Sectoral Effects of Monetary Policy Shock: Evidence from India

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Abstract
This paper analyzes the effect of monetary policy shock on the aggregate as well as on the sectoral output of Indian economy using reduced form vector auto regression (VAR) model. We find that the impact of a monetary policy shock at the sectoral level is heterogeneous. Sectors such as, mining and quarrying, manufacturing, construction and trade, hotel, transport and communications seems to decline more sharply than aggregate output in response to a monetary tightening. We also augment the basic VAR by including three channels- credit channel, exchange rate channel and asset price channel of the monetary policy, and analyze the sector specific importance of each of the channel. The channels through which monetary policy is transmitted to the real economy are found to be different for every sector. In most of the cases, multiple channels are responsible for the changes in the aggregate and sectoral output to the monetary policy shock. These results clearly indicate the need for a sector specific monetary policy in India.

Keywords: Monetary transmission mechanism, Sectoral output and VAR
JEL Classification: E50, E52, E58

1. Evolving Monetary Policy in India

It is crucial to the effective conduct of monetary policy that it must exert a systematic influence on the economy in a forward looking sense (Mohan & Patra, 2009). Such a systematic influence of the monetary policy on the economy can be encapsulated through monetary policy transmission mechanism (MTM). Therefore, it is crucial that a clear understanding of monetary transmission mechanism as well as the channels through which monetary policy affects financial markets, output and prices is required for evaluating the efficacy of monetary policy. Besides the quantum channel, three other channels of influence - the interest rate channel, the exchange rate channel and the asset price channel, indirectly influence real activities through changes in either interest rates or the exchange rate or asset prices. India, as any other emerging economy, is undergoing through a structural transformation of economic and financial sector, a clear identification of the influence of a particular channel of monetary transmission on the real sector is a complex task (Reddy, 2002). In the fast evolving India's monetary and financial system with increasing external orientation, monetary authorities have been actively engaged in managing price stability (inflation) through interest rate targeting and exchange rate stability (volatility) through active foreign exchange market intervention. The monetary policy framework as well as associated operating procedures of monetary policy has evolved over time in India. There has been a shift in monetary policy strand since the initiation of economic and financial reforms beginning early 1990s. With short-term liquidity management gaining prominence, the Reserve Bank of India (RBI) moved from the use of direct to indirect market based instruments and consequently interest rate has become important instrument of monetary policy. Yet it is through these developments one needs to examine the efficacy of monetary transmission mechanism in influencing output.

The remaining of the paper is organized as follows: Section 2 reviews the empirical evidence on monetary transmission mechanism and at the end delineates the scope of the present study and outlines the methodology of the study. Section 3 discusses the empirical model construction and the data structure. Section 3 analyses the estimation of results and Section 4 concludes the study by summarizing the findings.

2. Monetary Transmission Mechanism

There have been number of studies on monetary transmission mechanism in India (Ray, Joshi and Saggar, 1998; Al-Mashat, 2003; RBI, 2004; Aleem, 2010, Bhattacharya et al., 2011; and

Khundrakpam and Das, 2011) which has used VAR approach and conclude that monetary policy does have real effects, at least, in the short run. However, recently, the focus has been shifted from whether money matters to emphasizing other aspects of monetary policy and its relation to real sector. One of the aspects which has received considerable amount of attention is the disaggregated effect of monetary policy at sectoral or regional level.

One of the first such study at the disaggregated level, Bernanke and Gertler (1995), using a VAR approach, shows the varying impact of monetary policy on components of final expenditure. With reference to the regional effects, Carlino and DeFina (1998 and 1999) examine differential effects of monetary policy across regions of the USA. They find supportive evidence that certain regions are more responsive to changes in monetary policies. While measuring the regional and sectoral impact of monetary shocks across Netherland, Arnold and Vrugst (2002) find large regional and sectoral variation in monetary policy. Similar evidence was found for the European Union (Barran et al., 1996; Ramaswamy and Slok, 1998; Cecchetti, 1999; and Mihov, 2001). A developing country perspective analysis by Nachane *et. al.* (2002) study whether monetary policy has similar effects across major states of India. The impulse response functions from an estimated Structural VAR reveal two sets of states: a core of states that respond to monetary policy in a significant fashion vis-à-vis others whose response is less significant.

Disaggregating the Canadian economy at the level of final expenditures as well as at the level of output, Fares and Srour (2001) collect evidence of differing response of various sectors of the economy to innovations in monetary policy. Analyzing the UK data, Tena and Tremayne (2009) find evidence of cross-sectional differences across industries and asymmetries in some sectors to a monetary policy change while Ganley and Salmon (1997) provide evidence that the construction sector is the most interest-sensitive sector, followed by the manufacturing industry, services, and agriculture. In the case of India, Ghosh (2009) uses VAR model to ascertain the magnitude of a monetary policy shock on industrial output and his findings indicate that industries exhibit differential response to monetary policy. Furthermore, Dhal (2011) studies the impact of monetary policy based on five use-based classification of industry for India and concludes that following a tight monetary policy shock, the output growth of capital goods and consumer durables are affected more than the basic, intermediate and consumer non-durable goods.

Ibrahim (2005) and Alam & Waheed (2006) study the impact of monetary policy at sectoral level for the developing countries, Malaysia and Pakistan respectively and find sector

specific response to monetary policy. In response to positive monetary shocks, manufacturing, construction, finance, insurance, real estate and business services sectors seem to decline more than aggregate production whereas agriculture, forestry and fishing, mining and quarrying, electricity, gas and water seem to decline less than the aggregate production. Recently, Pellényi (2012), using a structural factor model to analyze sectoral heterogeneity in the impact of monetary policy in Hungary, find that sectors more reliant on external finance show larger output responses, while healthier corporate balance sheets imply weaker price responses.

