# Industry Effects of Monetary Policy: Evidence from India

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**Abstract**
The study exploits 2-digit level industry data for the period 1981-2004 to ascertain the interlinkage between a monetary policy shock and industry value added. Accordingly, we first estimate a Vector Auto Regression (VAR) model to ascertain the magnitude of a monetary policy shock on industrial output. Subsequently, we try to explain the observed heterogeneity in terms of industry characteristics. The findings indicate that (a) industries exhibit differential response to a monetary tightening and (b) both interest rate and financial accelerator variables tend to be important in explaining the differential response.

*JEL classification*: E52, L60, P20

*Keywords*: industry, monetary policy, interest rate channel, financial accelerator, vector auto regression

## I. Introduction

In simple textbook economics, monetary policy is assumed to exert a uniform effect on real economic activity. This is not surprising, since the majority of the analysis focuses on aggregate levels of variables, such as output and employment. This view, however, ignores the possible differential effects of monetary policy across sectors, such as industry. Carlino and Defina (1998, 1999), for instance, demonstrated that the differential responses of US regions (and states) were related, among others, to their industry composition. The differential response across industries has been cited to be a key factor in explaining the uneven response of monetary policy for the Euro area (Peersman and Smets, 2005). Despite the emerging literature in this area, little evidence on this count has been forthcoming in the context of emerging economies. The present

[1]Department of Economic Analysis and Policy, Reserve Bank of India, S.B.S. Marg, Fort, Mumbai 400001. Mail: saibalghosh @rbi.org.in. I would like to thank, without implicating, Prof. Pulapre Balakrishnan for the discussions on an earlier draft and especially an anonymous referee for the comments and insightful suggestions which greatly improved the exposition and analysis. Needless to state, the views expressed and the approach pursued in the paper reflects the author's personal opinion.

analysis addresses this gap in the literature by exploring the differential industry response to a monetary policy shock, using India as a case study.

Towards this end, the paper examines whether monetary policy shocks exert differential effects on industrial output. We choose India as a case study for three reasons. First, India is presently one of the most important emerging economies with a rich history of industrial controls. These controls were introduced in the aftermath of independence in order to dovetail investment into desirable areas within a mixed economy framework through a process of industrial licensing. Second, like most developed economies, India has a large and diversified manufacturing sector. Over time, industries have tended to develop distinct characteristics, driven by a combination of regulatory policies as well as factors internal to the organisation. The question, therefore, remains as to what extent external shocks such as those induced by a monetary policy affects industries differentially. Third, India has a rich history of industry-level database. The cross-sectional and time series variation in the data makes it amenable to econometric analysis and provides an ideal laboratory to explore the effect of policy-induced shock on industrial output.

The analysis which comes closest to the spirit of the present paper is Aghion *et al.* (2003). Using data on 3-digit manufacturing industries for 16 major Indian states covering 1980-97, they address the issue as to how technological capability of industries affects their response to a shock. The 'shock' considered in their analysis was India's trade liberalization in 1991. Although this shock was common across firms in the same industry; however, firms in different states in the same 3-digit industry varied in terms of their level of pre-reform productivity, which were taken as a proxy of their technological capability. The results demonstrated that state industries with higher pre-reform technological capability exhibited greater increases in output, employment, labor productivity and total factor productivity (TFP), following reform.

The present analysis also seeks to decipher the response of industries to a shock. In contrast to Aghion *et al*. (2003) however, it is a monetary policy shock. Second, unlike their analysis which relied on state-industry pair to ascertain the differential response, we rely solely on industries to determine the differential response. Third, in contrast to their model where the shock was 'exogenous', in our analysis, the shock is derived from an econometric exercise. And finally, in addition to examining the differential industry response, we also attempt to trace the proximate factors driving the response. As a consequence, unlike the panel data approach adopted by Aghion *et al.* (2003), we utilize both time-series techniques and cross-section regression analysis to ascertain the factors responsible for the differential impact of industries to a monetary tightening.

We exploit industry-level data for 1981-2004 to explore the interlinkage between monetary policy shock and the industry response. Accordingly, we first employ a Vector Auto Regression (VAR) model wherein we estimate the effect of monetary policy shock on industry value added. Subsequently, we try to explain the heterogeneity in terms of industry characteristics. The findings indicate that both interest rate as also financial accelerator variables are important in explaining the differential impact.

The paper combines several strands of literature. First, the paper focuses on the *differential* monetary transmission across industries. A number of studies (Ganley and Salmon, 1997; Hayo and Uhlenbrock, 2000; Dedola and Lippi, 2005) have examined the industry effects of a monetary policy shock. A common thread running through these studies is the considerable cross-industry heterogeneity in the impact of monetary policy. The former two studies focused merely on the cross-industry response, but did not dwell into the reasons for the differential response. Subsequent cross-country studies (Dedola and Lippi, 2005; Peersman and Smets, 2005) investigated the reasons for the differential response. However, as is widely acknowledged, owing to significant differences in the institutional and economic environment across countries, the estimates emanating from cross-country regressions are often in the nature of 'average' relationships, which makes the empirical results less appealing (Rodrik, 2005). Focusing on the effect of monetary policy on industrial output within a single country enables to bypass such limitations inherent in cross-country studies. The findings so obtained may be representative of the role of monetary shocks on industrial output in other emerging markets.

