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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Macroeconomic surprises and stock market responses—A study on Indian stock market

Santanu Pal^{1*} and Ajay K Garg²

Abstract: This study analyzes the sensitivity of a series of Indian stock indices for the astonishing component of monetary and macroeconomic policy with the data set from 1 April 2004 to 31 July 2016. The immediate impact is assessed with event analysis, and the dynamic effect is analyzed with the Vector Autoregression (VAR) model. The result of the event analysis indicates that the monetary policy surprise significantly affects the stock market and is more prominent than that of other macroeconomic surprises. Unlike the event study, the VAR analysis found that the other macroeconomic surprise also affects stock return. The study also highlights the industry effect and size effect, which is coherent with the predictions of the CAPM (Capital Asset Pricing Model) model. While many studies have been conducted on the monetary policy surprise in the developed economy, there are relatively few studies on macroeconomic surprises. Some studies conducted in India have analyzed the impact of monetary policy surprises on stock price; however, to the best of our knowledge, none of the studies has examined the simultaneous effect of both macroeconomic and monetary policy surprise. The study is relevant because the responses differ across sectors and vary with firm sizes. Thus, the study can effectively be used as a hedging instrument. Furthermore, the stock market acts as

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PUBLIC INTEREST STATEMENT

The paper explores the sensitiveness of stock returns in relation to both monetary policy and macroeconomic surprises. For this study, the sensitivity of a variety of Indian stock indices is considered in relation to unanticipated movements of macroeconomic indicators such as monetary policy, price indices, growth rates, industrial production, and current account. Through the use of different measures of monetary policy and other multiple macroeconomic surprises, the unanticipated elements of the monetary policy variable and other macroeconomic indicators are isolated. For estimating the sensitiveness of stock returns to monetary policy and macroeconomic surprises, we have considered 20 indices. In the Vector Autoregression analysis, all the surprises are considered as exogenous variables, and the dynamic effect highlights that the impact of surprise variables is primarily at the shorter horizons, instantly after the shock, and is diminutive over the period; however, the recovery period varies with industry category and type of surprises.

a vital channel for policy transmission and a critical decision driver for corporate finance. The understanding of firm and stock market dynamics against macroeconomic surprises can help policymakers in enhancing policy effectiveness and corporate finance professionals in improving decision-making.

Subjects: Economic Theory & Philosophy; Monetary Economics; Corporate Finance; Credit & Credit Institutions; Investment & Securities; Financial Management; Critical Management Studies

Keywords: macroeconomic surprise; monetary policy surprise; stock market response; event study; VAR; India

1. Introduction

On theoretical grounds, the stock prices equate with that of the estimated value of the total future cash flow. Therefore, it is evident that positive increase in macroeconomic and monetary policy results in the enhancement in stock returns, which is indicative of the escalating future cash flows or declining discount factors for the benefit of cash flows through the support of positive macroeconomic and monetary policy.

The financial markets do not have complete information, and so they take a forward-looking view. For the futuristic observation, they constantly monitor macroeconomic development and monetary policy stance. Any deviation from the expectation comes as a surprise, and it is supposed to be reflected in the market price.

The paper explores the sensitiveness of industry-specific stock returns in relation to monetary policy and macroeconomic surprises. For this study, the sensitivity of a variety of Indian stock indices is considered in relation to unanticipated movements of macroeconomic indicators such as monetary policy, price indices, growth rates, industrial production, and current account. There are three motivations for evaluating the stock market reaction to macroeconomic and monetary policy surprises. First, considering the perspective of monetary and macroeconomic policy, stock markets are part of the transmission mechanism, so policymakers can be benefitted for comprehending this channel, as it will enable them to examine and augment the efficiency of monetary and macroeconomic policy. Second, in corporate finance, it is crucial to understand the fundamental reasons for stock market movements and their heterogeneity because stock performances generally decide the strength of the balance sheets, and its understanding can improve the decision-making. Third, for an investor, it is advantageous to be acquainted with the performance of specific stocks and to develop an obvious idea about the influence of macroeconomic events on sector-specific, size-specific, and general stock market indices because most of these indices act as benchmarks for assessing the performance of existing investments, taking position for future index investment, and designing financial instruments such as options and derivatives.

The response of stock prices to monetary policy is heterogeneous in nature and is well researched. The stock market response on monetary policy relies on firm characteristic and the credit channel that a particular firm is accessing (Bernanke & Blinder, 1992; Ehrmann & Fratzscher, 2004; Kashyap, Lamont, & Stein, 1994; Kashyap, Stein, & Wilcox, 1993). The heterogeneity of the response also varies with firm size owing to its association with the risk perception (Benanke & Gertler, 1989; Kiyotaki & Moore, 1997). The heterogeneity of the impact of monetary policy also comes from the industries (Bernanke & Kuttner, 2005; Dedola & Lippi, 2005; Ehrmann & Fratzscher, 2004; Ganley & Salmon, 1997; Hayo & Uhlenbrock, 2000).

While many studies have been conducted on the ways in which monetary policy influences the stock market, only few studies have recorded the stock market returns relation with other macroeconomic variables. At the country level, for instance, Maysami, Howe, and Rahmat (2005), Ewing

(2002), Gupta and Reid (2013), Kyereboah-Coleman and Agyire-Tettey (2008), etc., have developed the relationship between stock market performance and different macroeconomic variables. However, in India, previous studies, such as Ghosh (2009), Bhattacharyya and Sensarma (2008), Pal and Mittal (2011), Singh and Pattanaik (2012), Sengupta (2014), and Prabhu, Bhattacharyya, and Ray (2015), have mainly focused on the impact of either monetary policy or macroeconomic factors on stock prices. It is probably the first study on India that scrutinizes the simultaneous effect of both monetary policy surprise and wide range of macroeconomic surprises on stock returns.

Besides the lack of research in this field, the analysis in the Indian market is also important for several reasons. First, according to the International Monetary Fund data, in terms of Gross Domestic Product (GDP), India occupies the seventh position in the world. However, considering the purchasing power parity, India occupies the third position and comes after China and the USA. Second, from 2000 to 2016, India has shown an average real GDP growth of 7.1%, thus becoming one of the fastest developing countries. Third, compared to the other developing nations of Asia, the Indian economy is more balanced because of large private consumption and less dependency on exports. India's "exports of goods and services" as a percentage of GDP was only 24% in 2008 and 19% in 2016, which was far less than 36% of Developing Countries in Asia as a whole in 2008 and 24% in 2016.¹ Fourth, India's financial system is robust and well regulated. Central bank and capital market regulator supervise the financial activities. It remained comparatively unscathed even at the time of the global financial crisis. Compared to the developed world, the shortcoming of the Indian economy was far better contained. The real GDP was almost 6.2% even during the global financial crisis in FY08 to FY09. Fifth, though India is mainly dependent on a bank-based system, by carrying out notable institutional and technological reforms, India has made an energetic stock market. Together with the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE), the average daily stock market turnover in 2016 was Rs. 203 billion (USD 2.9 bn).² As on 31 March 2016, market capitalization was Rs. 94 trillion (USD 1.4 trillion) for BSE and Rs.93 trillion (USD 1.4 trillion) for NSE.³ Indian stock market is also quite vibrant with the presence of Foreign Portfolio Investors (FPIs) and Foreign Institutional Investors (FIIs). Participants are active in all forms of market instruments, viz., debt, equity, and derivatives—Index Futures, Index Options, Stock Futures, Stock Options, and Interest rate futures. For example, on 31 March 2016, the gross purchase of equity was Rs. 59 billion (USD 0.98 billion) and gross sale of equity was Rs. 44 billion (USD 0.73 billion)⁴. This combined trade was approximately 50% of the average daily turnover of BSE and NSE. Lastly, there are several monetary policy interventions in the last few years to attain India's key economic objectives, namely, Price Stability, Economic Growth, Full Employment, and Maintenance of Balance of Payment. During different instances, the Reserve Bank of India (RBI) has introduced different instruments and indicators to achieve these objectives. For example, the RBI introduced Term Repo in 2013 to inject liquidity over a period longer than overnight. Market Stability Scheme in 2004 was also introduced for absorbing surplus liquidity through the sale of short-dated government securities, etc. The RBI has also changed indicators for monetary policy decision, i.e., while framing the monetary policy in 2014, the RBI transformed to a flexible inflation targeting framework from the multiple indicator approach. In the new framework, consumer price index (CPI) inflation is the nominal anchor; however, before the shift in 2014, the monetary policy was related to the movements in wholesale price index (WPI) inflation. Therefore, more research is needed with a focus on the macroeconomic policy, and hence, India has been taken as a focus country for investigating the relation of macroeconomic surprises with the stock market.

The present study aims to provide the first empirical evidence on the effect of both monetary policy and macroeconomic surprises on stock returns in India. This study investigates the effect of macroeconomic surprises on stock returns in India by following two different approaches—Event Study and Vector Autoregression (VAR). In VAR, we adopted the methodology of Bernanke and Kuttner (2005), but the paper is different in two ways. First, Bernanke and Kuttner's (2005) focus was on the developed economy, such as the USA, but our focus is on an emerging economy, viz., India, where the dynamics of the stock market and its transmission mechanism show a notable

difference from the developed economies. Second, Bernanke and Kuttner (2005) VAR approach analyzed the effect of monetary policy surprise, but by augmenting their approach with both monetary policy and other macroeconomic surprises, this paper separates the surprise elements of the monetary policy variable and other macroeconomic indicators while analyzing the effect of these surprises on stock returns in India.

Section 2 provides a literature review, and Section 3 presents the data and methodologies employed, especially the construction of the macroeconomic and monetary surprise variables. Section 4 focuses on the event study, while Section 5 on VAR analysis. Finally, Section 6 provides the conclusion.

2. Literature review

The good forecasters of real variable are interest rate, stock market, and spread between commercial rate and policy rate, as these variables provide crucial information. Financial market dynamically incorporates information on macroeconomic decisions to forecast the business environment and make a prudent financial decision, which is expected to be reflected in the stock price movement.

The stock market influences the macroeconomy through two channels. The first channel is that the changes in stock prices affect the cumulative consumption via the wealth channel of household (Keynes' General Theory; Gilbert, 1982; Modigliani, 1944 & 1971 etc.). The second channel is the effect of stock price movements on the cost of capital (Keynes' General Theory; Tobin, 1978; Modigliani, 1971, etc.) The stock market movements play a vital role in determining the decisions related to monetary policy owing to their probable effect on the macroeconomy. Mostly, the impact of equity prices on monetary policy is not precisely related to the influence of policy on the real interest rate. Instead, the policy surprises affect stock prices, which is evident through its impact on the expected future excess returns or expected future dividends.

The response of stock prices to monetary policy is heterogeneous in nature, and understanding of heterogeneity is important for policymakers and other market participants such as corporates and investors. The stock market response on monetary policy is dependent on firm characteristic and the credit channel that a particular firm is accessing (Bernanke & Blinder, 1992; Ehrmann & Fratzscher, 2004; Kashyap et al., 1994, 1993). Liquidity and leverage are the two important firm characteristics for maintaining heterogeneity in monetary policy response (Ehrmann & Fratzscher, 2004). For investment, a firm can raise funds either internally with the help of existing cashflows or externally through bank loans or capital markets. The tampering of monetary policy has a robust effect on bank-dependent firms. Monetary tightening reduces the supply of bank loans, and loans and nonbank sources of finance try to substitute the bank loan. The firms that make an investment without approaching the public debt markets face considerable liquidity-constrain, whereas the bank-dependent firms neither have accessibility to bond market nor have internal cash reserves; hence, they have to considerably reduce investment during the monetary contraction period in comparison to their nonbank-dependent counterparts. Similarly, firms with large cashflows need to be resistant to alterations in the interest rates because they are capable of depending on their internal source of finance for making investment.

The heterogeneity of the response of stock prices to monetary policy also varies with firm size. The imperfect capital market theory predicts that the risk associated with small and large firms can be affected in different ways owing to change in the credit market conditions (Benanke & Gertler, 1989; Kiyotaki & Moore, 1997). For small firms, the reaction of stock returns in relation to monetary policy is higher (Thorbecke, 1997). Further, small firms demonstrate the highest degree of asymmetry in relation to the risk associated with recession and expansion states that transforms into higher sensitivity of their expected stock returns concerning those variables, which determine the condition of credit market (Fama & French, 1995; Perez-Quiros & Timmermann, 2000). In comparison to big stocks, the small stocks also have reduced income on book equity.

