monetary policy variable which accounts for the largest proportion of the variation in each sectoral output VAR model will be taken as the most significant channel through which monetary policy is transmitted to each real sector.

Table 4 presents the variance decomposition estimates generated from the unrestricted VAR models for forecast horizon 2, 4, 8, 16 and 24 quarters. An interest rate shock accounted for a 0.2 per cent change in agricultural output (S1) in the fourth quarter which gradually increased to 3 per cent in the twenty-fourth quarter. The contribution of exchange rate to changes in agricultural output growth was 1 per cent in the twenty-fourth quarter. The credit channel accounted for 1.6 per cent change in agricultural output by the twenty-fourth quarter. The variance decomposition results suggest that the interest rate and the credit channels are stronger than the exchange rate channel. Further, the interest rate contributes maximum to the change in agricultural output. However, the

Table 4. Sector-wise Forecast Error Variance Decomposition (FEVD)

Sector	Period	S.E.	CR	LBCR	LREER
S1	2	0.025	0.006	0.002	0.138
	4	0.028	0.204	0.009	0.712
	8	0.032	1.467	0.394	1.298
	16	0.039	2.677	1.224	1.246
	24	0.046	3.163	1.605	1.161
S2	2	0.023	5.879	0.740	0.251
	4	0.030	9.200	3.329	1.636
	8	0.037	8.409	4.812	4.149
	16	0.043	7.544	4.767	4.845
	24	0.047	7.463	4.586	4.407
S3	2	0.029	11.841	1.665	0.683
	4	0.041	16.978	3.036	3.991
	8	0.056	14.739	3.631	9.827
	16	0.073	12.163	3.157	12.993
	24	0.085	11.563	2.864	13.442
S4	2	0.024	0.606	0.120	0.002
	4	0.031	1.510	0.292	0.005
	8	0.041	2.505	0.339	0.191
	16	0.056	3.915	0.378	0.902
	24	0.068	4.680	0.415	1.336
S5	2	0.034	1.726	0.913	0.123
	4	0.048	3.074	1.498	0.599
	8	0.066	2.973	2.123	1.496
	16	0.087	2.531	2.755	2.367
	24	0.098	2.306	3.028	2.770

Sector	Period	S.E.	CR	LBCR	LREER
S6	2	0.017	2.000	2.936	0.250
	4	0.026	1.758	4.898	1.741
	8	0.040	0.827	5.584	5.134
	16	0.063	0.422	5.476	9.007
	24	0.077	0.434	5.288	10.695
S7	2	0.016	2.446	4.740	0.767
	4	0.023	10.456	12.013	0.423
	8	0.033	18.048	11.269	0.269
	16	0.047	21.618	11.600	0.289
	24	0.058	22.748	11.730	0.290
S8	2	0.038	0.080	0.777	1.538
	4	0.043	0.324	1.494	3.701
	8	0.049	0.390	1.521	3.269
	16	0.061	2.344	2.304	3.032
	24	0.072	3.756	3.103	2.937

Source: Author's own work.

Granger causality test indicates the credit channel as the most effective channel. Considering both the test results we conclude that in the Agricultural sector the credit channel is the most dominant channel.

According to the Granger causality test the two potential channels for the Mining and Quarrying sector (S2) are the interest rate and the credit channels. The contribution of bank credit to mining output increased steadily from 0.74 per cent in second quarter to more than 4.5 per cent in the twenty-fourth quarter. However the contribution of the interest rate shock increased from 5.9 per cent in the second quarter to 7.5 per cent by the twenty-fourth quarter. Therefore out of the two potential channels of the Granger causality test we find the interest rate channel to be more effective in the Mining sector.

In the Manufacturing sector (S3), a shock to the interest rate affected output by 11.8 per cent in the second quarter which went up to 17 per cent in the fourth quarter. Although its significance steadily declined, the interest rate remained the most significant influence on the sectoral output even thereafter. Bank credit contributed the least to the transmission of monetary policy in this sector. The exchange rate channel too contributed significantly in this sector. It affected output by 4 per cent in the fourth quarter which further increased to 13 per cent in the twenty-fourth

quarter. The exchange rate channel is strong in this sector probably because a large number of inputs required for manufacturing are imported, the price of which depends upon the exchange rate. Also according to the 2011–2012 data, the Manufacturing sector contributes 61 per cent of the total exports, which means about 17 per cent of the total GDP is contributed by manufacturing exports. However the interest rate channel is the most dominant channel in this sector. This indicates that the Manufacturing sector is highly capital intensive. This result conforms to the results of Ganley and Salmon (1997), Hayo and Uhlenbrock (1999) and Ifeakachukwu and Saibu (2012). Thus, both the Granger causality and the variance decomposition results show that the interest channel is the strongest channel in the Manufacturing sector.