Second, the study sheds light on the *channels* of monetary transmission. Following from the literature, we distinguish between two main channels: the financial accelerator channel, in addition to the traditional interest rate channel, by constructing proxies that act as determinants of these channels.[2] By regressing the responses from the VAR model on a set of independent variables that proxy for the hypothesized explanatory factors, we are able to discern which set of variables are more relevant in explaining differential industry response in the Indian scenario.

Third, the paper examines the role of *institutions*, focusing on labor laws in general and the strength of trade unionism, in particular, as a plausible factor impacting industrial output. Besley and Burgess (2004), for instance, document that states with more pro-labor regulation had lower levels of manufacturing development. These states also exhibited higher levels of unionization. Sanyal and Menon (2005) also uncover evidence that state-level labor regulation variables such as number of labor courts, number of registered unions and number of mandays lost owing to labor disputes act as significant disincentives on firm location. Delicensed industries located in states with pro-employer labor regulations are found to exhibit faster growth in terms of both output and employment levels than those with pro-worker regulations (Aghion *et al*., 2006). More recent evidence suggest employment regulations to be an important constraint impeding the performance of Indian manufacturing (Gupta *et al*., 2007). To provide an illustration, consider a situation of a monetary tightening. By raising the cost of capital, this is likely to manifest itself in lower investment and consequently, lower output. If, in addition, the industry is highly unionized, the effect could be compounded, so much so that, the magnitude of the effect is larger as compared to a situation where the degree of unionization were low. Judged from this standpoint, it can be argued that the regulatory framework governing industrial disputes could be an important ingredient influencing industrial output.

[2]The *financial accelerator channel* operates through the effects of monetary policy actions on the balance sheets of firms, the strength of which has implications for their access to external finance.

The rest of the paper unfolds as follows. In Section 2, we provide an overview of the Indian industrial experience, as appropriate, and the position of this paper in that context. The subsequent section discusses the methodology for estimating the industry effects of an economy-wide monetary policy shock. The database and the variables employed in the study are discussed in Section 4. The results of the analysis and the findings related to the hypothesized industry characteristics which are presumed to be relevant in influencing industrial activity are discussed in the penultimate section, followed by the concluding remarks.

## 2. Overview of industrial policy

The introduction of the concept of a socialist economy in the 1960s with its concomitant focus on poverty reduction, egalitarianism and social equality meant that the Indian government followed highly restrictive policies with respect to trade, industry and finance. The process of transition towards self-reliance, driven to an overarching extent by concerns of 'export pessimism' amongst developing nations nested on the logic of heavy-industry oriented industrialization within a closed economy framework. Such a policy engendered the need for industrial licensing whereby firms would have to apply for a license for setting up new units or for capacity expansion. In effect, the policy exerted multiple controls over private investment that limited areas in which private investors were allowed to operate and also determined the scale of operations, the location of new investments and even the technology employed. This was buttressed by a highly protective trade policy, often providing tailor-made protection to each sector of industry. The costs imposed by these policies have been extensively studied (Bhagwati and Desai, 1965; Bhagwati and Srinivasan, 1971; Mookherjee, 1995), and by 1991, a consensus emerged on the need for greater liberalization and openness.

The post-1991 reforms laid strong emphasis on enabling markets and globalization coupled with lower degrees of direct government involvement in economic activities. The list of industries reserved solely for the public sector was gradually scaled down and reduced to three: defense aircrafts and warships, atomic energy generation and railway transport. The process of industrial licensing by the central government has been abolished, except for a few hazardous and environmentally-sensitive industries. The requirement that investment by large houses needed a separate clearance under the *Monopolies and Restrictive Trade Practices Act* to discourage the concentration of economic power was replaced by a new competition law that attempts to regulate anti-competitive behavior.

The net effect of these measures was a sharp rise in industrial growth. From an average of 4% in the 1970s and around 6.5% in the 1980s, industrial growth has averaged around 6% during 1991-2004, perhaps reflecting the effect of liberalization of various controls. Over the entire period beginning 1980 through 2004, industrial growth has been roughly of the order of 6.1% (Kohli, 2006).

While several aspects of industrial behaviour have been extensively studied in the Indian context, including employment issues (Goldar, 2000), productivity aspects, both at the overall industry (Pushpangadan *et al*. 2000; Balakrishnan and Pushpangadan, 2002; Goldar, 2004; Pattnayak and Thangavelu, 2005) as well as at the state-industry (Trivedi, 2004; Goldar and Veeramani, 2005) levels, as also competition aspects (Pushpangadan and Shanta, 2006) including growth and distributional concerns (Balakrishnan and Babu, 2003), the question of interface between monetary policy and industrial output, is, as yet, an unexplored terrain in India and this becomes the major concern of the paper.

## 3. Methodology

The importance of monetary policy for industry output is explored by means of an unrestricted reduced form vector autoregression (VAR) model, in the tradition of Sims (1980). Because the relationships which are defined in these are highly simplified, VAR techniques do not accurately differentiate between theoretical explanations of observed behavior; they are, in fact, efficient means of extracting 'stylised facts' regarding the monetary transmission process.