Given these findings of varying sectoral response to a monetary policy shock in different economies, we analyse the monetary transmission mechanism in India at the aggregate as well as at the sectoral level. The basic macroeconomic textbook would suggest for two possible level of disaggregation of an economy; one at the level of production and another at the level of final expenditure. For the present study, we confine our analysis to the disaggregated data of sectoral output. We use quarterly data from 1996:1 to 2013:2 to examine the effects of monetary policy impulse on aggregate as well as on sectoral output of eight different sectors such as, agriculture & allied activities (S1), mining & quarrying (S2), manufacturing (S3), electricity, gas & water supply (S4), construction (S5), trade, hotel, transport & communications (S6), finance, insurance, real estate & business services (S7) and community, social & business services (S8). We conduct our analysis with the standard vector autoregression (VAR) followed by impulse response function for evaluating responses of aggregate output as well as sectoral output to monetary policy shocks. Lastly, we augment the basic VAR by including various monetary transmission channels and analyze the sector specific importance of each channels.

3. Empirical Model Construction and Data Structure

3.1 Empirical Model Construction

The importance of monetary policy for aggregate as well as for sectoral 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; an efficient means of extracting stylized facts regarding the monetary transmission process (Ghosh, 2009).

We prefer reduced form VAR over structural VAR. Basically, a VAR is a system of linear equations wherein each variable is a function of its own lags and the lags of the other variables in the system[1]. The justification for VAR over structural VAR is that there was no clear stance that gave an idea about the underlying structural relationship between the relevant variables. Therefore, we prefer 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 offered 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 (Ghosh, 2009). To overcome this problem we employ impulse response functions. The impulse-response functions permit inferences on the direction of response of a variable of interest (i.e., aggregate and sectoral output) to a one standard deviation shock in another variable (i.e., monetary policy shock).

Hence, the bench mark VAR (p), where p is number of lags, can be represented as follows:

$$\sum_{i=0}^{p} \theta_i \, Y_{t-1} = \varphi X_t + \varepsilon_t$$

where Y_t is the vector of endogenous domestic variables and X_t is the vector of exogenous variables (foreign variables). θ and φ are polynomials and ε_t is an innovation term. Our justification for taking vector of exogenous variables in the basic model is due to growing integration of Indian economy with the rest of the world in recent years; both financial as well as real. Also, the influence of global commodity prices on some sectors of domestic prices have become important over the years, though pass-through still continues to remain significantly suppressed such as that of crude oil prices. The US Fed's monetary policy stance can have a major bearing on the domestic interest rate policy through the impact on the real economic activity and financial flows (Khundrakpam and Das, 2011).

The vector of endogenous domestic variables in the basic model consists of aggregate and sectoral output (Output), index of domestic prices (Price) and an indicator of the monetary

[1]The appropriate lag selection is based on AIC and SIC criteria. Though the AIC and BIC criteria suggest for one lag which is too short for the quarterly data. In line with Ramasway and Sloek (1997), Morsink and Bayoumi (2001), Al-Mashat (2003), Disyatat and Vongsinsirikul (2003), Aleem (2010), we have considered two lags.

policy stance i.e., overnight weighted call money rate (INT). While the vector of exogenous variables consists of oil price index (OIL), federal fund rate (FFR) and GDP of the USA (USGDP). Apart from that, there are monetary transmission related variables [proxy for credit (CREDIT), exchange rate (EXRATE) and asset price channel (SENSEX)] which are alternatively treated as endogenous and exogenous variable.

Basic model:

$$Y_t = [Output, Price, INT]$$

$$X_t = [WCP, FFR, OIL]$$

The ordering of the endogenous variables in the basic model is done according to the speed of the responsiveness of the variables to the monetary policy 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 indicator of monetary policy stance, i.e., overnight weighted call money rate, is set with information about the contemporaneous behavior of slowly moving output and prices. This seems plausible and consistent with actual behavior 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.

The transmission channel model:

$$Y_t = [Output, Price, INT, CREDIT/EXRATE/SENSEX]$$

$$X_t = [USGDP, FFR, OIL, CREDIT/EXRATE/SENSEX]$$

The vector of exogenous variables, apart from foreign variables, are taken as one of the channels of monetary transmission mechanism. By doing so, we measure the strength of each channel by first adding the basic model with a variable that captures the particular channel of interest and calculating two sets of impulse responses: one with the variable treated as endogenous in the VAR and another where it is included as an exogenous variable. The latter procedure generates a VAR identical to the former, except that it effectively blocks off any responses within the VAR that passes through the variable of interest. The comparison of the output responses of the two models thus provides a measure of the importance of that particular channel in acting as a channel for monetary policy to the real economy (Disyatat & Vongsinsirikul, 2003).

3.2 Data Structure

The period for our analysis is 1996:1 to 2013:2. The details about data series, their definitions and sources are presented in Table 1.

<Table 1 here>

3. Empirical Analysis

3.1 Preliminary Analysis

Before proceeding to any time series analysis, it necessary to perform preliminary analysis of the variables under study to understand the data generation process. In this regard, we tested stationarity of each variable by using Phillips-Perron unit root test[2]. Our results indicate that all the variables, except call money rate, REER and federal fund rate, are stationary in their first difference. However, we estimate the VAR model in level. VAR in level incurs some loss in estimator's efficiency but not consistency (Sims et. al., 1990). The objective, in our case, of estimating a VAR model in levels is to examine the relationship among variables, not to determine efficient estimates.

3.2 Basic Framework Analysis

The starting point of our analysis is confined to discuss the response of aggregate as well as sectoral output to one standard deviation shock to overnight call money rate in the absence of any transmission channel. Figure 1 depicts that aggregate and sectoral output (except S8 and to some extent S1) tend to decline with one standard deviation shock to the overnight call money rate. Table 2 shows the maximum magnitude and duration of output reduction in each sector of the economy in comparison to the aggregate output.

Figure 1 and Table 2 show that the sector which responds the most is S3 (manufacturing). A monetary policy shock causes the manufacturing sector output to decline by around 1 % from quarter 4 and it further declines up to 1.12 % in quarter 12. The other sectors which respond more than the aggregate output (GDP) are S2 (mining and quarrying), S5 (construction) and

[2] For brevity, we have not presented results of unit root test.