However, with regard to the small firms, the results obtained though indicative are not concluding, as there is no correlation between size and financial constraints. Many researchers have provided evidence against the impact of firm size (Arnold & Vrugt, 2004; Carlino & DeFina, 1998; Mojon, Smets, & Vermeulen, 2002). Moreover, in comparison to other measures, size cannot be considered as a good proxy for financial constraints. While firms in the constrained category are smaller than firms in the non-constrained category, size is not the dominant factor behind categorizing firms under the constraint category (Fazzari, Hubbard, Petersen, Blinder, & Poterba, 1988). Lamont, Polk, and Saaá-Requejo (2001) found that during 1968–1997 firms having financial limitation display certain co-movements in the form of stock returns, and it is not attributable to firm size or other factors like industry-specific effects.

The heterogeneity of the impact of monetary policy on the returns of the stock market comes not only from firms but also from the industries. For example, if monetary policy affects exchange rates, then there will probably be more impact on the industries involved in trading. For the capital-intensive industries, the changes made by the monetary policy related to the cost of capital play a very crucial role. Hence, it is implied that the impact on the predicted future earnings across industries is heterogeneous in nature, which is reflected through the changes in stock returns. Therefore, firms in the cyclical industries, capital-intensive industries, and industries that are relatively open to trade will probably be fervently affected (Ehrmann & Fratzscher, 2004). The natural question is whether the responses are consistent with the CAPM model. Bernanke and Kuttner (2005) concluded that one-factor CAPM provides a good explanation of the variation prevalent in the observed industry. With data from five OECD countries, Dedola and Lippi (2005) recognized the impact of monetary policy in relation to the cross-industry heterogeneity and associated it with the distinctive features of an industry, as recommended by the monetary transmission theories. Moreover, there are considerable and noteworthy differences in the ways monetary policies impacted. The sectoral output responses to monetary policy shocks are thoroughly associated with the stability of industry output, financial obligation, borrowing ability, and firm size. Similarly, Ganley and Salmon (1997) and Hayo and Uhlenbrock (2000) analyzed the industrial outcomes in the United Kingdom and Germany. Angeloni and Ehrmann (2003) analyzed the cross-sectional responses associated with the returns of the stock market regarding monetary policy in the euro-zone, and Bernanke and Kuttner (2005) performed a similar analysis in the US. The evidence related to India indicates that the differential response is primarily based on the variations of firm size and usage of working capital along with the percentage of interest cost. Hence, as per the financial accelerator and interest rate mechanisms, there is a presumed significance behind the reasons for a monetary policy having more impact on specific industries in India (Ghosh, 2009).

While many studies have been conducted on the impact of monetary policy on the stock market at the country level, only few studies have documented the relationship between stock market returns and other macroeconomic variables. Maysami et al. (2005) analyzed the presence of a long-standing and stable relationship between the selected macroeconomic variables and the Singapore stock market index. He further scrutinized the relationship with various Singapore Exchange Sector indices—the finance index, the property index, and the hotel index. The study further deduced that there is a cointegrating relationship of the Singapore's stock market and the property index with the temporary as well as continuous alterations in the interest rates, industrial manufacturing, costs, exchange rate, and money supply. Ewing (2002) analyzed the innovations made for numerous fundamental macroeconomic variables, which are conveyed through the functioning of financial sector stock returns, specifically, the NASDAQ Financial 100 index. The stock returns of financial companies are related to macroeconomic factors; the relationship was scrutinized by calculating the functions associated with the generalized impulse response, which is obtained by determining the vector autoregression model. Gupta and Reid (2013) analyzed the sensitiveness of diverse South African stock indices in relation to the unpredictable movements of macroeconomic indicators such as monetary policy and the CPI. He further examined the instantaneous effect of macroeconomic shocks on a variety of stock market indices, which was pursued by a Bayesian vector autoregressive analysis that imparted insights about the vibrant impact of

shocks on the stock market indices. Kyereboah-Coleman and Agyire-Tettey (2008) examined the ways in which the macroeconomic indicators affect the Ghana Stock Exchange and concluded that the lending rates from deposit money banks and inflation adversely affect the stock market performance. In contrast to the general expectation, the loss in exchange rate does not affect equities, and the depreciation of the domestic currency is beneficial for investors.

3. Methodology and data

The financial markets incorporate information in advance, and therefore, the stock price must have already captured the expected macroeconomic information. Nevertheless, the stock price must adjust with the unanticipated or surprise factor depending on its substantiation. Moreover, the surprise element related to macroeconomy eliminates any endogenous matter that initiates from the market information, as the predictable effects are integrated into the expected component of macroeconomic data (Gürkaynak, Levin, & Swanson, 2010).

The surprise is defined as the actual data minus forecast data; thus,

$$\text{Surprise} = \text{Actual data} - \text{Forecast data}$$

Surprise can be categorized into two parts; one is the macroeconomic surprise, and the other is the monetary policy surprise.

For macroeconomic surprise, the forecast data are the median forecast from the survey of a panel of professional forecasters. Bloomberg captures the professional forecast and updates it prior to the release of actual data. The actual data released on a particular date for macroeconomic indicators are the data of the previous period; hence, they are lag indicators.

The macroeconomic indicators considered for our study are GDP, WPI, CPI, Index of Industrial Production (IIP), and Current Account Deficit (CAD). The choice of these indicators is consistent with other literature (Bernanke & Kuttner, 2005; Gupta & Reid, 2013). Further, through a professional survey, Bloomberg predicted these macroeconomic economic indicators.

Contrary to the other macroeconomic variables, the market data are used for constructing the monetary policy surprise. The actual market data for monetary policy is forward indicators. However, the policy actions are not precisely visible as expected in the context of the market. In the US, there are tradable instruments—Fed Funds futures. The futures prices are the usual market-based proxy for the expectations. The forecasts of funds' rate as per the futures price are "efficient" because there is no considerable correlation between the forecast errors and other variables while pricing the contract (Krueger & Kuttner, 1996). Therefore, for the monetary policy, the majority of the studies in the US employ the data of federal funds futures for obtaining the surprise element of policy announcements.

Unfortunately, no such information for India is obtainable. The 91-day T-bill yield in the secondary market is the closest proxy for encapsulating the surprise factor due to any monetary policy action by the RBI. The other alternative could have been 90 days MIBOR rate (Mumbai Interbank Offer Rate), but MIBOR is more for liquidity management, which is not a true reflection of the policy action.

For estimating the sensitiveness of stock returns to monetary policy and macroeconomic surprises, we considered 20 indices. These indices are chosen as per the research objectives, viz., (a) Benchmark Indices, which is relevant to understand the response of overall stock market—BSE SENSEX (30 large well-established companies, which are the representative of various sectors of Indian economy and whose stocks are well traded) and NIFTY 50 (50 Indian company stocks in 12 sectors). The BSE Sensex and NIFTY 50 are also used as a proxy for the large-sized firms. The other sets of indices used for assessing the overall response of stock market are NIFTY 200 (a set of 200 companies representing 85% of free float market capitalization of NSE) and NIFTY 500 (a set of 500 companies representing 95% of free float market capitalization of NSE). (b) Sectoral Indices, which will be relevant to understand the

industry-specific response—NIFTY Energy (Energy sector), NIFTY Infra (Infrastructure sector), NIFTY PSU BANKS (Public sector banking sector), BSE BANKEX (Banking sector), BSE Auto (Automobile sector), BSE Capital Goods (Capital Goods sector), BSE Consumer Durables (Consumer durable sector), BSE Fast Moving Consumer Durables (Fast moving consumer durable sector), BSE Health (Health sector), BSE IT (Information Technology sector), and BSE Metal (Metal sector). The Indian financial sector being dependent on the banking sector, the bank indices are also considered to understand industry effect. (c) Size-specific indices to understand size effect—BSE Midcap, NIFTY 100 Midcap, and NIFTY 50 Midcap (representative of medium-sized firm), BSE Small Cap and NIFTY 100 Smallcap (representative of the small-sized firm), along with BSE Sensex and NIFTY 50, which are the representative of large-sized firms. In our size effect analysis, we considered market capitalization as the measure of firm size.

The data considered for the study were from 1 April 2004 to 31 July 2016. The macroeconomic and monetary policy release dates were taken from the Bloomberg and RBI website and were further validated through the FT Calendar. The data for macroeconomic indicators, monetary policy, forecast parameters, and the indices were gathered from Bloomberg. The patterns of Actual, Forecast, and Surprise factors of macroeconomic indicators are depicted in Figures 1–5. The surprises factors are plotted on the right-hand axis of each of these graphs, while the basic series are plotted on the left-hand axis. The surprise is the difference between actual data minus forecast data; and therefore, all surprises are in percentage-point, except CAD surprise, which is expressed in USD billion. From GDP surprises (Figure 1), it is clear that both the positive and negative surprises are equally probable, though the magnitudes of positive surprises are generally more than the negative one for this period. The number of positive surprises is more in WPI, whereas the number of negative and positive surprises is almost same for CPI (Figures 2 and 3: WPI and CPI surprises). The IIP surprise data show more positive surprises than negative, though the maximum magnitude of surprises in each direction is almost same (Figure 4), and the number of positive and negative surprises is almost equal in the case of CAD surprises (Figure 5).

Every monetary policy actions—any decisions on bank rate, liquidity adjustment facility, Repo/ Reverse Repo action, CRR (Cash Reserve Ratio), SLR (Statutory Liquidity Ratio), and MSF (Marginal Standing Facility)—are considered as the monetary policy announcement event. In the last 12 years, the frequency of monetary policy action changed significantly. For instance, from 2005, a half-yearly policy shifted to a quarterly schedule; the RBI started the mid-quarter policy

Figure 1. GDP surprise.

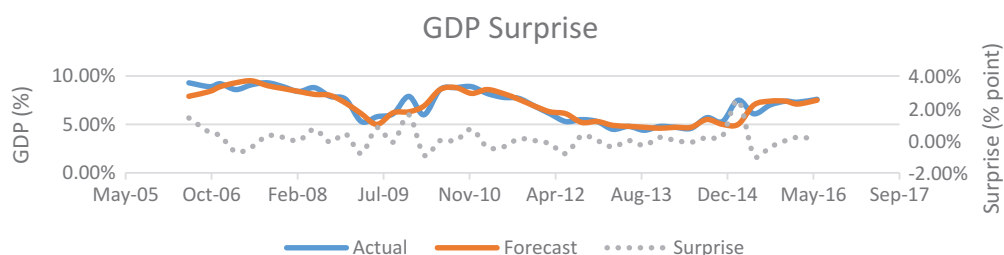


Figure 2. WPI surprise.

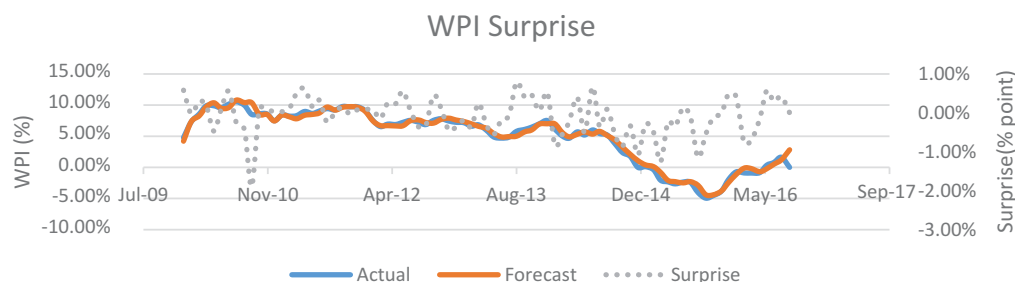


Figure 3. CPI surprise.

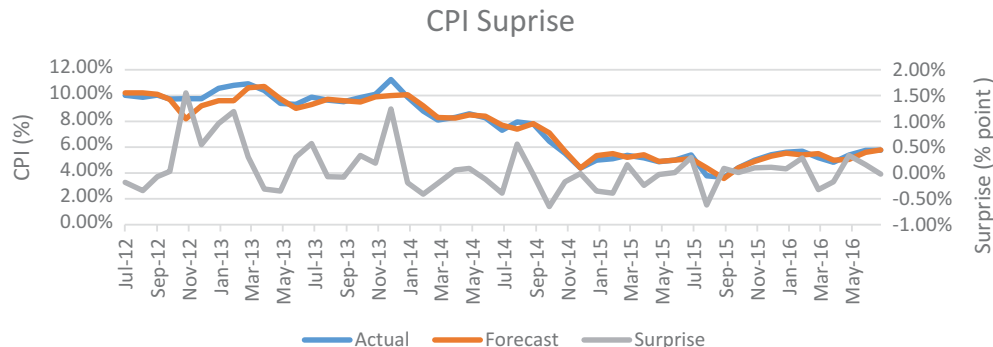


Figure 4. IIP surprise.