We preferred the reduced form non-cointegrated VAR technique to its two competing formulations: the cointegrated VAR and structural VAR. As far as cointegrated VARs are concerned, our data is of annual frequency; in such a situation, it was felt that any pre-testing of a long-run relationship might not be meaningful. Therefore, we included the variables in the form in which we expect them to be stationary. The preference over structural VAR also needs justification. In so far as the theoretical literature is concerned, there was no unequivocal stance that gave an idea about the underlying structural relationship between the relevant variables. Therefore, we preferred the Sims-type (1992) reduced form VAR. A major critique against such reduced form VAR is that structural inferences from the impulse responses of such VAR models are sensitive to the ordering of the variables. A solution is often proffered in the form of theoretically meaningful restrictions on the innovations in the VAR process. While such structural VARs have been quite popular in the literature, a caveat remains that unless grounded in a solid theoretical premise, there could be a temptation to adopt 'incredible' identifying restrictions. To address this aspect, we employ Pesaran *et al.*(1997) type generalized impulse response functions.

The preferred ordering of the VAR is real lending rate, (log) real GDP, an index of wholesale prices (P) and industrial output (captured by real value added or RVA), in that order. This suggests that interest rates do not respond to contemporaneous developments in the other variables in the system, that real GDP responds only to changes in interest rates and that, industrial output responds to developments in each of the other variables.[3] Because we are concerned only with identifying the monetary policy shocks, this seems sufficient for our purpose. We estimate separate VARs for each industrial sector and compare the effect of a monetary shock on each sector's output.

[3] Nevertheless, to check the sensitivity of the results to this assumption, we repeated our analysis with interest rates in the second, third and fourth place in the VAR. In the second case, the results were quantitatively similar to those reported in the text. In these two cases, the stability condition of the VAR (results not reported to save space) indicated that all the eigenvalues were inside the unit circle. In the latter two cases, the stability conditions were not satisfied and hence, they were not pursued further. The subsequent Granger causality results (Table 3) also lend support to our choice of ordering of the variables.

With all variables computed in real terms, monetary policy is postulated to be effective when monetary shocks explain a larger proportion of output variance in that industry. In view of the low-frequency nature of the data, we examined the 5-year ahead accumulated response to the shock.

The monetary shock in the present framework is defined in terms of the real lending rate.[4] The use of the real lending rate, as opposed to the real money stock or real liquidity in the system, deserves some justification. Since the 1990s, the focus in the developed economies has increasingly shifted towards interest rates as the operating procedure for monetary policy transmission (Borio, 1997). Even in India as well, the erstwhile monetary targeting procedure was replaced with a multiple indicator approach in 1998, wherein the Indian central bank started using the information content in interest rates and rates of return in different markets along with currency, credit, fiscal position, trade, capital flows, inflation rate, exchange rate, etc and juxtaposing it with output data for drawing policy perspectives. In other words, price-based indicators of monetary policy gained prominence over quantity-based indicators employed earlier. Given the change in the operating procedure and the time period of the analysis, it was deemed as desirable to employ a price (interest rate) variable for the analysis.[5]

Contextually, it needs to be recognized that there is no single lending rate available over the period; these rates, were, in fact, administered for a certain part of the period. Accordingly, we utilize the SBI advance rate for the period beginning 1980-81 through 1987-88 and subsequently, employ the minimum (general) rate. As is well-known, lending rates were de-regulated since 1994 and banks were given freedom to fix lending rates (termed as, prime lending rate) for credit limits in excess of Rs.2 lakh (RBI, 2007). Typically, this (interest rate) was a range and we take the mid-point of the range as the representative lending rate for the concerned year. To control for other

[4] Defined as {[(1+*lending rate*) / (1+*WPI inflation*)]-1} Sanchez (2001) utilizes a similar definition in the analysis of Mexican manufacturing firms.

[5] Another possibility could be to employ the real money supply as a monetary policy indicator. However, as the discussion earlier indicates, there has been a gradual switch from quantity – to price-based indicators of monetary policy. Focusing on quantity channel is also likely to bring into play the real balance or liquidity effect, operating through the balance sheet of households.

macroeconomic influences on sectoral development, we also include (log of) real GDP and a price variable (WPI for all commodities), to control for supply shocks as well as for shifts in aggregate demand resulting from influences other than those due to monetary policy, particularly interest rate changes (Nachane *et al*., 2002).

To identify the monetary policy shocks, we employ the Choleski decomposition – following Bernanke and Blinder (1992). As is well-known, this identification procedure is somewhat *ad hoc* and relies upon a recursive ordering of the relationship existing in the data. After determining the lags for the respective VARs, we estimated the VAR described above.[6]

## 4. The database

The study combines three sets of data. First, it employs data on industries at the two-digit level. Second, it utilizes information on macro and monetary variables as culled out from the *Handbook of Statistics on Indian Economy*, an annual publication of the Reserve Bank of India containing time-series information on macro and monetary variables. And finally, it employs data on trade union membership which is culled out from the *Indian Labour Yearbook*.

The *Annual Survey of Industries* (ASI) data provides information on industry at the 2-digit level. The data covers all factories registered under the Factories Act 1948 (defined as units employing 20 or more workers). The ASI frame can be classified into two sectors: the census sector and the sample sector. Units in the 'census' sector (all factories with more than 100 workers) are covered with a sampling probability of one, whereas units in the 'sample' sector (employing between 20 and 99 persons) are covered with probabilities one-half or one-third. The census sector covers 80% of the formal sector of industry and is considered more reliable than the sample sector. For each industry, data on a wide range of variables is available, including number of factories, capital employed, number of workers, gross value added and capital formation. The classifications are based on National Industrial Classification 1998 (NIC 98) which has

[6] The lags are determined through Schwarz Information Criteria (SIC), and through sequential testing using Sims (1980) Modified LR tests. The optimal lags of the VAR turned out to be 3 years.

been revised and evolved upon the earlier NIC 87 classification. The revised NIC 1998 has been followed by the Annual Survey of Industries 1998-99.[7] Data on industry-level variables are culled out from the ASI database (EPW Research Foundation, 2007).