S6 (trade, transport and communication). The sectors which respond moderately low are S4 (electricity, gas and water supply) and S7 (finance, insurance, real estate and business services). One possible reason for the surprisingly moderate response of S7 can be attributed to the inclusion of financial crisis period (2008-2010) in our study wherein monetary policy was less effective to affect the output of S7.

<Figure 1 here>

The sectors, whose response seems to be atheoretic, are S1 (agriculture and allied activities) and S8[3] (community, social and personal services). In these sectors, the response of output is initially positive for S1 and mostly positive for S8 to the monetary policy shock. The reason for such behavior, in case of S1, is that the output produced in this sector is mostly non-durable and this sector is mostly labor intensive. Whereas S8 is the sector which includes mostly services rendered by the administrative departments of the various central and state governments. Hence, the influence of the monetary policy in this sector (S8) is negligible (Ganley and Salmon, 1997; Arnold and Vrugt; 2002). With regard to the duration of response, S2, S3, S4, S5 and S7 respond faster than S1 and S6.

<Table 2 here>

From the above results, it can be inferred that there is a varying impact of monetary policy on different sectors of the economy. The reasons for such a varying impact could be related to sector wise differences in factor intensity (labor versus capital intensive sector), credit accessibility (agriculture versus industry), interest sensitiveness (credit dependence), formal vs. informal market, trade orientation, etc.

3.3 Monetary Transmission Channels[4]

3.3.1 Credit Channel

Through credit channel, our objective is to see the response of aggregate and sectoral output to an unanticipated monetary policy shock that passes through bank credit. As we know that small and medium-sized firms, facing informational frictions in financial markets, rely mostly on bank credit for external finance because it is too expensive for these borrowers to issue securities in the open market. The importance of this channel thus depends on two

[3] Since the impulse response results of S8 in most of the cases violates the postulates of IS-LM macroeconomic framework, we'll ignore the case of S8 hereafter.

[4]Our analysis of monetary transmission channels is in line with Morsink and Bayoumi (2001), Disyatat and Vongsinsirikul (2003), Aleem (2010) and Khundrakpam and Jain (2012). Also while dealing with the impulse response function, we do not report the error bands, as our focus is on the directions of the impacts and the differences of the impacts when a particular channel is alternatively opened and blocked.

factors: (i) the degree to which the central bank can affect the supply of bank loans; and (ii) the dependence of borrowers on bank loans (Disyatat and Vongsinsirikul, 2003).

In order to examine the effect of credit channel on the aggregate as well as sectoral output, given that monetary tightening reduces the aggregate as well as sectoral output, we examine how much of the effects of a monetary policy tightening passes through the bank credit. For this we extend the basic VAR model by including log of total non-food credit. Thus our vector of endogenous model becomes:

$$Y_t = [Output, Price, INT, CREDIT]$$

<Figure 2 here>

Figure 2 depicts the response of aggregate as well as sectoral output to one standard deviation shock to the overnight call money rate. The solid line in Figure 2 represents the impulse response of aggregate and sectoral output to positive overnight call money rate shock in the presence of bank credit channel. The aggregate output (GDP) declines around 0.28% up to fifth quarter and starts to recover after that. When compared to Figure 1 aggregate output response, we find that the decline in the aggregate output in the bank credit is less. The reason for that may be attributed to the possible influence of other channels like exchange rate and asset price in the aggregate output. The other sectors which are most sensitive to the credit channel of the monetary policy are S2, S3, S5, S6 and S7 whose maximum output reduces to 0.51%, 0.63 %, 0.99%, 0.56% and 0.13% respectively to the positive overnight call money rate shock. The sector which is moderately sensitive to the credit channel of the monetary policy are S4 whose maximum output reduction is 0.12%. Whereas the sectors whose response are atheoretic are S1 and S8. In case of S1, its output increases up to fifth quarter and then declines with monetary policy shock in the presence of credit channel. While in case of S8, its output increases initially up to third quarter and then declines but positive. These are the sectors whose behavior are inconsistent in the presence of credit channel.

However to calibrate the importance of credit channel on the aggregate and sectoral output, we re-estimate the model after treating bank credit as exogenous variable. After exogenizing the bank credit, the model represents the traditional money channel where there is no role of bank credit and the monetary policy shocks are transmitted to the real sector (aggregate and sectoral) in the standard IS-LM framework. The dashed line in Figure 2 represents the response of aggregate and sectoral output to positive overnight call money rate shock after exogenizing the bank credit. When we exogenise the bank credit channel, we find that the

aggregate and sectoral output is reduced significantly in most of the cases. Like in case of the aggregate output, around 9% and 40% of the impact of monetary policy tightening comes from bank credit at beginning of second and third year respectively. When we blocked off the channel, the accumulated response of GDP was reduced by 20% in twelve quarters. Similarly in case of S3, around 7% and 75% of the impact of monetary policy tightening comes from bank credit at the beginning of second and third year respectively. When we blocked off the channel, the accumulated response of S3 was reduced by 32% in twelve quarters. Almost same trend can be found if we carry out similar exercise for S6 and S7[5]. Such a difference between the two responses of aggregate and sectoral (S3, S6, and S7) output to positive overnight call money rate shock suggests the importance of the credit channel in these sectors. These are the sectors which are mostly capital intensive and interest rate sensitive. They mostly depend on the bank credit for working capital to accomplish their day to day operation.

3.3.2 Exchange Rate Channel

For a country like India, a potentially important channel through which monetary policy may affect aggregate and sectoral output is through its effects on the exchange rate. The strength of the exchange rate channel depends on the responsiveness of the exchange rate to monetary shocks, the degree of openness of the economy, and the sensitivity of net exports to exchange rate variations.