Furthermore, Table 3 established that the interest rate channel contributed progressively to the Electricity, Gas and Water Supply sector (S4). Interest rate affected this sector's output by 0.6 per cent in the second quarter. This shot up to 4.7 per cent by the twenty-fourth quarter. The other two monetary variables had very nominal influence on this sector. Thus, although the Granger causality test result does not clearly indicate any particular channel, the variance decomposition results strongly supports the interest rate channel as the most dominant channel of monetary transmission in the sector.

The Granger causality test finds the interest rate channel to be the only significant channel in the Construction (S5) sector. The contribution of shocks to interest rate to Construction output (S5) growth rose from 1.7 per cent in the second quarter to 3.1 per cent in the fourth quarter. Till the eighth quarter the interest rate channel was thus the strongest channel in the Construction sector which was in confirmation with the findings from the Granger causality test. However, after the eighth quarter the impact of interest rate starts declining although marginally. The influence of the bank credit and exchange rate hereafter starts increasing. The credit channel is strong in this sector as construction activities depend upon availability of bank credit. The exchange rate as a monetary policy instrument is also influential because of the foreign inputs used in this sector. Thus, variations in exchange rate significantly impact on this sector. This result confirmed the findings of Ganley and Salmon (1997) and Ifeakachukwu and Saibu (2012). From the results obtained from both the tests we conclude that although credit and exchange rate

channels play important roles, the interest channel is the most dominant channel in the Construction sector.

According to the Granger causality test there are two potential channels which affect the Trade, Transport and Communication sector output (S6). These two are the credit and the exchange rate channels. The variance decomposition results too support this finding. As we can see in Table 3 the credit channel steadily improves its influence on this sector from 3 per cent in the second quarter to 5.3 per cent in the twenty-fourth quarter. However, the strongest channel has been the exchange rate which has caused the maximum variation in this sector's output. The exchange rate contributed to 2 per cent variation in the output in the fourth quarter which increased to 10.7 per cent in the twenty-fourth quarter. The exchange rate channel is the most influential channel in this sector probably because trade carries the highest weightage of 14.6 per cent of GDP in this sector which involves the use of foreign currency for exports and imports. The remaining sub-sectors Hotels, Restaurant, Transport and Communication carry 9.9 per cent weightage.

As previously suggested by the Granger causality test the two possible channels of transmission of monetary policy for the Finance, Insurance, Real Estate and Business Services sector output (S7) are the interest rate and the credit channels. The variance decomposition table too supports this finding. The interest rate explains 10.5 per cent variation in output by the fourth quarter and further increases to 22.7 per cent by the twenty-fourth quarter. Along with the interest channel the credit channel too explains the variations in the output in a big way. The credit influences the sectoral output by 12 per cent in the twenty-fourth quarter. The exchange rate has a negligible role in this sector. Thus, in this sector although the credit channel is a major influence, it is the interest rate channel which transmits the monetary policy shock most efficiently.

According to the Granger causality test the credit channel is the most effective channel of transmission in the Social, Community and Personal Services (S8) sector. However, the variance decomposition does not show a clear dominance of this channel. According to the result the credit channel is important but the exchange rate channel is also important in this sector. Earlier we have seen that according to the impulse responses this sector is the least responsive to a monetary policy shock. This could be another reason why we do not clearly get a

dominant channel of transmission. Since this sector mainly includes the public administration services provided by the government and quasi-government organizations we consider the credit channel to be the most dominant channel as suggested by the Granger causality test result.

The above analysis on the channels through which monetary policies were transmitted to specific sectors revealed the following:

1. Monetary policy is transmitted by different channels to the various sectors of the economy. The sectors have different characteristics, therefore they respond differently to a monetary policy stimulus.
2. There are sectors where only one channel is dominant while there are others where more than one channels are dominant.
3. The interest rate channel emerges as the most dominant channel of transmission. This is reflected in various results. This is found in case of individual sectors such as Mining and Quarrying (S2), Manufacturing (S3), Electricity, Gas and Water Supply (S4), Construction (S5), Finance, Insurance, Real Estate and Business Services (S7). This is agreeable as we know that after the reforms the central bank shifted from direct to indirect instruments of monetary policy in tune with the increasing market orientation of the economy. The short-term interest rate emerged as an important policy instrument. The liquidity adjustment facility minimized the volatility in the money market by ensuring the movement of short-term interest rate within a corridor. All these developments have enabled the interest rate channel to emerge stronger than the remaining channels.
4. The credit channel continues to be strong channel of transmission in the Indian economy. Along with the interest rate channel it influences a number of sectors such as Mining and Quarrying (S2), Construction (S5), and Finance, Insurance, Real Estate and Business Services (S7). In the Agriculture (S1) and Social, Community and Personal Services Sector (S8) the credit channel is the most effective channel of monetary transmission.
5. The exchange rate channel was responsible for transmitting monetary policy impulse most efficiently in the Trade sector (S6). It

is one of the major channels of transmission in Manufacturing (S3) and Construction (S5) sectors. These sectors use a number of inputs which are imported; therefore their prices fluctuate with the changing exchange rate.