We have data for the period 1981 to 2004, which is an especially interesting period: the liberalization of the economy, which began somewhat hesitantly in the 1980s and was rapidly pushed forward in 1991 post initiation of a wider process of economic reforms, as also the growing importance of price-based indicators of monetary policy.

Finally, in the latter part of our analysis, we use information on the degree of trade unionism, defined as the number of employees listed as trade union members divided by the total number of workers in the concerned industry. It would have been useful to deflate the number of trade union members by number of employees. However, the reported numbers on employees is scanty; accordingly, to avoid loss of information, we employ number of workers instead. Employee is a much broader concept and includes, in addition to workers, persons receiving wages and holding supervisory or managerial positions engaged in administrative office and related activities. Accordingly, the measure of unionism could be an over-estimate of the actual degree of trade unionism.

Table 1 provides an overview of the real value added (RVA) by each industry during the sample period. As is evident, the shares of most industries remained more or less constant; notable exceptions to this fact were textiles, machinery and equipment, electricity and other transport, which witnessed declines or fluctuations in the shares of the total real value added of all industries. Several industries also witnessed perceptible increases in their share, salient among these included coke and nuclear fuel, chemicals and motor vehicles.

Table 1: Share of industry in real value added (percent)

| Industry (Code) | 1981-90 | 1991-1995 | 1995-2000 | 2001-2004 | *Memo: 1991-92* |
|---|---|---|---|---|---|

[7] The release of the United Nations International Standard Industrial Classification (ISIC) 2002, Rev. 3.1, coupled with immediate national requirements necessitated revision of NIC-1998. In this context, the Ministry of Statistics and Programme Implementation (MOSPI) constituted a Standing Committee on Industrial Statistics (SCIS). After due deliberations, the SCIS approved and adopted the updated National Industrial Classification in 2004. The present analysis is based on NIC 98 as reported in the EPWRF 2007 database.

| | | | | | |
|---|---|---|---|---|---|
| Food and beverages (15) | 8.7 | 8.3 | 9.1 | 9.7 | 8.8 |
| Tobacco (16) | 1.3 | 1.5 | 1.5 | 2.3 | 1.7 |
| Textiles (17) | 11.6 | 9.6 | 8.1 | 8.2 | 9.6 |
| Wearing apparel (18) | 0.5 | 1.6 | 1.6 | 1.8 | 1.4 |
| Leather (19) | 0.7 | 0.9 | 0.7 | 0.8 | 0.9 |
| Wood and straw (20) | 0.4 | 0.3 | 0.2 | 0.3 | 0.3 |
| Paper (21) | 1.8 | 1.8 | 1.5 | 2.2 | 2.1 |
| Publishing and printing (22) | 1.6 | 1.4 | 1.4 | 1.5 | 1.4 |
| Coke, nuclear fuel (23) | 3.5 | 4.1 | 3.7 | 8.6 | 3.1 |
| Chemicals (24) | 13.1 | 14.7 | 18.5 | 19.6 | 14.0 |
| Rubber and plastic (25) | 2.5 | 2.6 | 3.0 | 3.5 | 2.8 |
| Other non-metallic minerals (26) | 4.4 | 4.4 | 4.2 | 5.1 | 6.2 |
| Basic metal (27) | 10.9 | 10.2 | 11.7 | 11.7 | 8.9 |
| Metal products (28) | 2.3 | 2.2 | 2.4 | 2.5 | 2.6 |
| Machinery and eqpt. (29) | 7.0 | 5.5 | 5.8 | 5.6 | 6.3 |
| Office, accounting etc. (30) | 0.6 | 0.7 | 0.4 | 0.7 | 0.8 |
| Electrical machinery (31) | 3.9 | 4.1 | 3.8 | 3.4 | 4.5 |
| Radio, TV (32) | 1.5 | 2.1 | 2.0 | 2.2 | 2.4 |
| Medical precision (33) | 1.0 | 0.6 | 0.8 | 1.0 | 0.7 |
| Motor vehicles (34) | 3.8 | 3.5 | 4.7 | 5.1 | 3.9 |
| Other transport (35) | 3.2 | 2.8 | 2.6 | 2.8 | 3.0 |
| Furniture (26) | 0.7 | 0.7 | 1.1 | 1.4 | 0.5 |
| Electricity, gas, etc. (40) | 14.8 | 16.4 | 10.9 | .. | 15.0 |
| All industries | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

.. Figures on value added not reported for several years; hence not included in computations
Source: Computed from ASI database (2007)

## 5. Results and discussion

### *5.1 Time series properties*

The variables used in the estimation process must be stationary in order for standard theory to apply. Table 2 reports the results of the augmented Dickey-Fuller (ADF) unit root tests applied to the levels and first differences of the variables. All the variables are found to be I(1). Hence, the VAR framework described above is estimated in growth rates, owing to which one year of data is lost in the analysis.[8]

Table 2: ADF tests of the variables

| Variables | Level (a) | Growth rate (b) |
|---|---|---|
| *Industry-level* (Real value added) | | |
| Food and Beverages | -1.67 | -4.97 |