To examine the role of exchange rate in the aggregate and sectoral output, we add the log of real effective exchange rate (REER) in the basic VAR model and see how much of the effects of a monetary policy tightening passes through the exchange rate channel. Our vector of endogenous model, thus, becomes:

$$Y_t = [Output, Price, INT, EXRATE]$$

<Figure 3 here>

Figure 3 depicts the response of aggregate and sectoral output to one standard deviation shock to the overnight call money rate. The solid line in Figure 3 represents the impulse response of aggregate and sectoral output to positive overnight call money rate shock in the presence of exchange rate channel. The aggregate output (GDP) declines around 0.61% up to eighth quarter and slowly starts to recover after that. When compared to Figure 1 aggregate

[5] The results of to the impact of monetary policy tightening in the presence of various transmission channels and their accumulated response after blocking off the respective channels are provided in Appendix 1.

output response, we find that the decline in the aggregate output in the exchange rate channel is more but the recovery is relatively faster in the exchange rate channel. Similar to the aggregate output, the output of almost all the sectors, except S8, reduces to a positive overnight call money rate shock.

However to find out whether such reduction is due to the exchange rate channel, we re-estimate the model after treating exchange rate as exogenous variable. After exogenizing the exchange rate, the model represents the traditional money channel where there is no role of exchange rate, and the monetary policy shocks are transmitted to the real sector (aggregate and sectoral) in the standard IS-LM framework. The dashed line in Figure 3 represents the response of aggregate and sectoral output to positive overnight call money rate shock after exogenizing the exchange rate. Apart from the aggregate output, S1 and S6 are the sectors where monetary policy shock passes through exchange rate channel. In these cases, the dashed line is above the solid line (see Figure 3). In rest of the cases, the dashed line is below the solid line. The interpretation of such results is that after blocking off the effect of exchange rate in the system, the output reduces even more. It means that there are other channels of transmission mechanism such as, credit or asset price or combination of both the channels are operating in these sectors.

As has been in case of the aggregate output, around 16.5% and 20.45% of the impact of monetary policy tightening comes from exchange rate at beginning of second and third year respectively. When we blocked off the channel, the accumulated response of GDP was reduced by 17.3 % in twelve quarters. It means that monetary tightening that passes through exchange rate is moderately effective. Whereas in case of S1, around 31.27% and 47.86% of the impact of monetary policy tightening comes from exchange rate at beginning of second and third year respectively. When we blocked off the channel, the accumulated response of S3 was reduced by 37.28% in twelve quarters. It means that response of S1 (agriculture and allied sector) to the monetary policy tightening through exchange rate is highly significant. The reason for such a surprising result can be confirmed by analyzing the share of S1 exports in total exports of India. In 2012-13, the export share of S1 is around 14% of total exports which is quite significant. Similarly in case of S6, around 13.20 % of the impact of monetary policy tightening comes from exchange rate at beginning of second year. When we blocked off the channel, the accumulated response of S6 was reduced by 11.74% % in twelve quarters. Since S6 consists of trade activities of some firms which are actively involved in

international trade, this sector is expected to be moderately affected by monetary tightening that passes through exchange rate channel.

3.3.3 Asset Price Channel

Another potential channel of monetary policy shocks are volatility in asset prices. A tightening of monetary policy will make equity prices less attractive as compared to other alternative financial assets such as, bond, leading to fall in equity prices. When equity prices fall, firms may find it costly to replace capital, i.e., the Tobin's q effect and reduce investment. The decline in the asset prices will also have a net wealth effect of reducing consumption demand for households and further dampen the earnings outlook of firms (Khundrakpam and Jain, 2012).

To examine the role of asset price in the aggregate and sectoral output, we add the log of BSE SENSEX index in the basic VAR model and see how much of the effect of a monetary policy tightening passes through the asset price channel. Our vector of endogenous model, thus, becomes:

$$Y_t = [Output, Price, INT, SENSEX]$$

<Figure 4 here>

Figure 4 depicts the response of aggregate and sectoral output to one standard deviation shock to the overnight call money rate. The solid line in Figure 4 represents the impulse response of aggregate and sectoral output to positive overnight call money rate shock in the presence of asset price channel. The aggregate output (GDP) declines around 0.52% up to sixth quarter and almost remain same till twelfth quarter. When compared to Figure 1 aggregate output response, we find that the decline in the aggregate output in the asset price channel is slightly more. Similar to the aggregate output, the output of almost all the sectors, except S8, decline to a positive overnight call money rate shock.

To find out whether such reduction is due to the asset price channel, we re-estimate the model after treating asset price as exogenous variable. After exogenizing the asset price, the model represents the traditional money channel where there is no role of bank credit, and the monetary policy shocks are transmitted to the real sector (aggregate and sectoral) in the standard IS-LM framework. The dashed line in Figure 4 represents the response of aggregate and sectoral output to positive overnight call money rate shock after exogenizing the asset

price. Apart from the aggregate output, S2 and S8 are the sectors where monetary policy shock passes through asset price channel. In these cases, the dashed line is above the solid line (see Figure 3). In rest of the cases, except S1 and S4, the dashed line is below the solid line. The interpretation of such results is that after blocking off the effect of asset prices in the system, the output reduces even more. It means that there are other channels of transmission mechanism like credit or exchange rate or combination of both the channels are operating in these sectors. In case of the S1 and S4, we find that after exogenizing the asset price, the output of S1 and S4 increases up to some quarter and after that it move towards original output despite the monetary policy tightening. Agricultural and allied sectors (S1) in India are mostly dependent on institutional credit flow as well as informal credit but not a significant extent to capital market for resource mobilization. Similarly, electricity, gas, and water supply (S4) sector is dependent on institutional credit as well as government policy.

Like in case of the aggregate output, around 20.31% of the impact of monetary policy tightening comes from asset price at beginning of second year. When we blocked off the channel, the accumulated response of GDP was reduced by 20.1 % in twelve quarters. It means that monetary tightening that passes through asset price is significantly effective. Whereas in case of S2, around 53.7% and 72.3% of the impact of monetary policy tightening comes from asset price at the beginning of second and third year respectively. When we blocked off the channel, the accumulated response of S2 was reduced by 56.1% in twelve quarters. It means that response of S2 (mining and quarrying) to the monetary policy tightening through the asset price is highly significant. The reason for this may be attributed to the fact that the firms involved in mining and quarrying activities are some of the largest both in terms of size and value. They depend mostly on foreign investment to carry out their operations which require large investment and state of the art technology[6]. For raising foreign investment, these firms have to get themselves listed on the stock exchange. Firms' investment activities are influenced by firms' valuation which in turn is contingent on buoyant capital market. Similarly in case of S7, around 102.2 % and 72.6% of the impact of monetary policy tightening comes from asset price at beginning of second and third year respectively. When we blocked off the channel, the accumulated response of S7 was reduced by 76.24 % in twelve quarters. Since S7 consists of Finance, Insurance, Real estate &

[6]With exception of atomic and fuel mineral, India allows 100% FDI in the mining and quarrying sector (FICCI Report, October 2013).