Conclusion

This article analyzed the relations between the sectoral output and the monetary variables in a multivariate setting to find out whether monetary policy shocks have uniform or varying sectoral effects. Aggregate real output is considered to be the outcome of production activities in eight different sectors. The study estimates a VAR for aggregate output as well as for production of each sector. From the estimated VAR, we generate impulse response functions. In line with earlier studies this study finds a decline of aggregate output due to a monetary policy shock. Analyzing sectoral output responses to a monetary shock, we find that some sectors are more affected by monetary tightening. Manufacturing, Finance, Insurance, Real Estate and Financial Services, Mining and Quarrying and Construction are the most responsive to monetary policy shocks. These sectors are the main driving force behind aggregate fluctuations. In contrast, Agriculture, Electricity, Gas and Water Supply, Community, Social and Personal Services are less sensitive to a monetary policy shock. In short, we find that the sectors respond differently to a monetary policy shock. Therefore, in order to fully achieve the benefits of the various monetary policy measures the potential sectoral effects should be taken into consideration. This study uses a short span of time, therefore, for further research with a longer span of time it would be useful to examine the observed cyclicity of different sectors and compare that with the case when the shock was instituted. According to Barakchian and Crowe (2010) the conventional identification methods do not capture the shocks with a more systematic monetary policy responding better to the variables in the policymaker's information set. Therefore, as a topic of future research the underlying mechanisms behind heterogeneous sectoral impacts can be studied using the identification method devised by Barakchian and Crowe (2010) which includes forward looking variables.

The article further examined the different channels of monetary transmission across the different sectors of the Indian economy. For this purpose both the Granger causality test and the FEVD methodology were adopted. The findings revealed that the channels through which monetary policy is transmitted to the real economy are different for every sector. The study considered three main channels, that is, the credit channel, the interest rate channel and the exchange rate channel. The interest rate channel was found to be the most pronounced channel of transmission. The credit channel and the exchange rate channel also played significant roles in transmitting policy signals in a few sectors. The study concludes that there exists a disparity in the transmission channels of monetary policy impulse to the different sectors of the economy. One-size-fits-all-policy will be inefficient in reaching its targets. Therefore the need is to impart a sector-specific sensitivity to monetary policy with emphasis on the relevant channel of transmission.

Appendix

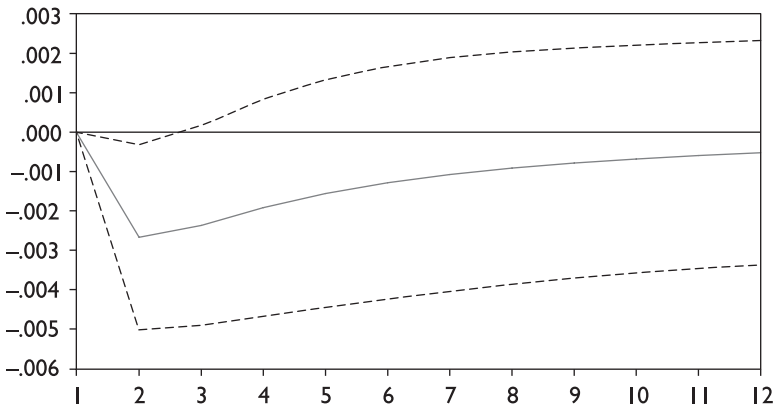
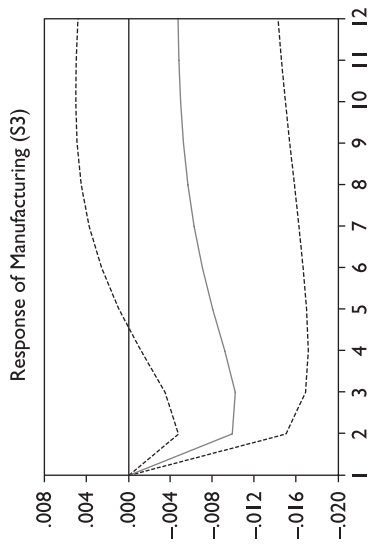
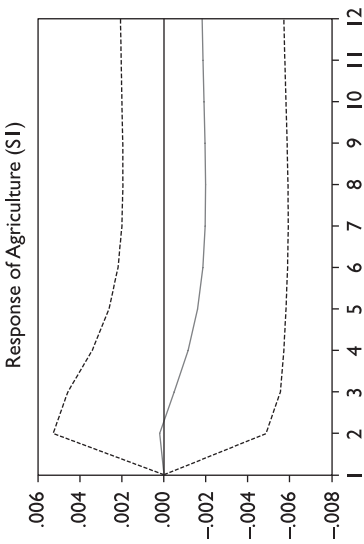
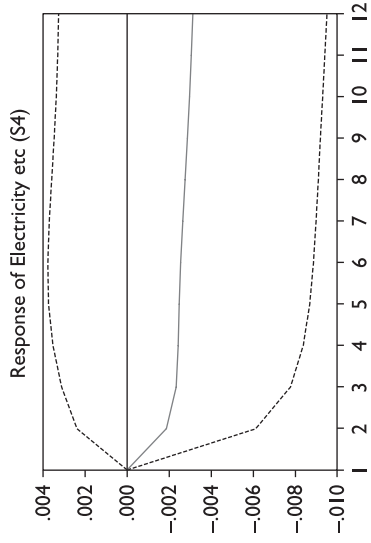
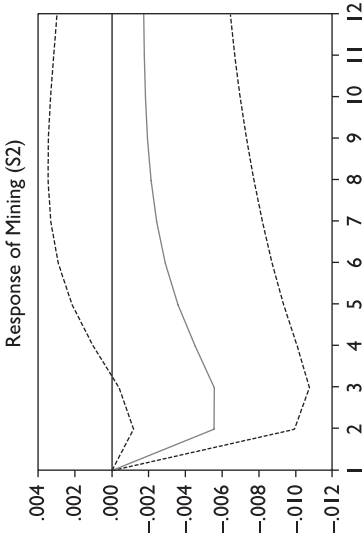