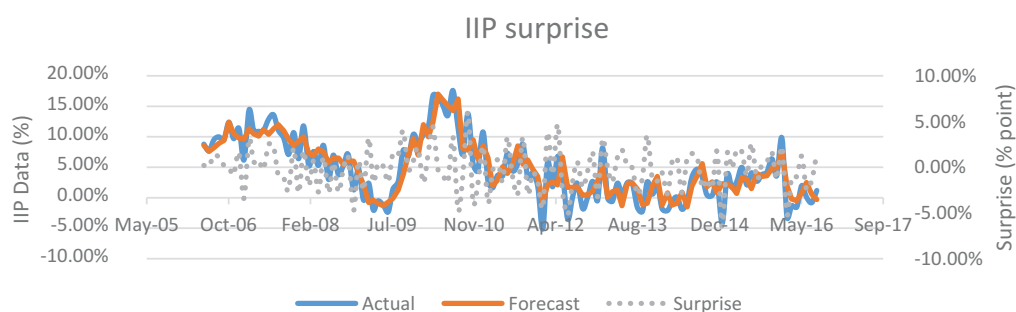


Figure 5. CAD surprise.

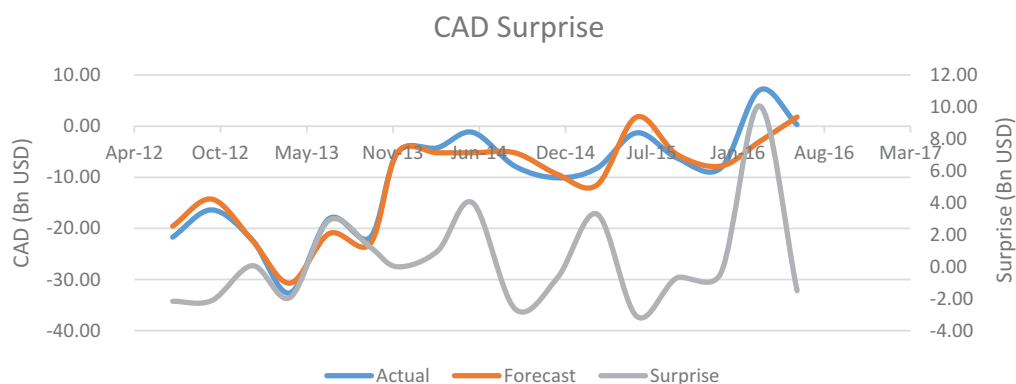
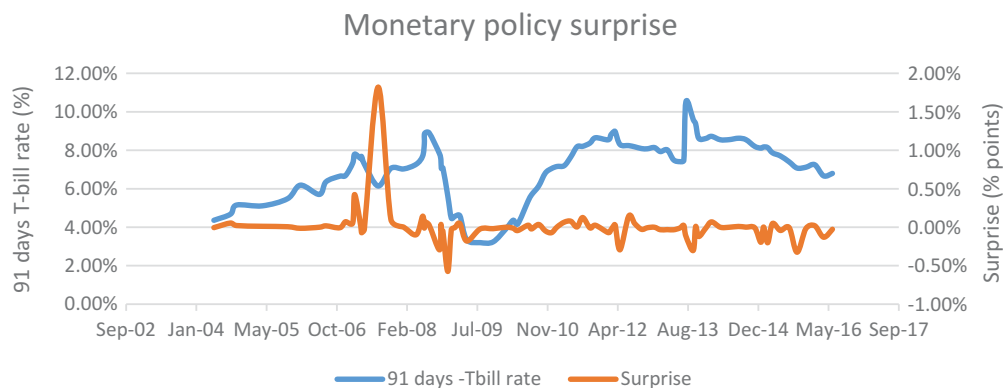


Figure 6. Monetary policy surprise.



announcements from 2011. Moreover, there were also non-scheduled policy announcements. From 1 April 2004 to 31 July 2016, a total of 86 policy announcements have been made, of which 63 were scheduled and 23 were unscheduled. The difference between 91-day T-bill yield both after and before the announcement is the monetary policy surprise. The monetary policy surprise is indicated in Figure 6. The right-hand axis is surprise in percentage point, and the left-hand side is T-bill. The monetary policy surprises have almost equal representation of both the positive and negative surprises in this sample period.

4. Event study and findings

According to the empirical literature, the policy and stock market relationship can be understood with the help of three broad methodologies. First, the event-based studies consider the chronological changes in stock price for making any declaration related to policy changes. Second, the VAR framework comprises few policy indicators, stock prices, and few related variables; and third, the heteroscedasticity is based on the Generalized Method of Moments.

The fundamental limitation of any of these methodologies is the endogeneity bias, i.e., the extraction of policy shocks or surprises from models or the changes in the economic variables utilizing the monthly or quarterly frequencies will not probably be absolutely exogenous. Any policy actions have certain economic impacts, but the isolation of these effects is not simple because the policy actions are dependent on the status of the economy. The response of economic variables to the reactive actions of policymakers reflects the collective impacts of the policy action and the variables that affect the policy. For isolating the impacts of policy actions, it is vital to ascertain the non-reactive element of the policy, i.e., the exogenous factor in relation to other variables (Christiano, Eichenbaum, & Evans, 1996).

Therefore, the dynamism associated with the short-term interest rate and asset prices are

$$\dot{i}_t = \beta s_t + \theta x_t + \gamma z_t + \varepsilon_t \quad (1)$$

$$s_t = \alpha i_t + \phi x_t + \delta z_t + \eta_t \quad (2)$$

where i_t is the three-month rate of Treasury bill and s_t is the daily stock return. The variables x_t and z_t represent the macroeconomic shocks or surprises, which probably affect the stock prices and interest rates. The macroeconomic indicators considered for analysis satisfy this criterion.

Our focus is on the short-horizon event study, which focuses on the momentary change, and the implicit assumption is that the change in stock price is related to the event only. The other stock market prediction model such as Fama–French is appropriate for long-horizon event studies, where appropriate adjustment for risk, aggregation of security-specific abnormal return, etc., become critically important. This is in sharp contrast to the short-horizon tests in which those adjustments are straightforward and typically unimportant (Kothari & Warner, 2006).

Therefore, in the event study approach, Equation (2) is only estimated, and the stock price changes are immediately utilized after the realization of the surprise element. There is an implicit assumption that within the limit, the variance of the shock caused by factors under consideration becomes substantially large in comparison to the variance of other shocks as has been on the announcement dates. Controlling the effect of endogeneity on the regression results is a challenge confronted by this type of analysis. To isolate the effect of a particular shock, it is preferable to use a small window period because there is less probability of encountering more than one macro shock, and thus, it facilitates in establishing the correlation between the specific shock and the stock indexes during the small phase.

For precise identification of policy shocks, much research on event studies has been carried out on the basis of higher-frequency observations—generally daily data—for analyzing the reaction of the equity market in relation to policy announcement. Keeping consistency with the efficient market hypothesis, it is observed that on the announcement day, markets do not react much on the announcements made; rather the reaction is more toward the unexpected (surprise) component, which has not yet been factored in the market price (Kuttner, 2001).

Another alternative to the daily data could be intraday data. With the use of intraday data in a comparatively narrow “event window”, the actual announcement can differentiate the influence of change in policy depending on the early or late incoming of news on a day. Through the application of narrow window with the intraday trading data, Gürkaynak, Sack, and Swanson (2005b) depicted that the response of equity price is effectively identical to the response obtained through the daily data, as done by Bernanke and Kuttner (2005), though the intraday data resulted in an improvement in the R^2 . However, the decision in favor of broader event window is that it avoids spurious data and hence is a balanced approach (Ehrmann & Fratzscher, 2004).

We conducted the event study by following the methodology of Bernanke and Kuttner (2005). The daily data were employed to segregate the effect of the surprise that the market experience with the release of macroeconomic data or declaration of monetary policy.

For the event study, we considered only the relevant data sets that are affected by the event. Here, the event is the surprise, which happened when monetary policy or macroeconomic variables are announced. Hence, for each macroeconomic variable and monetary policy, surprise (actual vs. expected) is recognized only on those relevant dates, and on other dates, it is zero. Therefore, this event study data set constitutes 358 observations.

Following the approach employed in Bernanke and Kuttner (2005), we conducted 17 regressions with one stock index at a time, and in each case, the dependent variable was the stock returns. We calculated the stock return as the first differences of the log-levels of the stock indices in percentages; thus,

$$\text{Stock return} = \ln(S_{t+1}) - \ln(S_t) \quad (3)$$

where S_{t+1} is stock indices in day $(t + 1)$, and S_t is stock indices in day t .

The log of the stock return was regressed with the surprise component of macroeconomic and monetary policy parameters.

$$\begin{aligned} \text{Stock return} = & \text{Constant} + \beta_1 \text{GDP}_{\text{surprise}} + \beta_2 \text{IIP}_{\text{surprise}} + \beta_3 \text{WPI}_{\text{surprise}} + \beta_4 \text{CPI}_{\text{surprise}} \\ & + \beta_5 \text{CAD}_{\text{surprise}} + \beta_6 \text{Monetary_policy}_{\text{surprise}} \end{aligned} \quad (4)$$

For normalizing these macroeconomic surprise variables, each series of these variables were divided by its standard error. Through this process, it becomes easy to interpret the regression coefficients as the effect of one-standard-error-surprise in that release (Gürkaynak, Sack, & Swanson, 2005a). However, the monetary policy surprise derived from 91-day T-bill was not normalized as it was possible to interpret the data.

The results of the event study are presented in Table 1. The results signify that the effect of domestic monetary policy surprises on stock indices controls all the other macroeconomic surprises. The negative relationship between monetary policy surprises and stock returns is the theoretical expectation, and depending on the expectation, it is observed that the coefficients of monetary policy are negative and statistically significant for all indices. The surprise in monetary policy of 100 basis points changes the stock market returns represented by various indices from 1.4% to 3.8%, significant at 1% level, which is similar to the findings of Bernanke

Table 1. Result of event study

Index		C	Monetary_Policy_Surprise	GDP_Surprise	WPI_Surprise	CPI_Surprise	IIP_Surprise	CAD_Surprise	R ²
Nifty 50	Coefficient	0.001294	-2.876292	0.009043	-0.003995	-0.020843	-0.004245	0.015835	0.032461
	P value	0.1861	0.0009	0.9181	0.8604	0.5637	0.7737	0.8818	
Nifty 200	Coefficient	0.00095	-2.619555	-0.002295	-0.010379	-0.012867	-0.004205	0.039802	0.034456
	P value	0.2792	0.0007	0.9767	0.6094	0.6902	0.7508	0.676	
NIFTY 500	Coefficient	0.000926	-2.56107	-0.002792	-0.009142	-0.011838	-0.004502	0.03596	0.033883
	P value	0.2836	0.0008	0.9712	0.6471	0.7091	0.7295	0.7009	
NIFTY 50 Midcap	Coefficient	0.001352	-2.86406	-0.00073	-0.00919	-0.03101	-0.00163	0.05675	0.031259
	P value	0.191	0.0017	0.9938	0.7007	0.4145	0.9165	0.6127	
NIFTY 100 Midcap	Coefficient	0.001266	-2.39327	-0.0078	-0.00287	-0.01636	-0.00317	0.017419	0.0306
	P value	0.140982	0.001451	0.918613	0.884002	0.601192	0.804824	0.850406	
NIFTY 100 Smallcap	Coefficient	-0.00169	-4.19559	0.032441	-0.0104	0.002662	-0.01504	0.105427	0.046867
	P value	0.058545	0.020458	0.695999	0.560288	0.910236	0.289618	0.130502	
NIFTY_Energy	Coefficient	0.000714	-2.579615	-5.43E-03	-7.76E-03	-2.22E-03	5.95E-03	0.059602	0.027454
	P value	0.465	0.0027	0.9506	0.7315	0.9507	0.6864	0.574	
NIFTY_Infra	Coefficient	0.000993	-3.130476	-0.037631	-5.07E-03	-0.016139	-3.74E-03	0.078741	0.034112
	P value	0.3534	0.0009	0.694	0.8372	0.6807	0.8162	0.4963	
NIFTY_PSU Bank	Coefficient	0.000735	-2.184582	0.02329	-0.034119	-0.081052	-0.013093	0.002797	0.021574
	P value	0.5936	0.0701	0.8561	0.2877	0.1092	0.5283	0.985	
BSE Sensex	Coefficient	0.00082	-2.7112	-0.016499	-0.010555	-1.11E-02	-0.004791	0.046076	0.03754
	P value	0.3407	0.0004	0.8315	0.5982	0.7264	0.7122	0.6237	
BSE Midcap	Coefficient	0.001096	-2.087223	0.011081	2.04E-03	-0.017097	-5.17E-03	0.027696	0.024454
	P value	0.187	0.0045	0.8822	0.916	0.5774	0.68	0.7597	
BSE Smallcap	Coefficient	0.000973	-1.81282	0.013548	0.011322	-0.009977	-0.007846	-0.010483	0.019723
	P value	0.2407	0.0135	0.8561	0.5574	0.7448	0.5306	0.9077	

(Continued)

Table 1. (Continued)