Business services which are mostly listed in the equity market, this sector is expected to be significantly affected by monetary tightening that passes through asset price channel.

4. Conclusion

Analyzing the response of the aggregate and sectoral output to the monetary policy shocks we try to answer the question: does monetary policy have differential effect at the sectoral level? For this, we take into account eight sectors of the Indian economy and estimate reduced form VAR followed by generating impulse response function for evaluating responses of aggregate output as well as sectoral output to monetary policy shocks. Further, we also augment the basic VAR by including various transmission channels of the monetary policy and analyze the sector specific importance of each channel.

Our findings suggests, at aggregate level, that there is a real effect of monetary policy shock. At the sectoral level, we find that some sectors are more and some are less affected by the monetary policy shock. Sectors like S2 (mining and quarrying), S3 (manufacturing), S5 (construction) and S6 (trade, hotel, transport and communications) seem to decline more than aggregate production in response to the interest rate shocks. It seems that these four sectors are the driving force behind the aggregate fluctuations. In contrast, we observe the insensitivities of sectors like S1 (agriculture and allied activities) and S8 (community, social & business services) to the monetary policy shock. The remaining two sectors, S4 (electricity, gas & water supply) and S7 (finance, insurance, real estate and business services), are also moderately sensitive to monetary policy shocks.

With regard to the sector specific importance of the three monetary transmission channels, we find that the channels through which monetary policy is transmitted to the real economy are different for every sector. In most of the cases, more than one channel is responsible for the changes in the aggregate and sectoral output to the monetary policy shock. In case of the aggregate output and S7, monetary policy shock that passes through the credit and asset price channel is stronger whereas credit channel and exchange rate channel is much effective in S6. Besides, credit channel is effective in most of the sectors.

From the monetary policy making point of view, this study would be quite useful. Over the last two decades, the RBI have been actively engaged in achieving the monetary policy objective of price stability and output growth in the economy. However, the potential benefits of monetary policy objective need to be fully assessed in terms of potential unequal income distribution effects across different sectors. In order to achieve the desired objective

of monetary policy, we therefore, suggest that there is a need for a more focused sector specific monetary policy in India.

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Table 1: Estimable Data Structure (1996:1-2013:2)

Variables	Definition and Measurement	Sources
Endogenous variables		
Output	Log of seasonally adjusted aggregate as well as sectoral output at factor cost at 2004-05 price	Authors calculation based on RBI Database
Price[7]	Log of wholesale price index at 2004-05 price	Authors calculation based on RBI Database
INT[8]	Overnight weighted call money rate deflated by GDP deflator	RBI Database
Exogenous variables		
USGDP	Log of seasonally adjusted GDP of the USA at factor cost at 2000 price	Federal Reserve Bank of St. Louis
OIL	Log of crude oil price index	OECD
FFR	Federal fund rate deflated by the USA GDP deflator	Federal Reserve Bank of St. Louis
Monetary transmission channel related variables		
CREDIT	Log of total non-food credit deflated by GDP deflator (Proxy for credit channel)	RBI Database
EXRATE	Log of trade based 36 currency Real effective exchange rate (REER) at 2004-05 price (Proxy for exchange rate channel)	RBI Database
SENSEX	Log of BSE SENSEX 30 Index (Proxy for asset price channel)	RBI Database

[7] In India, the choice of price level is between consumer price index (CPI) and wholesale price index (WPI). The CPI is composed of around 260 commodities and available on monthly basis with a time lag of one month whereas the WPI is composed of around 676 commodities and available on a weekly basis with a time lag of two weeks. Due to wide coverage of WPI both on the basis of number of commodities and its uniformity across geographical area, we use WPI as an index of domestic price.