[8] We also computed the correlation coefficients among these variables (table not reported to save space). The correlation between GDP growth and interest rate was -0.067 (p-Value of 0.75) and between the price index and GDP growth was -0.301 (p-Value of 0.15). Most of the correlation coefficients between the industry value added and interest rate variable were negative and significant at the 0.05 level or higher.

| | | |
|---|---|---|
| Tobacco | -3.16 | -6.18 |
| Textiles | -2.47 | -5.89 |
| Wearing apparel | -2.08 | -4.43 |
| Leather | -1.13 | -5.29 |
| Wood | -3.06 | -5.70 |
| Paper | -3.10 | -4.94 |
| Publishing and printing | -2.38 | -3.95 |
| Coke, ref. petroleum and nuclear fuel | -2.56 | -4.39 |
| Chemicals | -1.54 | -4.35 |
| Rubber and plastic | -2.22 | -3.82 |
| Other NMM | -2.75 | -3.72 |
| Basic metals | -2.45 | -3.80 |
| Metal products | -1.91 | -3.34 |
| Machinery and equipment | -2.26 | -4.26 |
| Office accounting and computing machinery | -2.61 | -5.01 |
| Electrical machinery | -1.31 | -4.32 |
| Radio, TV and communication equipment | -1.86 | -4.35 |
| Medical precision and optical instruments | -3.04 | -5.01 |
| Motor vehicles | -3.16 | -3.65 |
| Other transport equipment | -2.32 | -3.57 |
| Furniture | -2.49 | -3.48 |
| Electricity, gas and water supply | -1.81 | -3.97 |
| *Macro level* | | |
| WPI | -1.37 | -5.49 |
| Log (real GDP) | -3.15 | -5.07 |
| Real lending rate | -4.58 | -6.74 |

a. includes intercept and time trend

b. includes intercept

Note: The 95% values for a and b are -3.63 and 3.01, respectively

*5.2 Granger causality pattern*

Our primary concern is to see whether real lending rate matters for real value added (and also real GDP growth). In order to do that, we examined the joint significance of various independent variables, using the standard F-test. As can be seen from Table 3, real lending rate seems to be Granger causing real GDP growth; none of the other causality relationships (apart from own past values of the same variable) are statistically significant. Overall, the evidence indicates that the VAR framework chosen in the present context is appropriate.[9]

Table 3: Granger causality patterns in the VAR – F-statistics

| | Dependent variable | | |
|---|---|---|---|
| Independent variable | Real GDP growth | Real lending rate | WPI |

[9] The real lending rate is found not to Granger-cause WPI as also vice versa. These control variables are not found to be statistically significant.

| | | | |
|---|---|---|---|
| Real lending rate | 2.781 (0.078)* | 4.279 (0.00)*** | 0.357 (0.731) |
| Real GDP growth | 19.102 (0.00)*** | 0.466 (0.627) | 1.454 (0.223) |
| WPI | 0. 877 (0.451) | 0.519 (0.701) | 5.231 (0.00)*** |

p-Values within brackets

** and * denotes statistical significance at 1% and 10%, respectively

*5.3 Results*

The results of the VAR analysis are set out in Tables 4 and 5. An interesting pattern emerges from the response of industries. In particular, there is a clustering of industries into two broad groups: the first where the response to a shock is low (Table 4) and the second, where the response to the shock is on the higher side (Table 5), although there are certain exceptions under both categories. Since the response of industry value added is expected to be negative to an increase in the real lending rate, industries with larger absolute response are shown at the bottom of the column. Accordingly, we arrange the industries in terms of descending order of response to the monetary policy shock in the final year.

Without loss of generality, the first set of industries appears to be more or less related to consumer demand. The reaction of personal consumption to monetary shocks, however, tends to be quite diverse. Textile, wearing apparel and food products exhibit a more or less similar response, since such purchases are more often made out of current income rather than from borrowed funds, which could perhaps be responsible for the observed response. Typically, industries exhibiting relatively higher response within this category are those having interface with industrial demand and more capital-intensive as well; examples are machinery and equipment, radio and TV *etc*.

To provide some sense of the magnitudes, we computed the ratio of interest payment to gross value added, a proxy for the share of interest payment in the cost of production, averaged over the sample period. For industries such as food, textiles and wearing apparel, this was in the range of 13.6-15.5%. In contrast, for industries having interface with industrial demand, the ratio was much higher – such as 17.4% in case of machinery and equipment and about 21% in case of radio, TV, etc - highlighting the impact of the interest cost in the differential industry response to monetary policy.[10]

Table 4: Industries exhibiting moderate response: accumulated response to a monetary shock

| Period/ Industry | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Food and beverages | -0.0023 | -0.0065 | -0.0077 | -0.0109 | -0.0203 |
| Furniture | 0.0310 | -0.0112 | -0.0213 | -0.0223 | -0.0279 |
| Wearing apparels | -0.0077 | -0.0165 | -0.0258 | -0.0345 | -0.0358 |
| Office, accounting | -0.0064 | -0.0176 | -0.0244 | -0.0309 | -0.0363 |
| Textiles | -0.0121 | -0.0177 | -0.0236 | -0.0341 | -0.0396 |
| Radio, TV | -0.0137 | -0.0394 | -0.0472 | -0.0566 | -0.0635 |
| Medical eqpt. | -0.0112 | -0.0179 | -0.0286 | -0.0508 | -0.0640 |
| Leather | -0.0365 | -0.0581 | -0.0662 | -0.0789 | -0.0875 |
| Tobacco | -0.0401 | -0.0559 | -0.0745 | -0.0854 | -0.0973 |
| Wood | -0.0257 | -0.0471 | -0.0635 | -0.0866 | -0.1009 |
| Machinery and eqpt. | -0.0208 | -0.0436 | -0.0677 | -0.0925 | -0.1176 |

The second set of industries seem to be linked more closely to industrial demand: chemicals, non-metallic minerals, metal products, electrical machinery, rubber *etc*. This is in accordance with the evidence that investment expenditures tend to be more interest sensitive, so much so that purchases of capital goods are likely to exhibit a sharper decline in response to a monetary tightening. This is also evidenced from the high proportion of interest expenses in total value added in these industries: for chemicals, this proportion is 22% and even higher for several other industries.