Index		C	Monetary_Policy_Surprise	GDP_Surprise	WPI_Surprise	CPI_Surprise	IIP_Surprise	CAD_Surprise	R ²
BSE Auto	Coefficient	0.001616	-2.303724	-0.000232	0.002526	-0.008305	0.002124	0.103052	0.025841
	P value	0.0795	0.0047	0.9978	0.9061	0.8071	0.8784	0.3049	
BSE Bankex	Coefficient	0.000699	-2.408053	0.106851	-0.032847	-4.47E-02	-0.00524	0.059641	0.026627
	P value	0.5471	0.019	0.3073	0.2245	0.2977	0.7649	0.6378	
BSE Capital Goods	Coefficient	0.000981	-2.840587	-0.072901	-0.00353	-0.031476	-0.008703	0.114373	0.029836
	P value	0.3772	0.0039	0.4663	0.8914	0.4434	0.6036	0.3455	
BSE_Consumer Durables	Coefficient	0.00057	-2.23776	-0.084899	-1.85E-02	-0.015854	0.001951	0.046583	0.021498
	P value	0.5857	0.0157	0.3682	0.4479	0.682	0.9017	0.6834	
BSE_Fast Moving Consumer durable	Coefficient	0.000947	-1.419826	-1.83E-01	-5.61E-03	-0.006659	-0.007815	-0.035189	0.037834
	P value	0.1905	0.0263	0.0053	0.7389	0.8032	0.4739	0.6556	
BSE_Health	Coefficient	0.000993	-1.632766	8.41E-02	1.02E-02	-6.73E-03	-0.007069	0.003027	0.031551
	P value	0.1245	0.0043	0.1486	0.4986	0.778	0.4682	0.9657	
BSE_IT	Coefficient	0.000839	-2.20899	-2.66E-02	-0.021973	9.00E-03	-0.031068	0.004236	0.035645
	P value	0.3724	0.008	0.7534	0.3156	0.7957	0.0291	0.9671	
BSE_Metal	Coefficient	0.001891	-3.824946	-0.019053	-0.000723	0.000245	-0.014285	0.09753	0.034621
	P value	0.1403	0.0008	0.8688	0.9806	0.9959	0.4599	0.4852	

and Kuttner (2005), Rigobon and Sack (2003), and Ehrmann and Fratzscher (2004) related to the US stocks.

The coefficients of the other macroeconomic surprises are found to be strongly insignificant, which is in line with the low effect size of each surprise variable. This result is consistent with other studies conducted in different countries, for example, South Africa (Gupta & Reid, 2013). According to the literature of other economy, few of the possible explanations of this result are investor's interpretation of macroeconomic surprises and risk (Chen, Roll, & Ross, 1986; McQueen & Rolew, 1993; Pearce & Roley, 1985), quality of the data and announcement (Gilbert, Scotti, Strasser, & Vega, 2010), time lag between the reference period and the announcement release time (Gilbert, Scotti, Strasser, & Vega, 2017), and market adjustment in the next trading day (Pearce & Roley, 1983). There are two other possibilities in the Indian context. First, during the study period, the uncertainty associated with the Indian macroeconomic fundamentals was rather low owing to the functioning of its well-regulated financial system. In this relatively stable microenvironment, the extent of surprises was low. Second, the Indian stock market is well integrated with active participation of FPIs and FIIs investment, and many of the stock market reactions may not be governed by domestic macroeconomic surprises, rather it depends on global developments. We tend to believe more on India-specific reasons for low effect size of surprise variable.

The stock price movement is dependent on many factors other than those defined in the model as surprises, and therefore, it is expected that the overall R^2 value will be low. The low R^2 means that very little of stock price variance can be explained with macroeconomic surprises; however, the range of R^2 value is consistent with the observations of Bernanke and Kuttner (2005).

Industry effect is observed in the event study. The capital-intensive sectors, for instance, the infrastructure sector and capital goods, are more sensitive to monetary policy surprise as characterized by a higher coefficient of monetary policy than NIFTY200. The sectors that are more vulnerable to the economic cycle and are relatively open to international trade—for instance, Metal has a higher coefficient of monetary policy—will be affected more strongly by monetary policy surprise. Contrary to this, the recession-proof sectors such as healthcare or fast-moving consumer durables demonstrate lower coefficient of monetary policy.

According to the prediction of the imperfect capital market theory, the alterations in the credit market conditions can differently affect the small and large firms. We observed the responses of stock returns of the large-sized firms through BSE Sensex, the medium-sized firms through BSE Midcap, and the small-sized firms through BSE Smallcap. We found that the responses of stock return to monetary policy are different for large, medium, and small firms as depicted through their coefficients. The sensitivities of stock return to monetary policy are maximum for a large firm, which is followed by the medium-sized firm and subsequently by the small firm. The result is consistent for NSE Indices also (NIFTY 50 proxy for large firms, and NIFTY 50 Midcap and NIFTY 100 Midcap are the proxies for medium-sized firms), except the small firms that are represented by NSE 100 SmallCap, which shows increased sensitivity. However, this finding is quantitatively different from the observations made by Thorbecke (1997), Kiyotaki and Moore (1997), Perez-Quiros and Timmermann (2000), etc., as in those studies, it has been shown that the response of stock returns to monetary policy is larger for small firms. The reason for the higher sensitivity of smaller firms in those studies is the higher degree of risk associated with smaller firms with the change in the credit market conditions during the recessionary or expansionary economy. For our study, this is not the case, as there is no correlation between firm size—which is represented by various indices—and the financial constraints. Moreover, upon using the different indices as the proxy for size, the industry effect dominates the size effect.

5. VAR analysis and findings

The event study based on the equity return with respect to the surprise element does not address the dynamic relationship; however, we are also interested in understanding the dynamic

relationships of all macroeconomic surprises on stock prices and their heterogeneity, which can be captured through a VAR model.

Many VAR models were used for evaluating the effect of monetary policy on various parts of the economy by focusing on an unanticipated element of the action. Kim (2001) using the VAR model evidenced international transmission of the US monetary policy shocks. In the VAR model, Canova (2005) treated the US shocks as exogenous in relation to the Latin American economies and focused on the transmission of the US shocks to eight Latin American countries. Miniane and Rogers (2007) analyzed the ways through which the exchange rate and foreign country interest rates are influenced by the identified US monetary shocks and treated the US variables as exogenous. Goto and Valkanov (2000) employed a VAR-based method focusing on the covariance between inflation and stock returns. Campbell (1991) and Campbell and Ammer (1993) tried to understand the factors responsible for excess return in long-term assets and utilized the VAR technique to calculate revisions in expectations of the key variables, viz., future interest rates, dividends, and excess returns. In their study, by extending the Campbell–Ammer (Campbell & Ammer, 1993) model, Bernanke and Kuttner (2005) employed a VAR methodology to obtain proxies for the relevant expectations and derived the surprise component of monetary policy from federal fund futures. Patelis (1997) also used the Campbell–Ammer framework for variance decomposition to find how monetary policy affects the components of excess return but derived the policy shocks from the identified VAR itself.

A VAR model constituting of shocks associated with the predictor variables, viz., dividend yield, term spread, default spread, and Treasury-bill yield, is capable of explaining the average return better than the Fama–French model (Petkova, 2006). Further, Campbell (1996) argued that parsimony is particularly important for a VAR model and the default spread can be omitted, as it has no marginal explanatory power for stock returns if the dividend yield is included in the system. The work of Bernanke and Kuttner (2005), which is actually an extension of the framework of Campbell–Ammer (Campbell & Ammer, 1993), uses all these relevant predictive variables, viz., dividend yield, term spread, and Treasury-bill yield, and is an efficient VAR framework.

Realistically, like many of the economic analysis focusing on economic shocks, in our analysis also, the surprises are treated as exogenous variables. But, in the classical VAR model, if the surprises are treated as exogenous variables, it is difficult to obtain impulse responses by changing these surprise variables. The Bernanke and Kuttner (2005) methodology allows us to do that.

We adopted the VAR model proposed by Bernanke and Kuttner (2005) and extended it further. We augmented their VAR model with both monetary policy and other macroeconomic surprises. This allowed us to separate the unanticipated elements of the monetary policy variable and other macroeconomic indicators. We further tested the heterogeneity of stock response at industry level and firm level (size effect) with this VAR approach.

Bernanke and Kuttner's (2005) VAR model is an extension of Campbell–Ammer (Campbell & Ammer, 1993) model. Campbell–Ammer method used a log-linear approximation to decompose the excess equity returns into components attributable to news about real interest rates, dividends, and future excess returns and subsequently employed a VAR methodology to obtain proxies for the relevant expectations. Bernanke and Kuttner (2005) took this further by relating the proxies for expectations to the surprises on monetary policy from the Federal funds futures, which permitted them to calculate the effect of federal funds surprises on the expected future dividends, real interest rates, and expected future excess returns.

$$\begin{aligned}
 y_{t+1} &= \log(\text{Excess return of equity}) \\
 &= \text{Total return on equity (i.e. Price change + Dividend)} \\
 &\quad - \text{The risk free rate (3 - month Treasury bill rate)}.
 \end{aligned}$$

The y_{t+1} represents the log of excess return on a stock kept from the beginning of the period t to the beginning of the period $t + 1$, and it is measured relative to the return on short debt.

Let e_{t+1}^y = unexpected excess return = $y_{t+1} - E_t y_{t+1}$; E_t is the expectation formed in the beginning of the period t .

The basic equation of stock returns relates the unexpected excess return in time $t + 1$ to changes in rational expectations of future dividend growth, future real interest rates, and future excess stock returns. The d_{t+1} is the log real dividend paid during the period $t + 1$, and r_{t+1} is the log real interest rate from t to $t + 1$

$$e_{t+1}^y = y_{t+1} - E_t y_{t+1} = (E_{t+1} - E_t) \left(\sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - \sum_{j=0}^{\infty} \rho^j r_{t+1+j} - \sum_{j=1}^{\infty} \rho^j y_{t+1+j} \right) \quad (5)$$

while Δ indicates one-period backward difference and the discount factor ρ comes out from the process of log-linear approximation (linearization) and is representative of the steady-state ratio of the equity price to the price plus dividend, and it is a number smaller than 1 (0.9962) (Campbell & Ammer, 1993).

Equation (5) shows that in case the unexpected excess return is negative, then either the expected future dividend growth is lower or the expected future real stock returns is higher or both.

Equation (5) can be rewritten with simplified notation as

$$e_{t+1}^y = e_{t+1}^{\sim d} - e_{t+1}^{\sim r} - e_{t+1}^{\sim y} \quad (6)$$

where the “e”s represent the revision in expectation between periods t and $t + 1$, and the tilde denotes a discounted sum so that,

$$e_{t+1}^{\sim d} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} \quad (6a)$$

$$e_{t+1}^{\sim r} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{t+1+j} \quad (6b)$$

$$e_{t+1}^{\sim y} = (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j y_{t+1+j} \quad (6c)$$

The implementation of this decomposition needs empirical proxies for the expectations appearing in Equation (6). Campbell and Ammer (1993) modeled this using the VAR approach on the basis of the assumption that it is possible to present the unobserved components of returns as linear combinations of innovations or surprises associated with the observable variables. With the use of a time-series model, the coefficients of these linear combinations are estimated and used for constructing forecast related to the discounted value of future dividends, real interest rates, excess returns, etc. The revisions of these forecasts are subsequently employed as proxies for the revisions in investors’ expectations.

In the stock market, the long-term asset prices are used as the forecasting variables and the log dividend–price ratio or dividend yield satisfies the following equation

$$d_t - p_t = E_t \sum_{j=0}^{\infty} \rho^j [-\Delta d_{t+1+j} + r_{t+1+j} + y_{t+1+j}] \quad (7)$$

The third term on the right-hand side, y_{t+1+j} , is the long-horizon excess return. Therefore, if the first two terms (Δd_{t+1+j} and r_{t+1+j}) on the right-hand side are considered as stationary, the dividend–price ratio acts as a proxy for the long-horizon expected excess return.

Let,

r_t is the real interest rate, which is calculated as the difference between one-month bill yield and the log difference in the non-seasonally adjusted CPI.

$x_{n,t+1}$ is the log excess one-period return of n -period zero coupon bond held from time t to time $(t + 1)$.

$p_t^{(n)}$ is the log price of n -year discount bond at time t .

$k_{n,t}$ is the nominal log yield to maturity, which is $-\frac{p_t^{(n)}}{n}$ because, at the maturity, bond price is unity, and hence, $p_{t+n}^{(0)} = 0$

$\Delta k_{1,t}$ is the change in the nominal interest rate.

$s_{n,t}$ is the difference or yield spread between n period nominal interest rate and the one-period nominal interest rate, i.e., $k_{n,t} - k_{1,t}$. The yield spread between the interest rates of the two different maturities is to eliminate unit root in the nominal interest rate (Campbell, 1991).