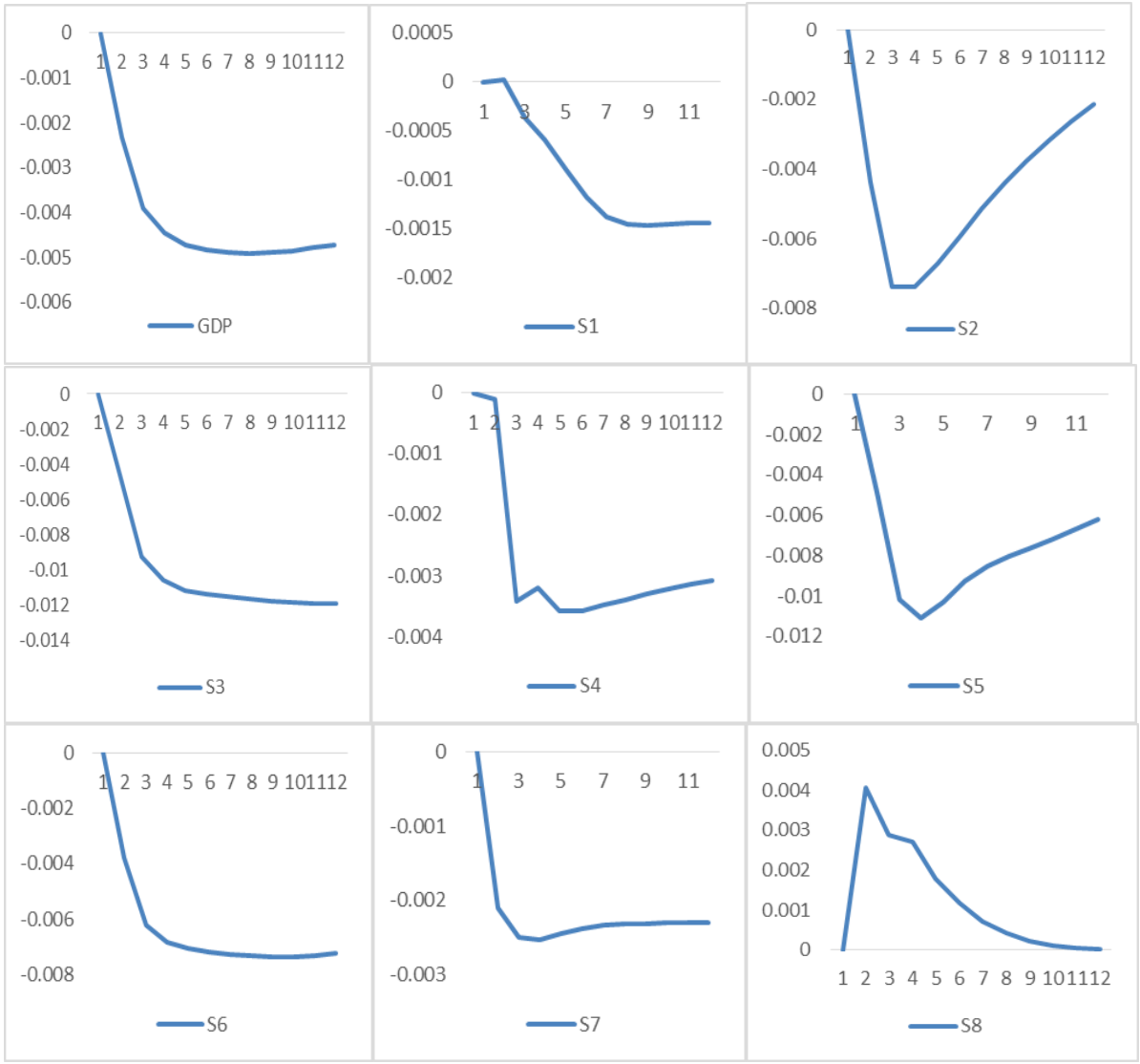
[8] We use weighted average of interbank call money rate supported by number of literatures on the monetary transmission mechanism (Al-Mashat, 2003; Singh & Kalirajan, 2007; Aleem, 2010).

Table 2: The Magnitude and Duration of Output Response

Sector	Maximum Output Reduction	
	Percent	Quarter
Aggregate GDP	0.49	08
S1	0.15	09
S2	0.74	03
S3	1.12	12
S4	0.36	05
S5	1.10	04
S6	0.74	09
S7	0.25	04
S8	0.00	02

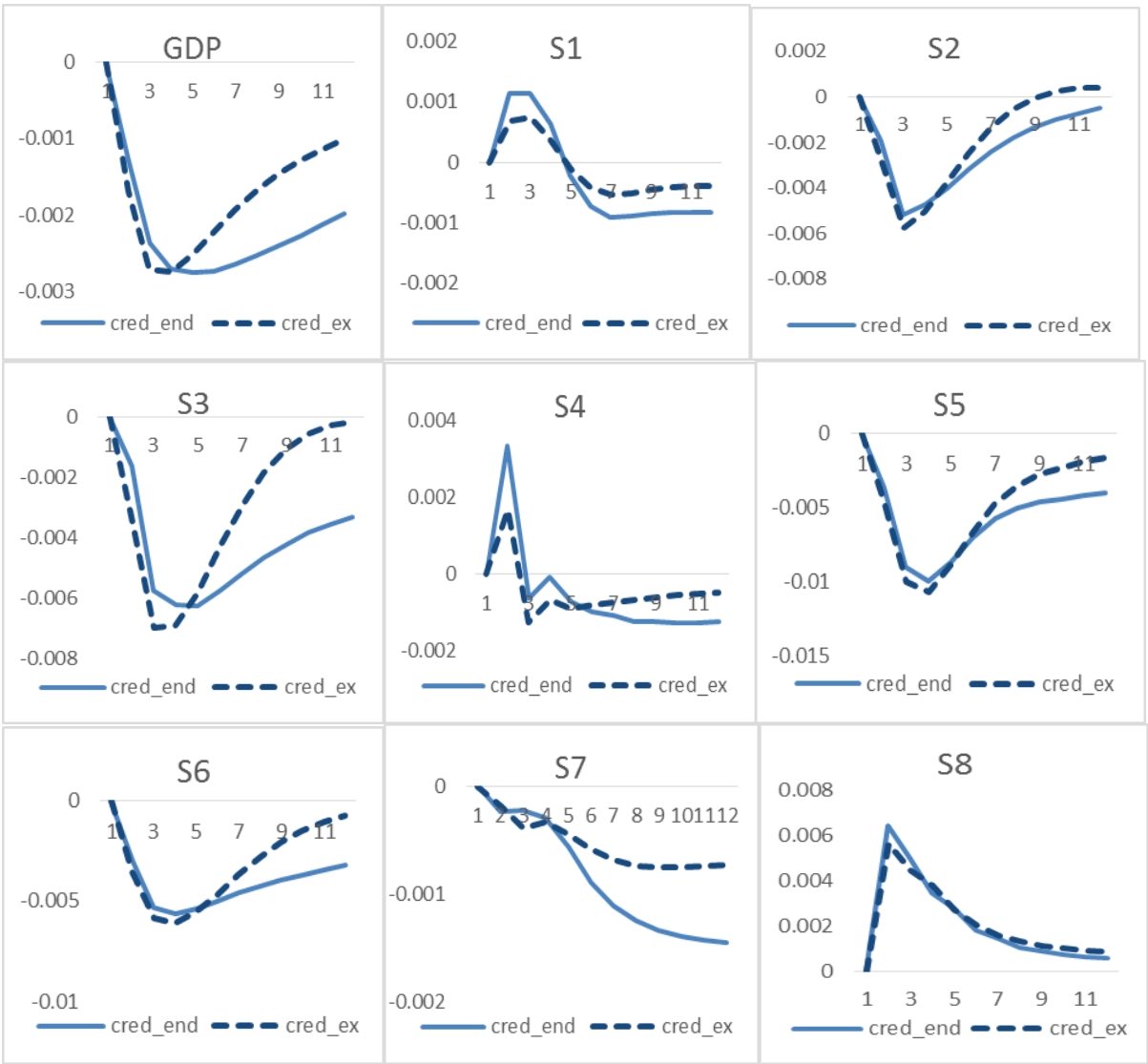
Source: Author's calculation based on the impulse- response function