Figure A1. Impulse Response of Aggregate Real Output to Cholesky one S.D Innovations ± 2 S.E to Call Rate



(Figure A2. continued)

(Figure A2. continued)

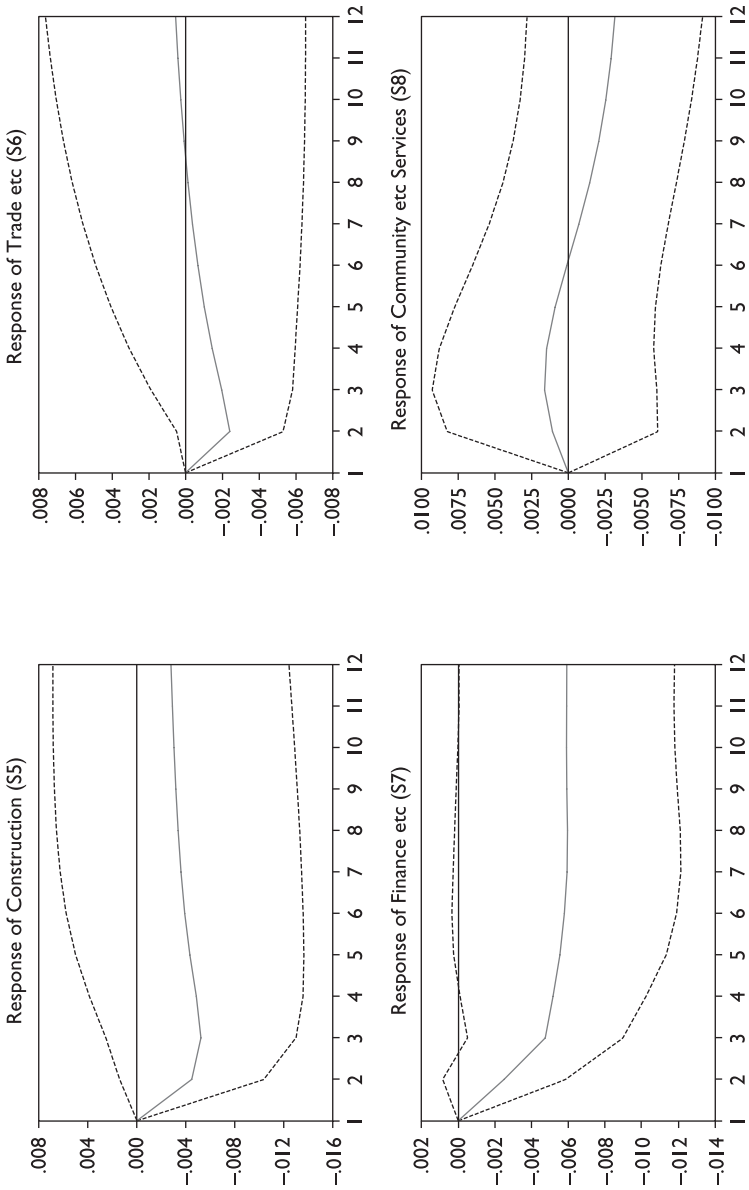


Figure A2. Impulse Responses of Sectoral Real Output to Cholesky one S.D Innovations ± 2 S.E to Call Rate

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