Campbell and Ammer (1993) considered another parameter, the relative bill rate, which is the difference between T-bill rate and one-year backward moving average. The inclusion of these short-term interest rates improves the forecasting power of stock return.

Therefore, the relative bill rate is defined as,

$$rb_t = k_{1t} - \frac{1}{12} \sum_{i=1}^{12} k_{1,t-i} = \sum_{i=0}^{12} \left(1 - \frac{i}{12}\right) \Delta k_{1,t-i} \quad (8)$$

With these, Campbell and Ammer (1993) defined the state vector, z_t , where

$$z_t = \begin{pmatrix} y_t \\ r_t \\ \Delta k_{1,t} \\ s_{n,t} \\ d_t - p_t \\ rb_t \end{pmatrix} \quad (9)$$

If the state vector follows the first-order VAR process, then the VAR equation becomes

$$z_{t+1} = Az_t + w_{t+1} \quad (10)$$

where z_{t+1} is $np \times 1$ matrix, A is the $np \times np$ coefficient matrix, and w is a sequence of a serially uncorrelated random $np \times 1$ matrix.

For this VAR equation, Campbell and Ammer (1993) wrote the solution as

$$e_{t+1}^y = s_y w_{t+1} \quad (11)$$

$$e_{t+1}^{-y} = s_y \rho A (I - \rho A)^{-1} w_{t+1} \quad (12)$$

$$e_{t+1}^{-r} = s_r (I - \rho A)^{-1} w_{t+1} \quad (13)$$

$$e_{t+1}^{-d} = e_{t+1}^y + e_{t+1}^{-y} + e_{t+1}^{-r} \quad (14)$$

where s_y and s_r are appropriate $1 \times np$ selection matrix.

The VAR equation (Equation 10) proposed by Campbell and Ammer (1993) was further modified by Bernanke and Kuttner (2005) by introducing monetary policy surprise as the contemporaneous exogenous variables in Equation (10)

$$z_{t+1} = Az_t + \xi^u_{t+1} + f_{t+1}^\perp \quad (15)$$

where i^u is the monetary policy surprise. ξ is $1 \times n$ matrix that captures the contemporaneous response of z_{t+1} to the monetary policy surprise factors in the period $(t + 1)$, and f_{t+1}^\perp is orthogonal to monetary policy surprises. The error associated with the VAR's 1-month-ahead forecast (w_{t+1}) is efficiently broken into a component, which is related to the monetary policy surprises, ξ^u_{t+1} , and a component other than the monetary surprises, f_{t+1}^\perp . Because i^u_{t+1} is the forecast error at time t , it is orthogonal to z_t . Therefore, both A and ξ can be estimated through VAR estimators. The incorporation of the monetary policy surprise into the VAR allows the extraction of an orthogonal element ξ^u_{t+1} from (w_{t+1}) forecast error, and this is used to estimate the impulse responses of the variables in VAR to the orthogonal component.

For Equation (15), the unexpected excess return can be rewritten as

$$e^y_{t+1} = s_y w_{t+1} = s_y (\xi^u_{t+1} + f_{t+1}^\perp) \quad (16)$$

Thus, the instantaneous response of unexpected excess return to the 1-percentage-point surprise increase is $s_y \xi$. For longer window, they estimated the impulse response through multiplier analysis. In that analysis, if it is assumed that unit shock happens in period $t = 0$ and no further shocks happen in subsequent period, in general, the increase of k -month response to a 1-percentage-point surprise increase can be written as $A^k \xi$.

In our model, we extended Bernanke and Kuttner (2005) methodology for other macroeconomic surprises. We constructed the VAR model for all six surprises and added five macroeconomic surprises with the monetary policy surprise and created the Macroeconomic Surprise Vector. Therefore, Equation (15) in our model is modified further as

$$z_{t+1} = Az_t + \varphi x_{t+1} + w_{t+1}^\perp \quad (17)$$

where x_{t+1} is the Macroeconomic Surprise Vector that captures all the macroeconomic surprises. φ is $1 \times n$ matrix that captures the exogenous response of z_{t+1} to the macroeconomic policy surprises and w_{t+1}^\perp is the orthogonal component. Because x_{t+1} is the normal forecast error of macroeconomic factors at time t , it is orthogonal to z_t . Therefore, both A and φ can be estimated through VAR estimators, as done by Bernanke and Kuttner (2005) in their monetary policy model. So, for Equation (17), the unexpected excess return in our model can be rewritten as,

$$e^y_{t+1} = s_y w_{t+1} = s_y (\varphi x_{t+1} + w_{t+1}^\perp) \quad (18)$$

Here also, the impulse response can be estimated through multiplier analysis. If we assume that unit shock happens for a particular exogenous variable in period $t = 0$ and no further shocks happen in subsequent period, the increase of k -month response to a 1-percentage-point surprise increase can be written as $A^k \varphi$ for that particular variable.

The orthogonalization procedure suggested by Bernanke and Kuttner (2005) prohibits any contemporaneous reaction of the macroeconomic parameters derived from any economic announcement, and in our model also, we did not consider this contemporaneous effect.

In our present VAR model, we employed BSE SENSEX (BSESSReturn) for return. Other predictive variables are Real Interest rate (ReaIntRate) estimated as 91-day T-bill rate minus non-seasonally adjusted CPI (In India, the CPI data series is non-seasonally adjusted and, therefore, we used it directly without any adjustment), Relative Bill rate (RltvbRate) estimated as 91-day T-bill rate minus 12 months lagged moving average, the change in the nominal interest rate measured by change in the T-bill rate (ChngeTBrate), Dividend–Price ratio (BSEsDvdPrRatio), and Spread between 10 years bond and 91-day T-bill rate (SprdLT_ST). The Macroeconomic Surprise Vector comprises six exogenous surprise variables and is used in the model. Those variables are Surprise in Monetary

policy (SMpolicy), Surprise in GDP (SGDP), Surprise in WPI (SWPI), Surprise in CPI (SCPI), Surprise in IIP (SIIP), and Surprise in CAD (SCAD).

The periodic time series data are necessary for VAR; hence, all variables along with the surprises are employed considering their monthly measures. In case multiple monthly policy data are available for any particular macroeconomic parameter, the value of the corresponding surprise in a month is calculated by taking average of the event-based daily data. This approach is generally applicable only for monetary policy surprise, as, during the post-financial crises in 2008, there are several occasions of unscheduled monetary policy announcements. In case there is no such policy announcement in a particular month, the value of the surprise for that specific month is set to zero.

All data series were available from 1 April 2004 to 31 July 2016, except the data for dividend-price ratio, which is available from September 2005. Since the dividend-price ratio is critical for the Structural VAR model, we developed the model based on data from October 2005 to July 2016. Taking into consideration all these criteria, we had 130 data points.

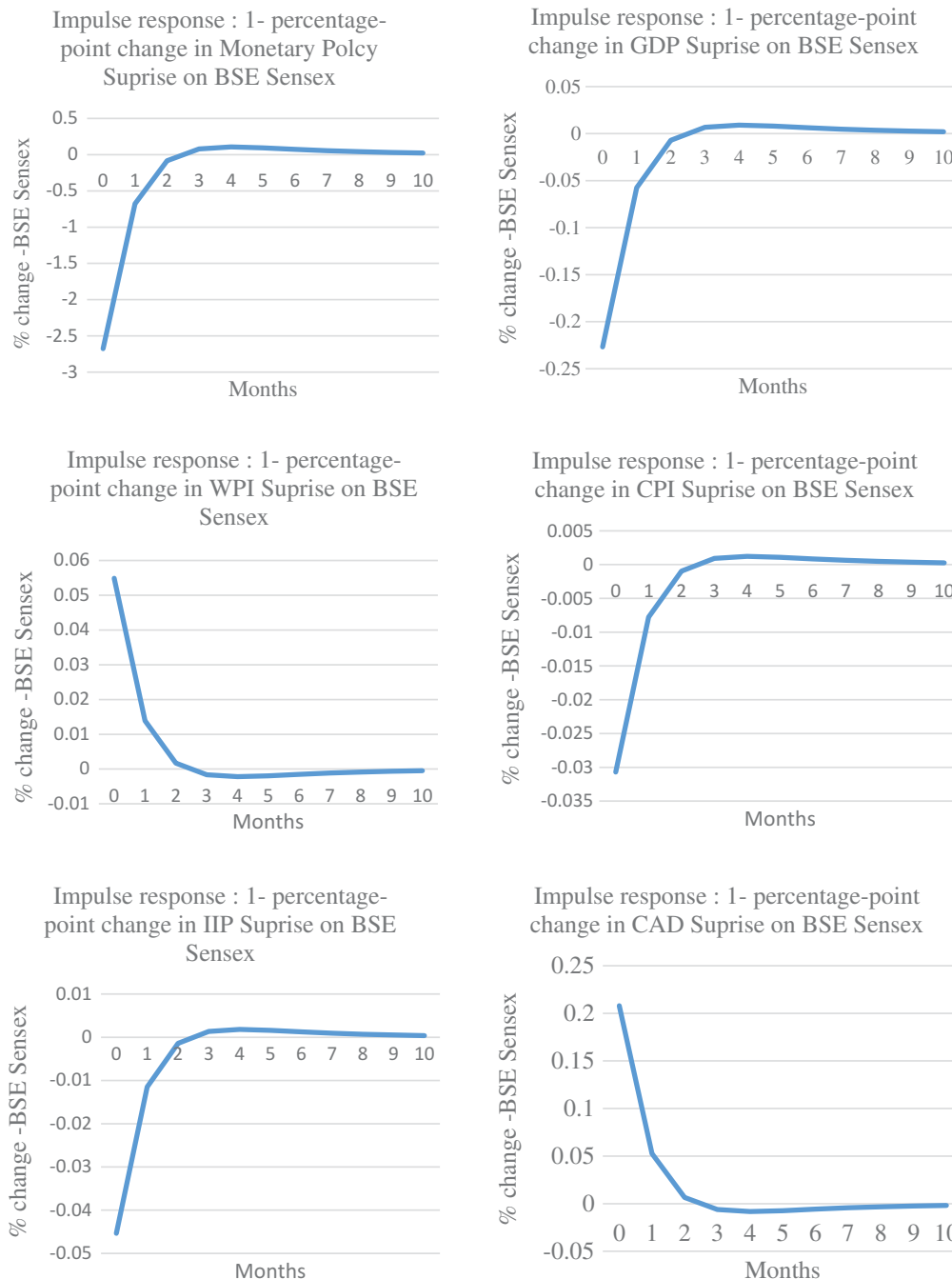
We constructed both the first-order and second-order unrestrictive VAR model. The lag length 1 gives minimum Schwarz Criteria (SC) value, whereas the lag length 2 generates minimum Akaike Information Criteria (AIC). The SC criterion is supposed to be superior to the AIC for the large sample size; hence, we applied the VAR model with one lag length. By restricting the lag length to maximum one, the over-parametrization problem is not envisaged in the unrestrictive VAR model.

The impulse responses of stock return for 1 (one)-percentage-point change in six macroeconomic surprises are calculated over a 10-month period from this VAR(1) model, and the increase in the k -month response to a 1-percentage-point surprise increase is calculated as $A^k\phi$. With this model, the impulse response of BSE Sensex return associated with 1-percentage-point change in the six macroeconomic surprises over a 10-month horizon is shown in Figure 7. In general, the impact of the stock returns originating due to different surprises is small and diminutive over the period. The magnitude of the effects ranges between 2.6% (monetary policy surprise) and 0.03% (CPI surprise). The monetary policy surprise results in the initial decline of the stock returns, followed by recovery in subsequent months. This finding is consistent with the general expectation of negative co-relation. The GDP surprise also leads to an initial decline, but the magnitude of decline is much less. The WPI surprise results in the initial increase of the stock returns, which subsequently decrease. The CPI surprise results in a considerable decline of the stock returns. The IIP surprise leads to negative stock returns, whereas the CAD surprise leads to positive stock return. We saw an exactly similar pattern with NIFTY 50 data, which is also representative of large-sized firms (Figure 8). All these behaviors of stock returns against various macroeconomic surprises are intuitively obvious, except initial positive reaction against WPI and CAD surprises. One possible reason could be the markets' perceptions immediately after surprise. The market probably reacts positively after surprise because of the perceived increased profitability on account of price and export competitiveness, but gradually that positive sentiment dies down as other macroeconomic parameters, particularly CPI, starts showing adverse reactions.

While comparing the results on impulse response with that of the event study, all the signs are the same, excluding the WPI surprise. However, along with the monetary policy surprise, it is observed that the GDP, WPI, CAD, IIP, and CPI shocks show a significant impact. According to the dynamics and magnitude, the monetary policy, GDP, WPI, CAD, and IIP surprises majorly influence the stock returns, and the influence of CPI surprise is relatively less. This pattern is also found to be consistent with the event study.