Figure 1: Response of aggregate and sectoral output to overnight call money rate shock: Basic Framework



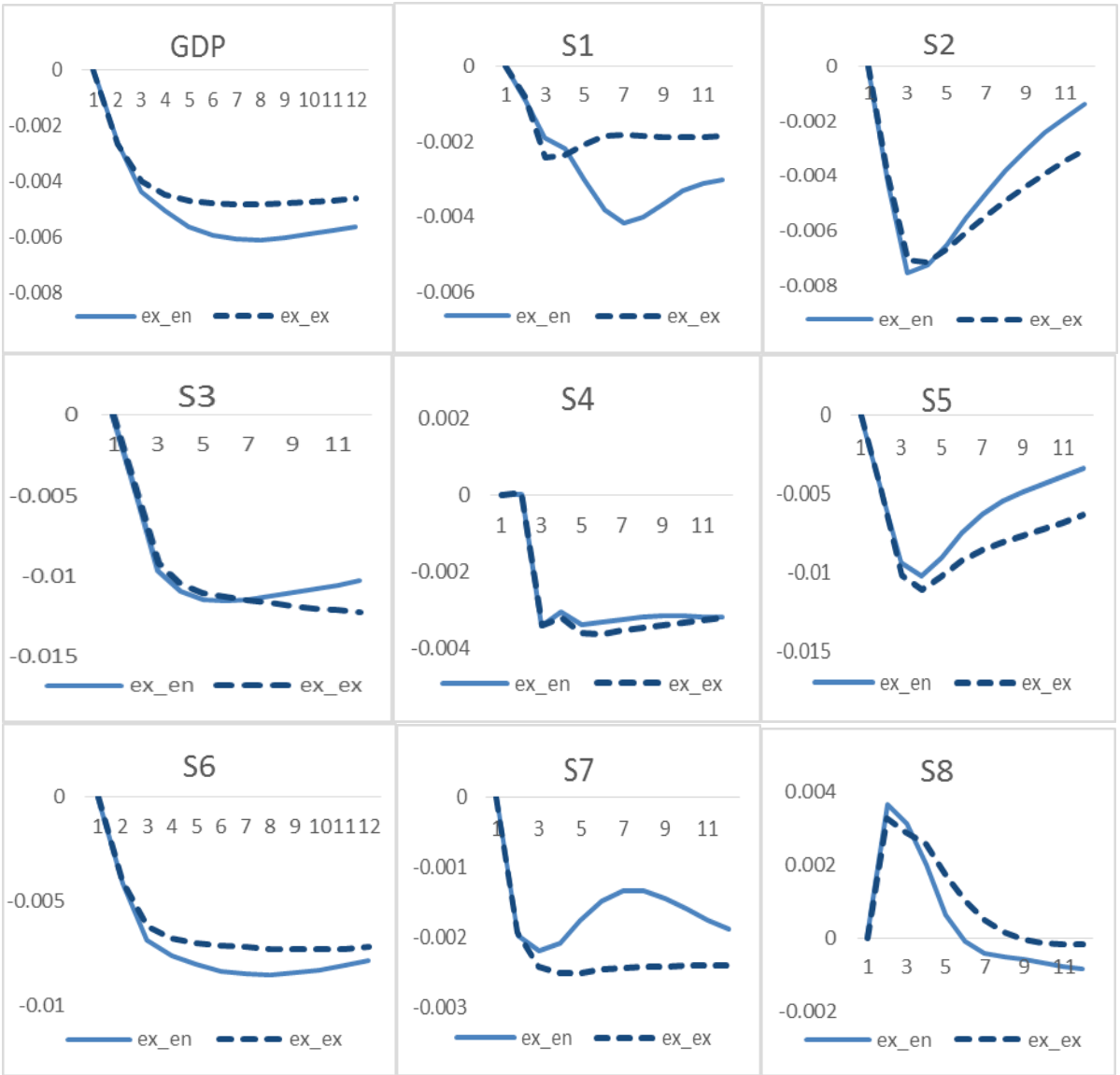
Note: While dealing with the impulse response function we find that standard error band for all the sectors are found to be statistically significant. Our purpose here is only to show the direction of the impact. Here S1=Agriculture & Allied Activities, S2=Mining & Quarrying, S3=Manufacturing, S4=Electricity, Gas & Water Supply, S5=Construction, S6=Trade, Hotel, Transport & Communications, S7=Finance, Insurance, Real estate & Business services and S8=Community, Social & Business Services.

Figure 2: Response of Aggregate and Sectoral Output to Overnight Call Money Rate Shock: Credit Channel