Table 5: Industries exhibiting high response: accumulated response to a monetary shock

| Period/ Industry | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Printing | -0.0176 | -0.0659 | -0.1321 | -0.1685 | -0.2045 |
| Paper | -0.0119 | -0.0767 | -0.1545 | -0.1769 | -0.2126 |
| Coke, nuclear fuel | -0.0110 | -0.0568 | -0.1237 | -0.1794 | -0.2142 |
| Chemicals | -0.0233 | -0.0715 | -0.0983 | -0.1643 | -0.2241 |
| Metal products | -0.0259 | -0.0667 | -0.1096 | -0.1883 | -0.2385 |
| Elec. Machinery | -0.0382 | -0.0717 | -0.1262 | -0.1739 | -0.2402 |
| Basic metals | -0.0248 | -0.0819 | -0.0970 | -0.1809 | -0.2422 |
| Other transport | -0.0231 | -0.0653 | -0.1119 | -0.1734 | -0.2527 |
| Motor vehicles | 0.0225 | -0.0359 | -0.1060 | -0.1622 | -0.2601 |
| NMM | -0.0357 | -0.0604 | -0.1563 | -0.1971 | -0.2847 |
| Electricity | -0.0521 | -0.0780 | -0.1757 | -0.2541 | -0.2933 |
| Rubber | -0.0376 | -0.1466 | -0.2279 | -0.2917 | -0.3436 |

The industry with the highest observed response is rubber. This is typically a diverse industry, largely dependent on demand from a manifold of sectors including

[10] I am grateful to the referee for suggesting this analysis

construction, motor vehicles manufacturers and service-like haulage, the demand for all of which also appears to be also interest responsive, and therefore, the magnitude of the response could be reflective of a cumulative reduction in demand emanating across several industries.

On balance, the evidence indicates that the impact of a monetary shock tends to be pronounced in case of certain industries, which could provide the authorities with early information on the likely eventual impact of monetary shocks on these industries.

*V.4 What factors drive the differential response?*

The earlier sub-section identified the differential response of industries to a monetary shock. The present section attempts to trace the proximate causes of the differential response. We classify the set of possible factors under three heads: the interest rate channel, the broad credit channel and labor market characteristics. Table 6 provides the empirical definitions of the variables and the data source.

Table 6: Variables and empirical definition

| Variable (Notation) | Empirical definition | Source |
|---|---|---|
| Investment intensity (*investment*) | Gross fixed capital formation/ gross value added | EPWRF industry database |
| Durable dummy (*durable*) | Dummy =1 if an industry produces durable goods, else zero | Dedola and Lippi (2005) |
| Interest cost (*interest*) | Interest payments/ gross value added | EPWRF industry database |
| Leverage ratio (*leverage*) | Outstanding loans/ capital | EPWRF industry database |
| Coverage ratio (*coverage*) | Net income / total interest payments | EPWRF industry database |
| Working capital ratio (*working capital*) | Working capital/ gross value added | EPWRF industry database |
| Average factory size (*size*) | Total number of workers / number of factories | EPWRF industry database |
| Trade unionism (*union*) | Number of employees listed as trade union members/ number of workers | Numerator is from Indian Labour Yearbook. Denominator is from EPWRF industry database |

Under the first channel, we consider three variables: interest cost, investment and the fact as to whether an industry is in the traded sector. Industries with a high interest cost in total production are likely to be affected more adversely by a rise in interest rate. To capture this aspect, we define a variable *interest* which equals the proportion of interest payment in gross value added. To the extent that industries with high interest costs are more affected by monetary policy shocks, we expect a negative coefficient on this variable.

The second variable is the industry's investment intensity (*investment*), to describe the strength of the interest rate channel. This variable has also been employed by Dedola and Lippi (2005). *Ceteris paribus*, higher *investment* will imply higher capital stock in relation to output and the more dependent will the industry be with respect to an increase in the cost of capital. Therefore, industries characterized by high *investment* will be impacted relatively hard by a negative monetary shock.

In addition, we also use a dummy *tradable,* as to whether the industry is in the traded goods sector. Economically, participants in the tradable goods sector might have relatively better access to foreign currency earnings (Martinez and Weiner, 2002) and to that extent, could be less impacted by a monetary shock.

The second channel is based on the financial accelerator theory. The first indicator is *leverage*, defined as the ratio of total loans to total capital. On the one hand, industries exhibiting high leverage are likely to encounter greater difficulties in obtaining additional funds from the market. Based on this conjecture, we expect a positive influence of *leverage* on monetary policy response. On the other hand, high leverage ratio could be indicative of the level of indebtedness of a concerned industry. For example, Dedola and Lippi (2005) interpret leverage as an indicator of borrowing capacity, consistent with the finding that more leveraged firms tend to obtain loans at better terms. In that case, leveraged industries could be less sensitive to monetary policy changes.