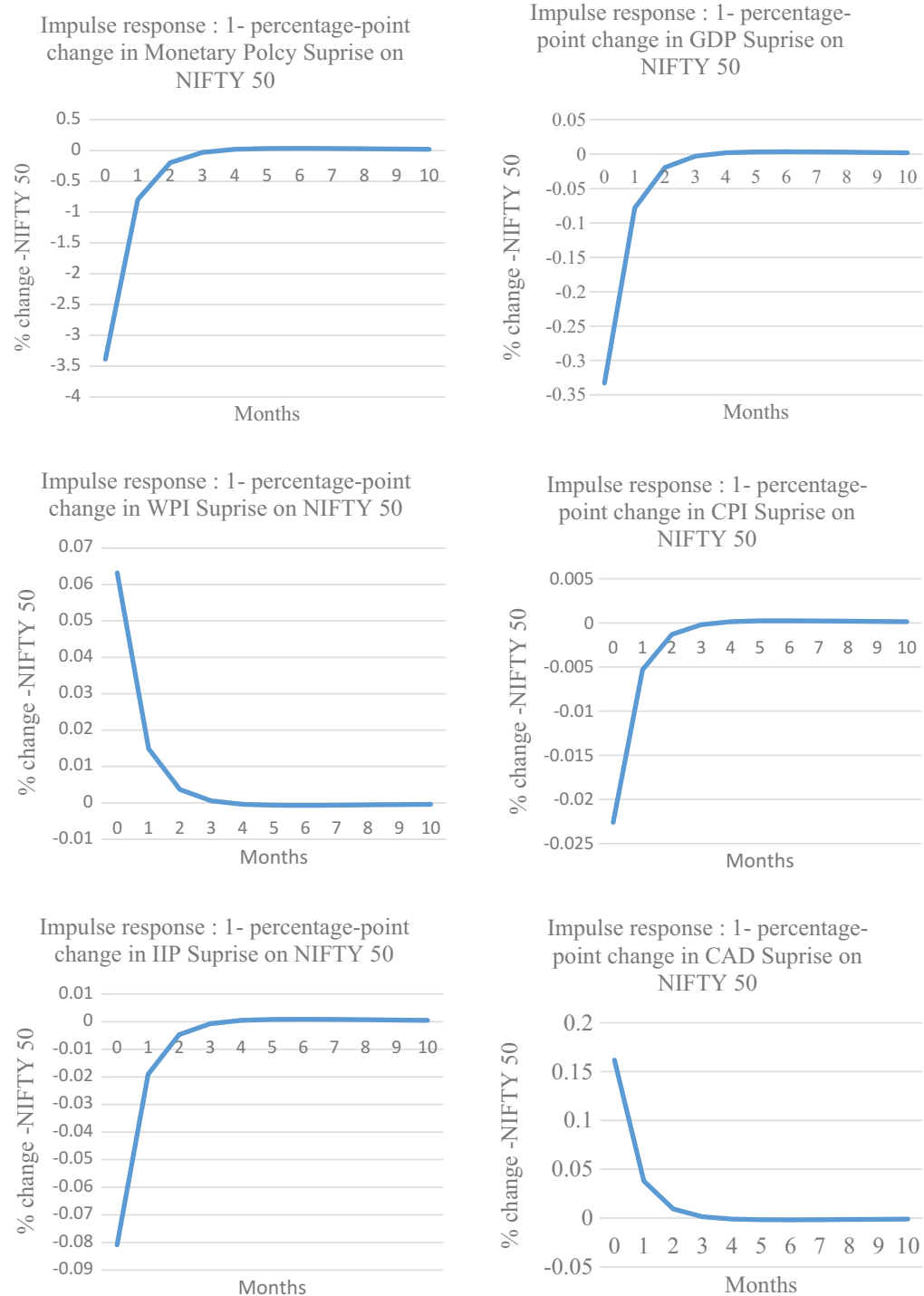
In the event study, we observed the industry effect on monetary policy surprise and found that some capital-intensive sector or sectors affected by economic cycle are more sensitive to shock than the recession-proof sectors, and the findings are consistent with that of Ehrmann and Fratzscher (2004). Though in the event study, we did not observe the differential effect of other macroeconomic surprises on the representative industrial indices; however, in VAR, we observed

Figure 7. Impulse response of BSE Sensex to monetary policy and macroeconomic surprises with lag length 1.



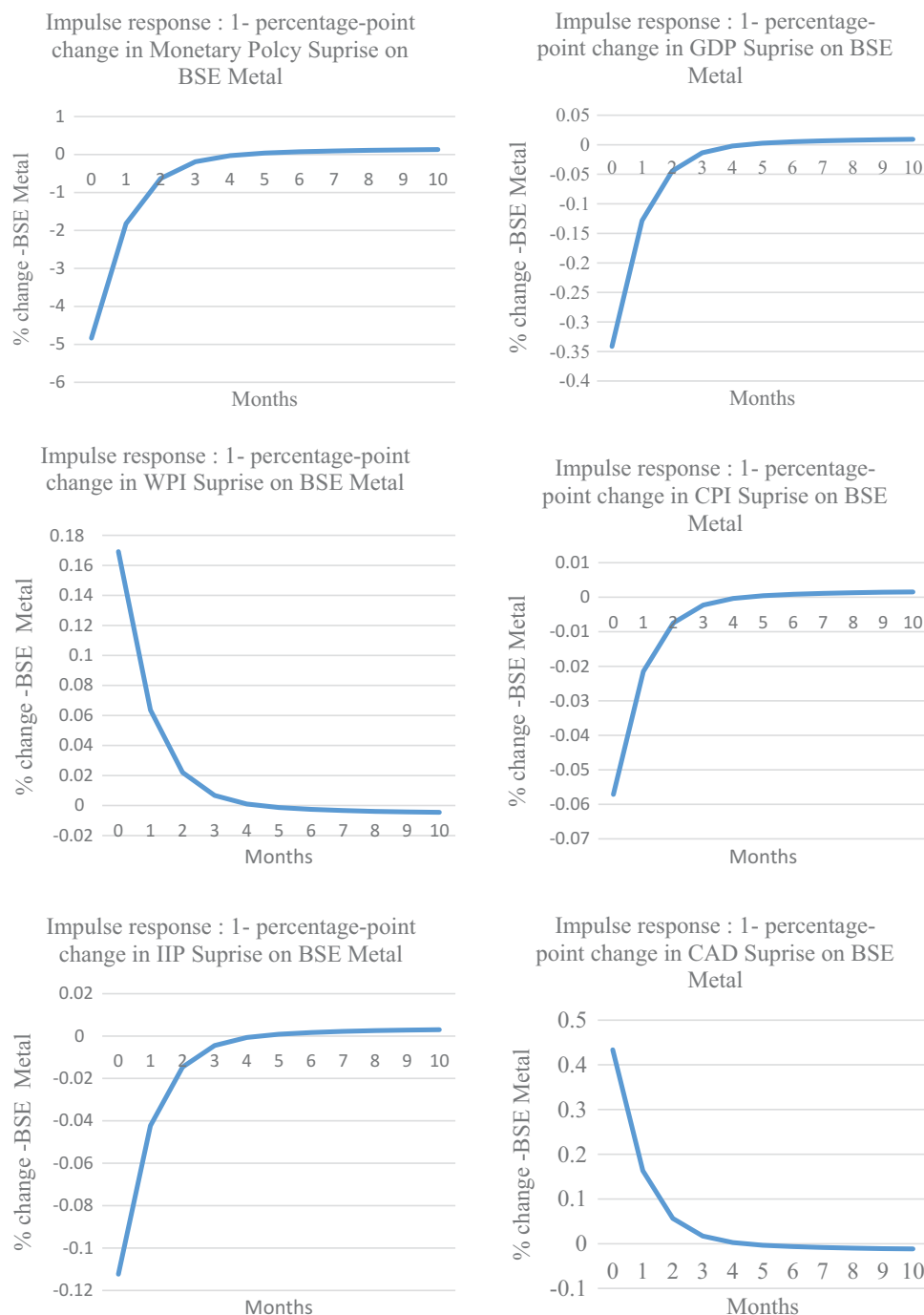
the differential effect. Though the impact originating from the initial surprise is small and diminutive over the period, the recovery period varies with the industry category. In VAR analysis, we expected a differential outcome of cyclical sector and recession-proof sector and thus selected the BSE Metal as the representative of cyclical sector and BSE Healthcare as the representative of recession-proof sector. The impulse-response functions of BSE Metal and BSE Healthcare are plotted in Figures 9 and 10, respectively. According to our expectation, the initial reaction of BSE Metal is higher than BSE Healthcare in all six surprises parameters, and each response is very different from the BSE Sensex. We further tested the industry response with other industry-specific indices. In the BSE BankEx (Banking Index), we expected that the stock reaction will be more in monetary policy, GDP surprises, and CAD surprise because of their direct implication on banking

Figure 8. Impulse response of NIFTY 50 to monetary policy and macroeconomic surprises with lag length 1.



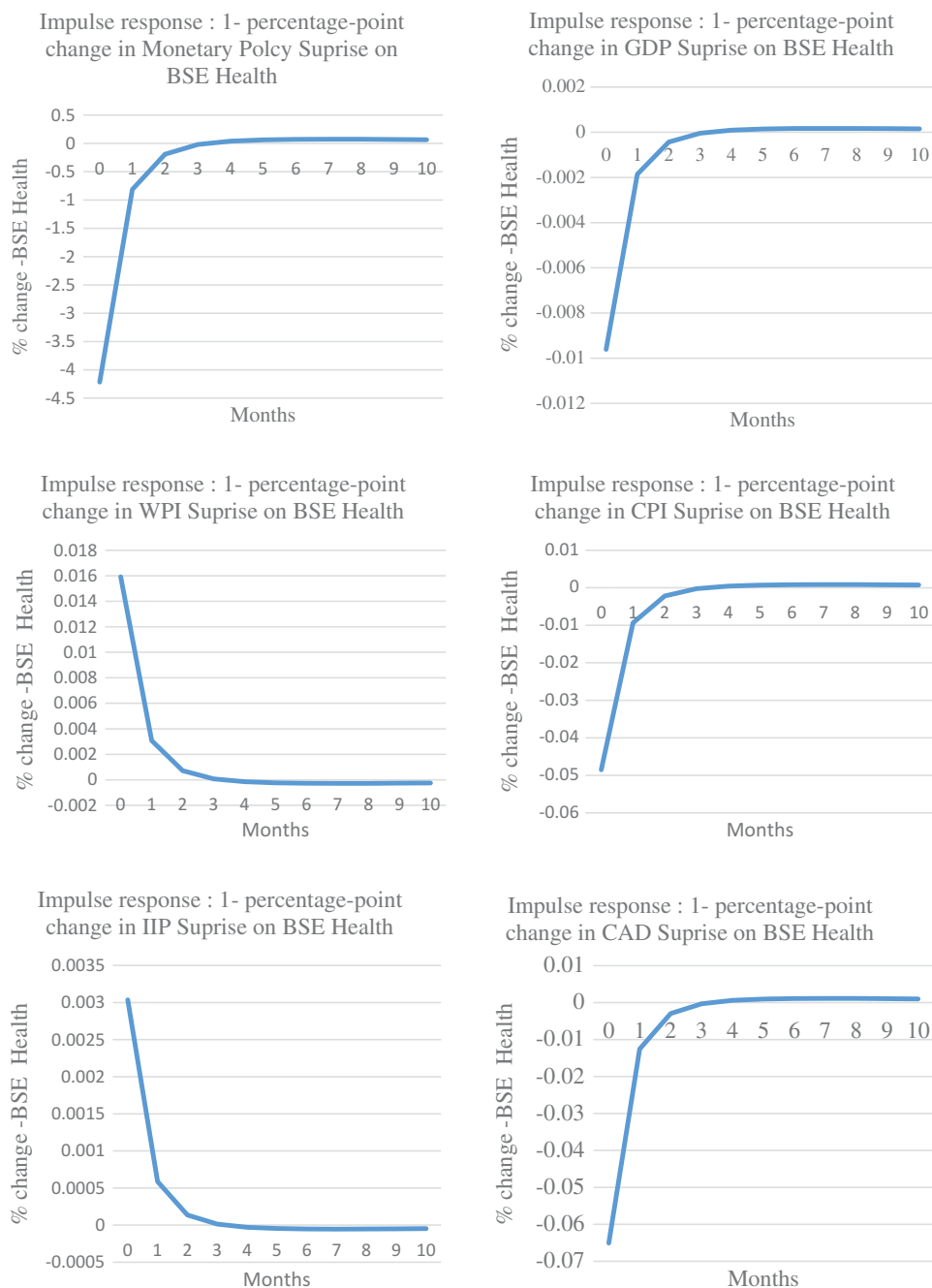
operation compared to WPI, CPI, and IIP surprises. We observed the impulse response of the VAR model in line with our expectation (Figure 11). In the BSE IT Index (Figure 12), we observed very short recovery time in all six surprises and relatively larger positive response on the CAD surprise. The generic business model of Indian IT companies is greatly reliant on exports and offshore clients, and therefore, the sector is expected to be less sensitive to domestic macroeconomic surprises as seen in shorter recovery time.