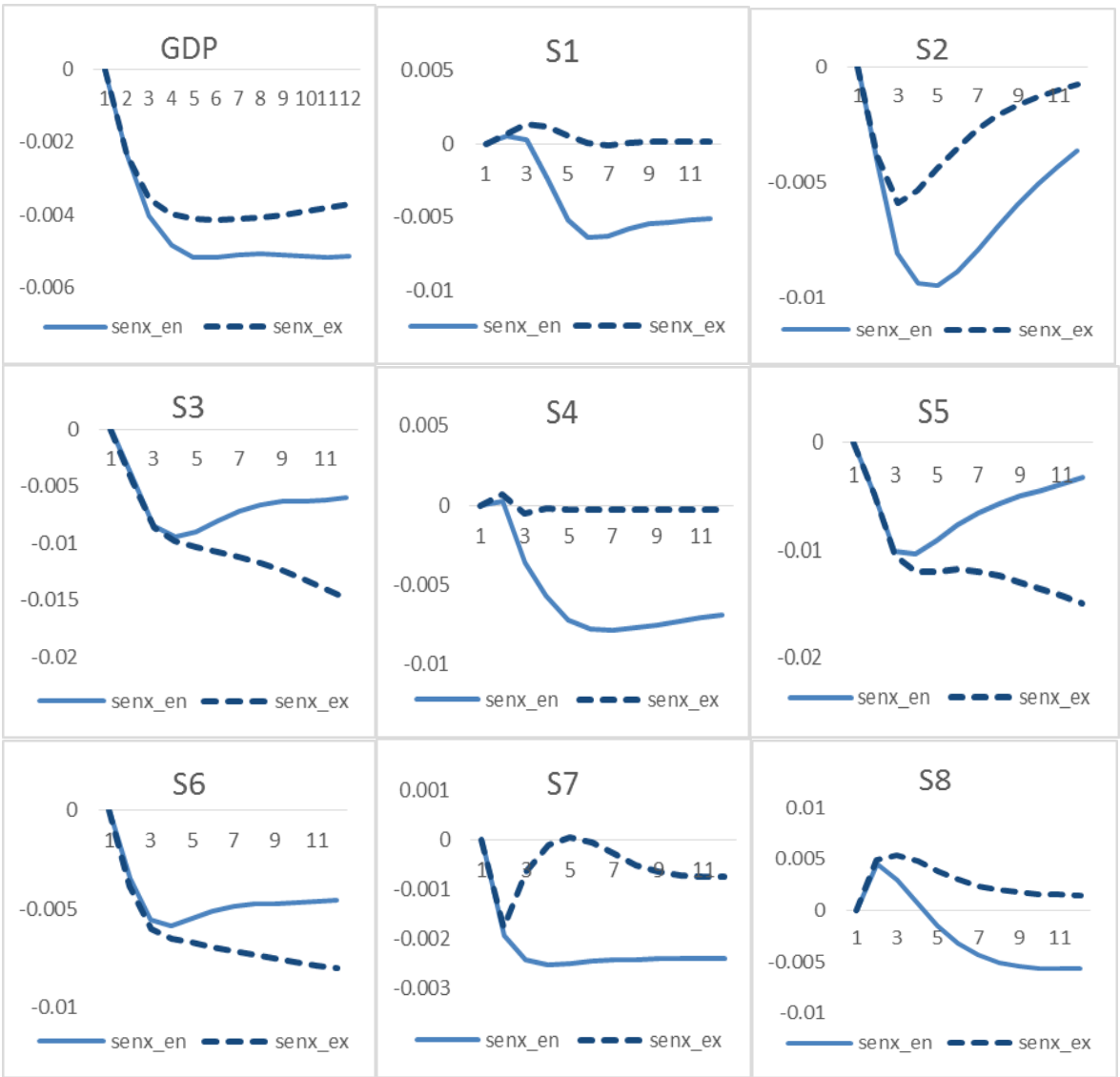
Note: Here cred_end= credit channel endogenous, cred_ex= credit channel exogenous, S1=Agriculture & Allied Activities, S2=Mining & Quarrying, S3=Manufacturing, S4=Electricity, Gas & Water Supply, S5=Construction, S6=Trade, Hotel, Transport & Communications, S7=Finance, Insurance, Real estate & Business services and S8=Community, Social & Business Services.

Figure 3: Response of Aggregate and Sectoral Output to Overnight Call Money Rate: Exchange Rate Channel



Note: Here ex_en= exchange rate channel endogenous, ex_ex= exchange rate channel exogenous, S1=Agriculture & Allied Activities, S2=Mining & Quarrying, S3=Manufacturing, S4=Electricity, Gas & Water Supply, S5=Construction, S6=Trade, Hotel, Transport & Communications, S7=Finance, Insurance, Real estate & Business services and S8=Community, Social & Business Services.

Figure 4: Response of aggregate and sectoral output to overnight call money rate: Asset price channel



Note: Here senx_en= asset price channel endogenous, senx_ex= asset price channel exogenous, S1=Agriculture & Allied Activities, S2=Mining & Quarrying, S3=Manufacturing, S4=Electricity, Gas & Water Supply, S5=Construction, S6=Trade, Hotel, Transport & Communications, S7=Finance, Insurance, Real estate & Business services and S8=Community, Social & Business Services.

Appendix 1

Table 1(A): Change in Aggregate and Sectoral Output (in %) for Different Transmission Channels

Sector	Quarter	Credit channel	Exchange rate channel	Asset price channel
GDP	5	8.52	16.49	20.31
	9	39.35	20.45	21.54
	12	48.89	18.09	27.81
S1	5	57.03	31.27	110.68
	9	46.20	47.86	102.34
	12	53.27	38.72	102.62
S2	5	5.70	-2.49	53.70
	9	96.35	-42.74	72.36
	12	184.03	-123.14	79.18
S3	5	6.82	3.44	-14.61
	9	74.91	-7.13	-94.90
	12	94.85	-19.20	-149.07
S4	5	-23.87	-5.95	96.06
	9	51.85	-7.17	96.32
	12	61.67	-0.22	95.96
S5	5	-2.92	-124.47	151.72
	9	39.87	10.57	121.06
	12	57.55	32.00	148.08
S6	5	-2.48	13.20	-22.29
	9	47.59	13.27	-59.04
	12	76.71	8.31	-76.71
S7	5	21.42	-42.42	102.22
	9	43.33	-67.41	72.66
	12	49.55	-27.04	68.58
S8	5	3.10	-167.19	346.95
	9	-28.15	95.25	132.26
	12	-52.05	77.25	125.25

Table 1(B): Accumulated Response of Aggregate and Sectoral Output (in %) after Blocking Off Respective Transmission Channel after Twelfth Quarter

Sector	Credit channel	Exchange rate channel	Asset price channel
GDP	**20.89**	**17.03**	**20.11**
S1	55.67	**37.28**	109.24
S2	**22.36**	-16.11	**56.07**

S3	**32.02**	-3.85	-56.46
S4	14.11	-5.07	96.83
S5	12.77	-30.99	-85.38
S6	**20.88**	**11.74**	-40.90
S7	**37.47**	-39.75	**76.24**
S8	-2.66	-110.42	214.35