The second indicator is *coverage* which measures the extent to which cash flows are adequate to cover for financial costs and is, therefore, related to creditworthiness. Industries with higher coverage ratios are expected to be less sensitive to monetary policy changes.

The third indicator, working capital ratio (*working capital*) captures the extent to which the industry depends on financing for its current assets. This variable acts as a proxy for the short-term financing requirements of the industry. The financial accelerator is expected to be stronger in industries with a higher level of working capital.

Finally, the size of an industry (*size*) is often used as an indicator for the degree of asymmetric information problems in lending relationships. Agency costs are usually smaller for large industries because of scale economies in information acquisition and processing. As a result, such industries are able to finance themselves directly through financial markets and are less dependent on banks. To control for the fact that size varies significantly across industries, we normalize this variable by defining it as the total number of workers in an industry divided by the number of factories and expect a negative coefficient on this variable.

The final variable is related to labor market institutions. Under an adverse monetary shock, it seems likely that industries would prefer to cut down on costs in order to preserve bottom lines. Flexibility in retrenchment constitutes an important ingredient of the process. However, if an industry is highly unionized, such retrenchment could prove difficult. Trade union membership represents an important constituent of bargaining power of workers and it seems likely that highly unionized industries could be relatively more affected by a monetary tightening. To address this aspect, we include a variable *union*, defined as the number of employees listed as trade union members divided by the total number of workers in that industry.[11]

To examine the relative strength of alternative channels, the *absolute value* of the long run industry response (the estimated cumulative response 5-years following the policy shock) is regressed on the aforesaid variables, averaged over the period 1981-2004. Estimated parameters from four cross-section regressions are presented in table 7. Models (1) through (3) sequentially incorporate the three channels elucidated earlier before combining them together in a final model (Model 4).

[11] A major limitation of this variable is that the number of trade union members is reported only from unions submitting returns. Moreover, submission of these returns is purely voluntary. As a result, these numbers could be under-estimates, since it does not take cognizance of the members of non-reporting unions. Notwithstanding these deficiencies, trade unionism is an important component of bargaining power of workers that helps steer the course of negotiations along a defined path.

Table 7: Explaining cross-industry variation in monetary policy responses

| Variable | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Intercept | 0.201 (0.077)*** | -0.143 (0.078)*** | 0.087 (0.039)*** | 0.195(0.091)*** |
| *Interest rate channel* | | | | |
| Interest | -0.023 (0.014)* | | | -0.019 (0.010)** |
| Investment | -0.011 (0.043) | | | -0.053 (0.057) |
| Traded | -0.032 (0.054) | | | -0.011 (0.050) |
| *Financial accelerator channel* | | | | |
| Leverage | | -0.023 (0.060) | | -0.065 (0.079) |
| Coverage | | 0.013 (0.021) | | 0.020 (0.017) |
| Working capital | | -0.006 (0.003)** | | 0.019 (0.011)* |
| Size | | -0.101 (0.051)** | | -0.095 (0.045)** |
| *Institutional factor* | | | | |
| Union | | | 0.187 (0.219) | 0.154 (0.207) |
| R-square; N.Obs. | 0.025; 23 | 0.221; 23 | 0.074; 23 | 0.261; 23 |

Heteroskedasticity consistent standard errors within parentheses
***, ** and * denote statistical significance at 1, 5 and 10%, respectively

The findings can be summarized as follows. First, the interest cost has a significant bearing on the monetary response, testifying the relevance of the interest rate channel. Second, the financial variable that seems to work most consistently with the financial accelerator hypothesis is the *working capital ratio*. In other words, industries with higher short-term financing requirements as measured by the working capital variable, exhibit greater output responsiveness. This is consistent with the evidence proffered by Dedola and Lippi (2005) in their cross-country analysis. In addition, the coefficient on *size* is negative: larger industries are better able to shield themselves against a monetary contraction. Finally, the trade union variable is found not to be significantly related to the monetary policy effects.

## VI. Concluding remarks

The primary focus of the paper was to investigate the effects of monetary policy transmission on the Indian manufacturing sector. Since we did not intend to model individual industry behavior in detail, the relevant stylized facts were analyzed within a microeconomic setting by means of a VAR model.

The analysis indicates that industries respond quite differently to a monetary tightening. An examination of the observed response across industries indicates 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.

The analytics thereafter explores which industry characteristics can account for this differential response. The evidence indicates that the differential response seem to be related mainly to differences in size of the industry and its intensity of working capital use. As well, the proportion of interest cost is observed to play an important role. Therefore, both the financial accelerator and interest rate mechanisms assume relevance in explaining why certain industries are more affected by monetary policy *vis-à-vis* others in the Indian context.

The results need to be viewed as preliminary. Further investigation would of course, be relevant, examining in particular, whether the results are robust to alternative sub-periods of the sample or even to other monetary policy indicators. However, to the extent that there exists differential influence across industries, there is no gainsaying that monetary policy in the Indian context would need to take on board this hitherto neglected perspective. Addressing such issues constitutes agenda for future research.

**References**

Aghion, P., R.Burgess., S.Redding and F.Zilibotti (2003). Entry liberalization and inequality in industrial performance. *Journal of the European Economic Association* 2/3, 291-302.