Figure 9. Impulse response of BSE Metal to monetary policy and macroeconomic surprises with lag length 1.



In the event study, we also observed the size effect of monetary policy but did not observe the differential effect of other macroeconomic surprises. In VAR analysis, we expected differential dynamic response of large-sized, medium-sized, and small-sized firms, against both the monetary policy and macroeconomic surprises. We selected BSE Sensex as the representative of large firms, NIFTY 50 Midcap and NIFTY 100 Midcap as the representative of medium-sized firms, and NIFTY 100 Small Cap as the representative of small-sized firms. We found smaller firms are very sensitive to monetary and macroeconomic surprises. The impulse responses on the macroeconomic surprises and monetary policy surprises of small firms (Figure 13) are more than the medium-sized

Figure 10. Impulse response of BSE Health to monetary policy and macroeconomic surprises with lag length 1.



firm (Figures 14 and 15). The response of large-sized firms is the least (Figure 7). However, since the price to dividend ratio of NIFTY 100 Small Cap index is available from 17 November 2011, we could perform the VAR analysis with relatively smaller data set. For size effect, the direction of VAR analysis result is different from the result obtained in event analysis, but the VAR analysis result confirms the findings of other sets of literature, Thorbecke (1997), Kiyotaki and Moore (1997), Perez-Quiros and Timmermann (2000), etc., in which it has been shown that the response of stock returns to monetary policy is larger for small firms. However, this confirmation is mostly because of the type of firms representing different industries rather than the firm's financial constraints as theorized by those pieces of literature.

Figure 11. Impulse response of BSE BankEx to monetary policy and macroeconomic surprises with lag length 1.

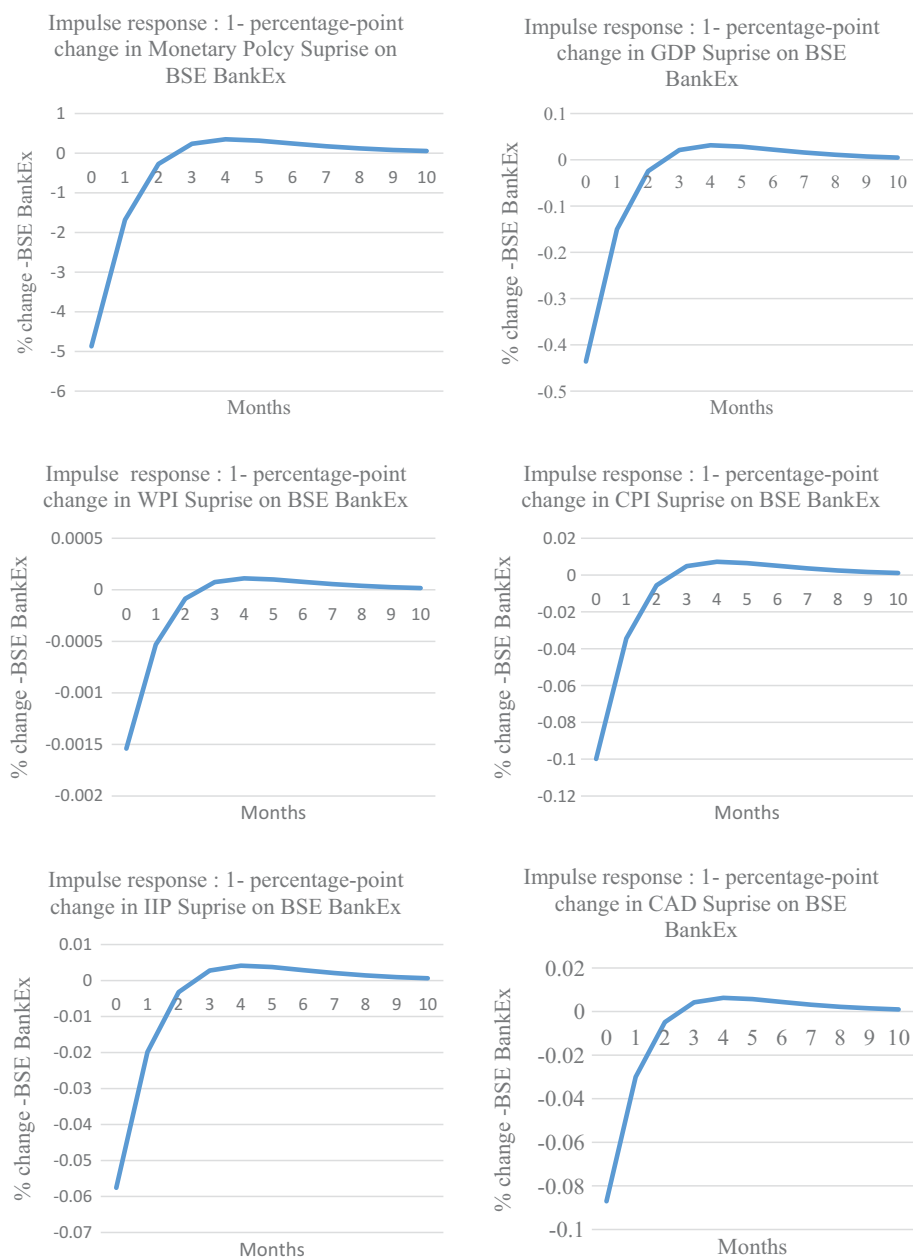


Figure 12. Impulse response of BSE IT Index to monetary policy and macroeconomic surprises with lag length 1.

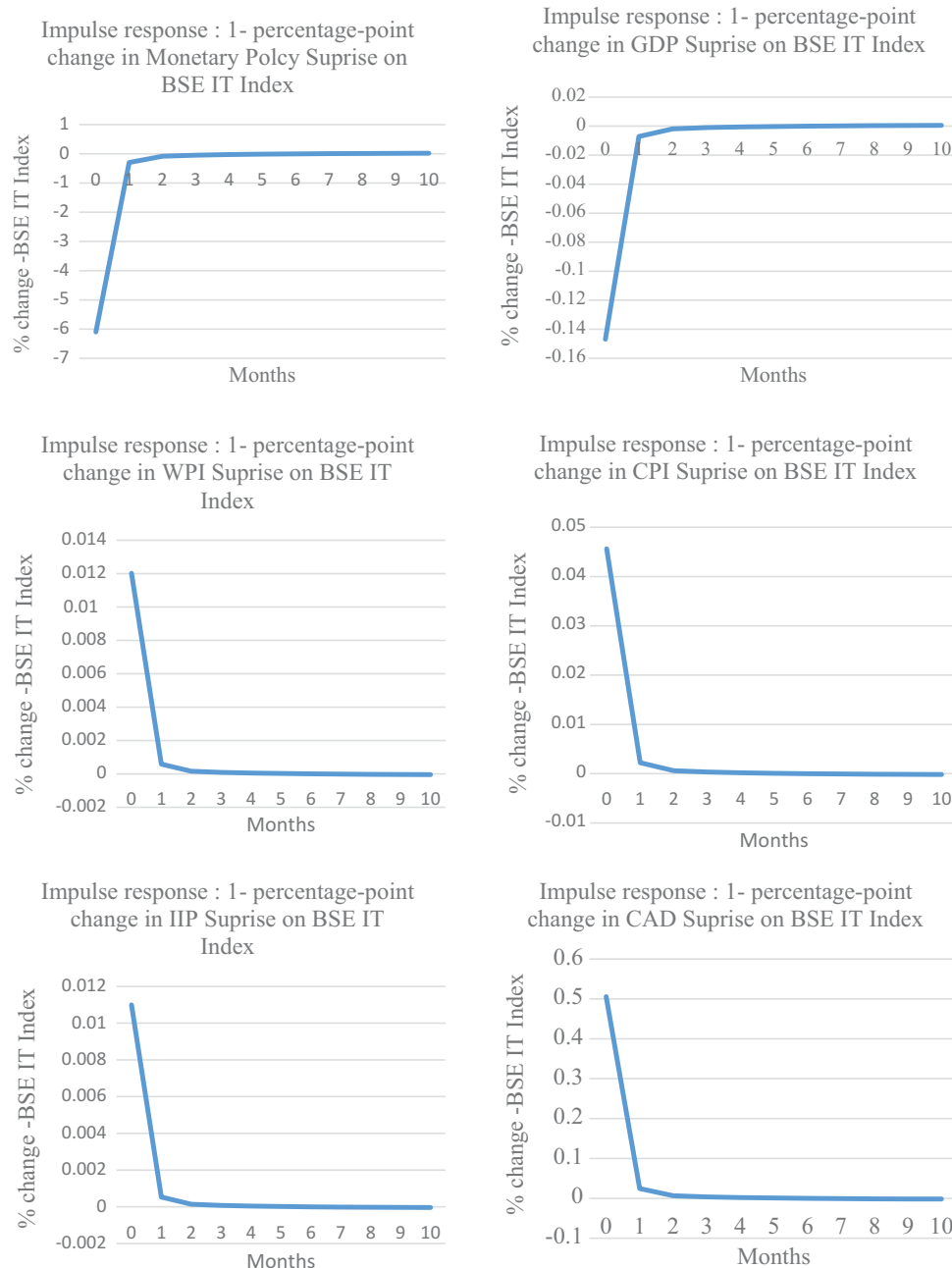


Figure 13. Impulse response of NIFTY 100 Small Caps to monetary policy and macroeconomic surprises with lag length 1.

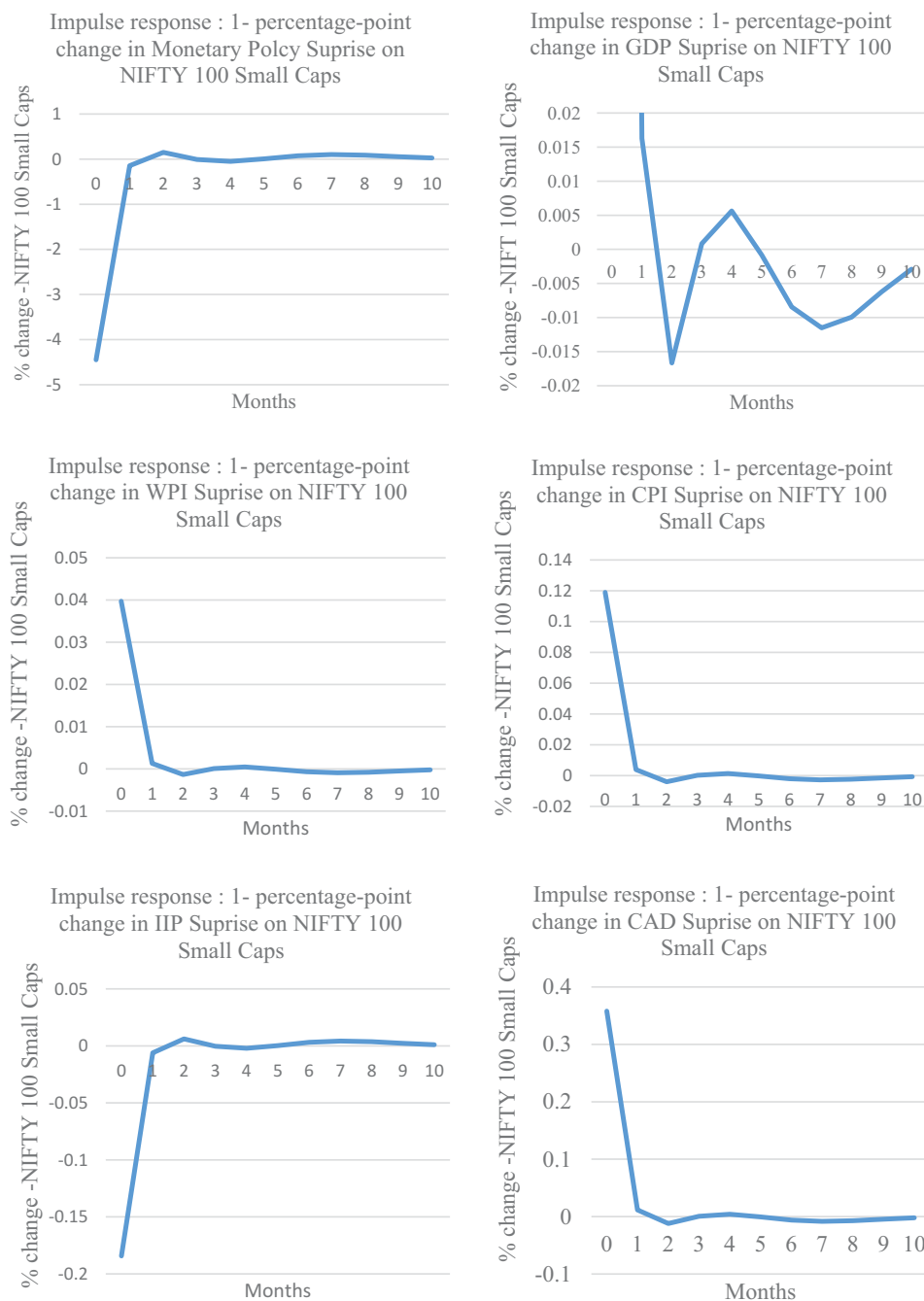


Figure 14. Impulse response of NIFTY 50 MidCap to monetary policy and macroeconomic surprises with lag length 1.