Balakrishnan, P., and K.Pushpangadan (2002). TFPG in manufacturing: The 80s revisited. *Economic and Political Weekly* 47 (January), 323-25.

Balakrishnan, P., and M.Suresh Babu (2003). Growth and distribution in Indian industry in the nineties. *Economic and Political Weekly* 48 (September), 3997-4005.

Bernanke, B., and A.Blinder (1992). The federal funds rate and the channels of monetary transmission. *American Economic Review* 82, 901-21.

Besley, T., and R.Burgess (2004). Can labour regulation hinder economic performance? Evidence from India. *Quarterly Journal of Economics* 119, 91-134.

Bhagwati, J. and T.N.Srinivasan (1975). *Foreign trade regimes and economic development*. New York: Columbia University Press.

Bhagwati, J., and P.Desai (1970). *India: Planning for Industrialization*. London: Oxford University Press.

Borio, C. (1997). The implementation of monetary policy in industrialized countries: A survey. *BIS Economic Papers* No.47. BIS: Basel.

Carlino, G., and R.Defina (1998). The differential regional effects of monetary policy. *Review of Economics and Statistics* 80, 572-87.

Carlino, G., and R.Defina (1999). The differential regional effects of monetary policy: Evidence from the U.S. states. *Journal of Regional Science* 39, 339-58.

Dedola, L., and F.Lippi (2005). The monetary transmission mechanism: Evidence from the industry data of five OECD countries. *European Economic Review* 49, 1543-69.

Economic and Political Weekly Research Foundation (2007). *Annual Survey of Industries: 1973-74 to 2003-04.* Mumbai.

Forbes, K.J. (2002) How do large depreciations affect firm performance?, *NBER Working Paper* No.9095, Cambridge: MA.

Ganley, J., and C.Salmon (1997). The industrial impact of monetary policy shocks: Some stylised facts. Bank of England Working Paper No.68, UK.

Goldar, B.N. (2000). Employment growth in organised manufacturing in India. *Economic and Political Weekly* 45 (April), 1191-95.

Goldar, B.N., and C.Veeramani (2005). Manufacturing productivity in Indian states: Does investment climate matter?. *Economic and Political Weekly* 50 (June), 2413-20.

Government of India. *Indian Labour Yearbook.* Labour Bureau: Shimla (various years).

Gupta, P., R.Hasan and U.Kumar (2007). What constraints Indian manufacturing? Paper presented at the Conference on India and China's role in international trade and finance and global economic governance. December 6-7, Indian Council for Research on International Economic Relations: New Delhi.

Hayo, B., and B.Uhlenbrock (2000). Industry effects of monetary policy in Germany. In J.Hagen and C.Waller (Eds.) *Regional Aspects of Monetary Policy in Europe.* Boston: Kluwer.

Kohli, A. (2006). Politics of economic growth in India (Part I). *Economic and Political Weekly* (April), 1251-59.

Martinez, L. and A.Werner (2002). The exchange rate regime and the currency composition of corporate debt: The Mexican experience. *Journal of Development Economics* 69, 315-34.

Mookherjee, D. (1995). *Indian Industry: Policies and Performance* (Editor). OUP: New Delhi.

Nachane, D.M., P.Ray and S.Ghosh (2002). Does monetary policy have differential state-level effects? An empirical evaluation. *Economic and Political Weekly*, 47 (October), 4723-28.

Pattnayak, S.S., and S.M.Thangavelu (2005). Economic reform and productivity growth in Indian manufacturing industries: An interaction of technical change and scale economies. *Economic Modelling* 22, 601-15.

Peersman, G., and F.Smets (2005). The industry effects of monetary policy in the Euro area. *Economic Journal* 115, 319-42.

Pesaran, H., and Y.Shin (1997). Generalised impulse response analysis in linear multivariate models. University of Cambridge Working Paper. Cambridge: UK.

Pushpangadan, K., and N.Shanta (2006). Competition in Indian manufacturing industries: A mobility analysis. *Economic and Political Weekly* 51 (September), 4130-37.

Pushpangadan, K., M.Suresh Babu and P.Balakrishnan (2000). Trade liberalisation and productivity growth in manufacturing: Evidence from firm-level panel data. *Economic and Political Weekly* 45 (October) 3679-82.

Reserve Bank of India (2002). *Report on Currency and Finance 2000-01*. RBI: Mumbai.

Reserve Bank of India (2004). *Report on Currency and Finance 2003-04.* RBI: Mumbai.

Reserve Bank of India (2007). *Handbook of Statistics on the Indian Economy.* RBI: Mumbai.

Rodrik, D., (2005). Why we learn nothing from regressing economic growth on policies. Available at <http:// ksghome.harvard.edu>.

Sanchez, O. (2001). Investment by manufacturing firms and the transmission of monetary policy in Mexico. CREDPR Working Paper No.111, Stanford University: US.

Sanyal, P and N. Menon (2005). Labor disputes and the economics of firm geography: A study of domestic investment in India. *Economic Development and Cultural Change* 53, 825-54.

Sims, C. (1980). Macroeconomics and reality. *Econometrica* 48, 1-48.

Sims, C. (1992). Interpreting macroeconomic time series facts: the effects of monetary policy. *European Economic Review* 36, 975-1011.

Trivedi, P. (2004). An inter-state perspective of manufacturing productivity in India: 1980-81 to 2000-01. *Indian Economic Review* 39, 203-37.