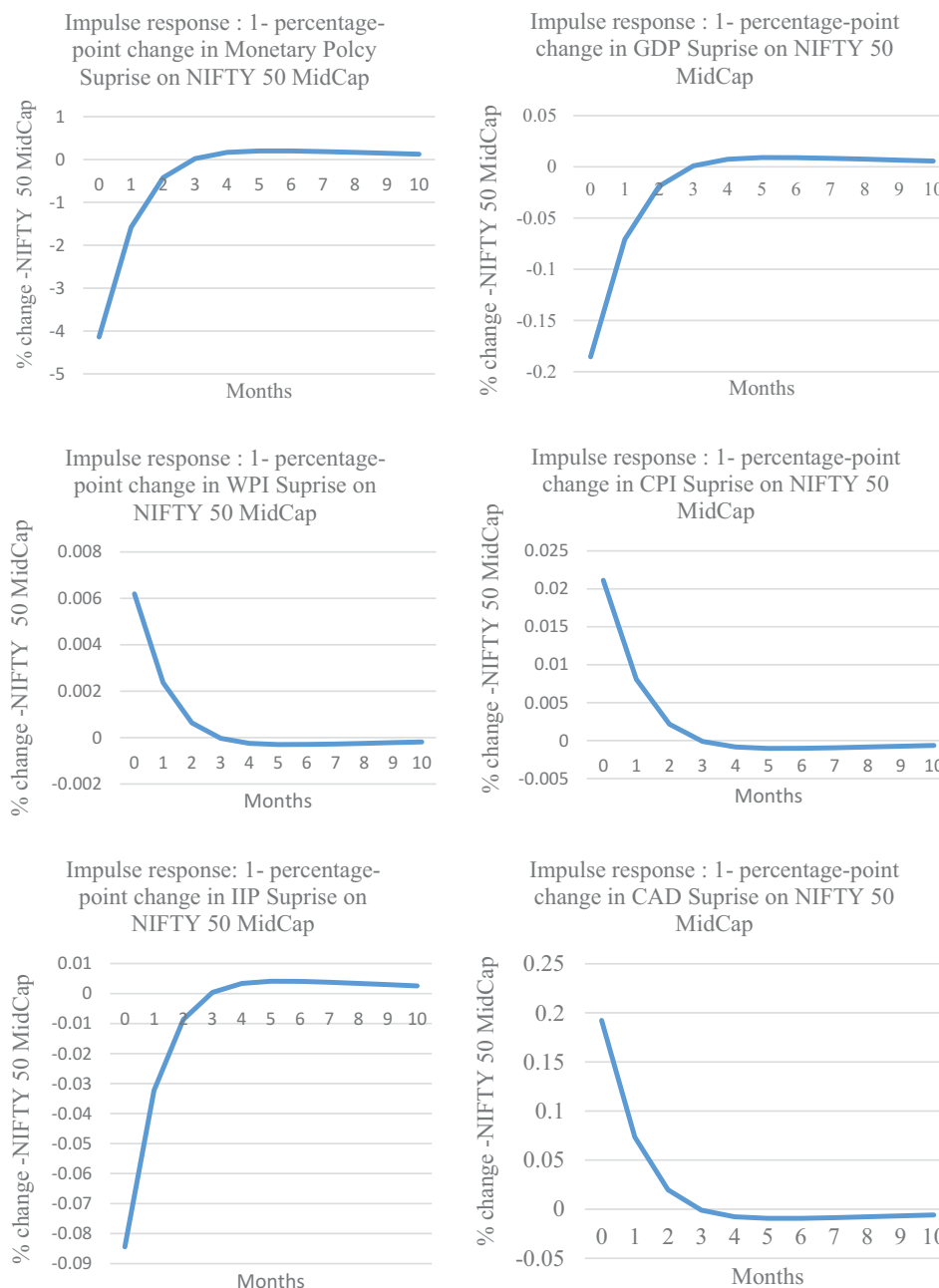
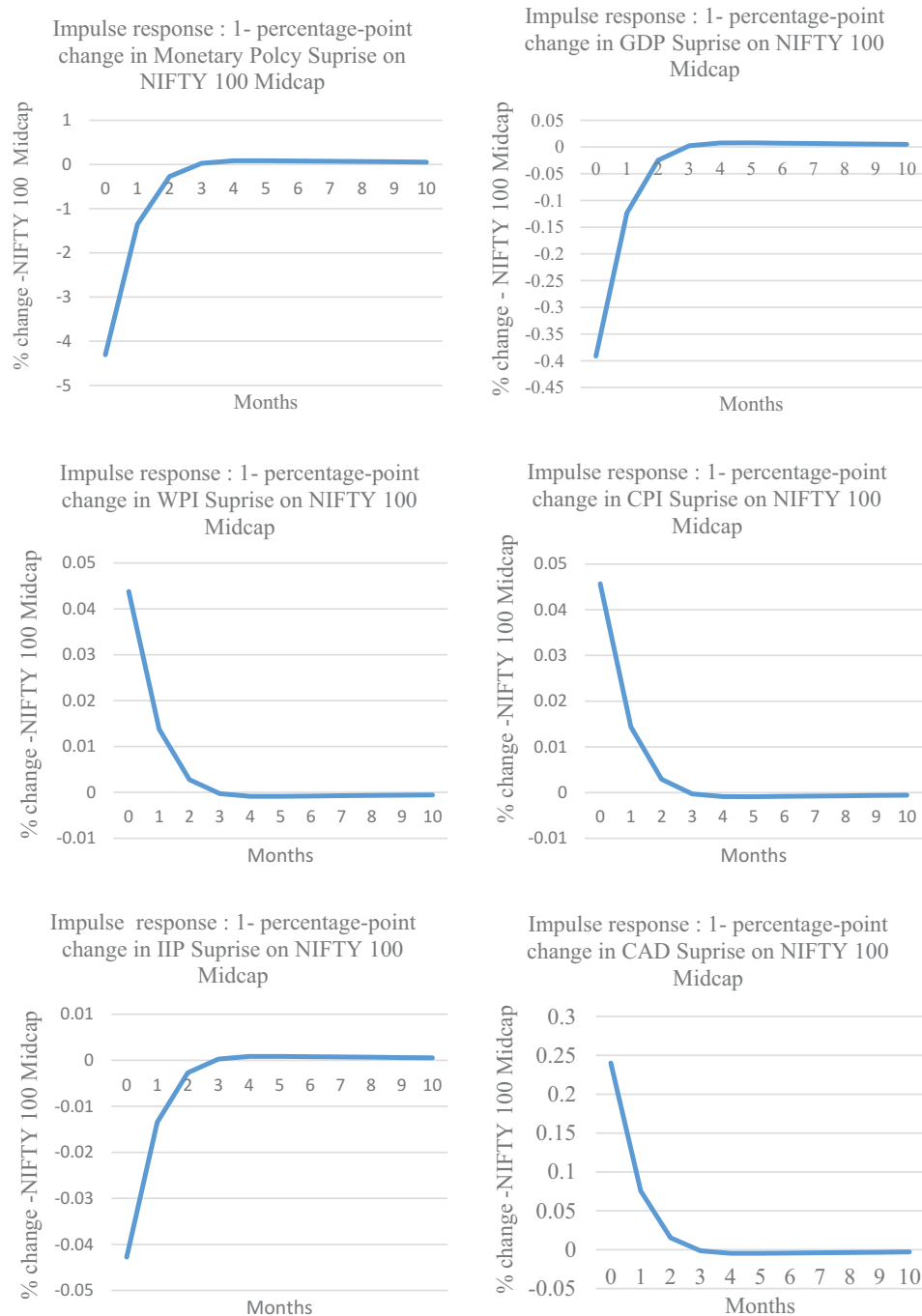


Figure 15. Impulse response of NIFTY 100 MidCap to monetary policy and macroeconomic surprises with lag length 1.



6. Conclusion

The aim of this paper is to examine two issues—first is the sensitivity of simultaneous impact of monetary and macroeconomic surprises in the Indian stock market, and second is the heterogeneity of stock responses, characterized by industry type and firm size, to monetary policy and macroeconomic surprises. Primarily, we conducted an event study that explores the instant effect of macroeconomic shocks on varied stock market indices. The result from the event study depicts that the monetary policy surprise considerably affects the stock market than that of other macroeconomic surprises. Theoretically, monetary policy surprises are negatively correlated to stock returns, and as per our expectation, it is observed that the coefficients of monetary policy are negative for all indices, and all the results are statistically significant as seen in our event study. We observed that the result is consistent with the results estimated for the US stocks by Bernanke and Kuttner (2005), Rigobon and Sack (2003), and Ehrmann and Fratzscher (2004). We further observed that the clear industry effect with respect to monetary policy surprise, i.e., the response of stock against monetary policy, varies with industries, which confirms the findings for the US stocks by Ehrmann and Fratzscher (2004) and Bernanke and Kuttner (2005). We also observed the firm's size effect against monetary policy surprise upon measuring stock market response through the indices and found that the response of stock market is maximum for large firms, which is followed by the medium-sized firm and the small firm. Our finding is directionally different from the findings of other studies by Thorbecke (1997), Kiyotaki and Moore (1997), and Perez-Quiros and Timmermann (2000). In those studies, it has been shown that the response of stock returns to monetary policy is larger for small firms. However, the focus of those studies is mainly on financial constraints, which becomes more relevant with the change in the credit market conditions, and the changed scenario is expected to persist in the short and medium term. Several studies have provided evidence about the lack of correlation between the firm size and the financial constraints, for example, Carlino and DeFina (1998), Mojon et al. (2002), and Arnold and Vrugt (2004). Moreover, upon using the different indices as the proxy for size, the industry effect might dominate the size effect.

In the VAR analysis, we examined the dynamic impact of the macroeconomic surprises on the stock market indices. Unlike the event study, which is only indicative of the fact that the monetary policy is the only surprise variable that significantly affects stock returns, the VAR analysis found the effect of the macroeconomic surprise variables on stock return, though the other macroeconomic surprises are accountable for a small portion of the total variability of the stock prices. The dynamic effect in the VAR analysis highlights that the impacts of surprise variables are primarily at the shorter horizons, instantly after the shock. Consistent with the result of the event study, the industry effect is also observed in VAR. The industry responses to macroeconomic surprises are generally coherent with the industry characteristics. We further observed the size effect in VAR analysis, as impulse responses of stock indices vary with firm size—largest for small firms, lowest for large firms, and for medium firms the responses are in-between. The direction of this size effect confirms the findings of Thorbecke (1997), Kiyotaki and Moore (1997), and Perez-Quiros and Timmermann (2000). Though both the event study and VAR analysis successfully conclude the heterogeneous response of stock indices against monetary policy and macroeconomic surprises, whether the response is dominated by industry effect or size effect depends on the composition of firms in the indices.

While there are limited studies in this area even in the developed economy, none of the studies have examined the simultaneous effect of both the monetary policy surprises and the wide range of macroeconomic surprises in the Indian context. Through the implementation of the measures of monetary policy as well as other multiple macroeconomic surprises, the paper separates the unanticipated elements of the monetary policy variable and other macroeconomic indicators. The understanding of this stock market dynamics can help market participants and policymakers to develop the right strategy to achieve their desired objectives.

In this study, we provided a few conjectures in relation to the interpreted results in the Indian context. During the study period, the uncertainty present in the Indian macroeconomic fundamentals was rather low because of the functioning of its well-regulated financial system. In this relatively stable macroenvironment, the surprises occurred was low. Further, the Indian stock market is well integrated with the active participation of FPIs and FIIs investment, and many of the stock market reactions may not be governed by domestic macroeconomic surprises, rather it depends on global developments. A firm-level analysis that includes a wider class of firms representing different sizes, different industries, and ownership can help to substantiate these interpretations. The exploration of stock market reaction on macroeconomic and monetary policy surprises along with these linkages can be considered for future research.

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Notes

1. Source: World Bank data resource.
2. Source: BSE and NSE data source.
3. Source: BSE and NSE data source.
4. Source: NSDL (National Securities Depository Ltd.) database.

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