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How Asymmetric is the Monetary Policy Transmission to Financial Markets in India?

Bhupal Singh*

The empirical estimates suggest that short end of the financial market, particularly the call money rate, exhibits a significant and contemporaneous (instantaneous) pass-through of 75 - 80 basis points in response to a percentage point change in the monetary policy rates under deficit liquidity conditions and phases of relatively tight monetary policy. The state of liquidity in financial markets is found to play an important role in conditioning the pass-through of policy rate changes to short end of financial market. A significant asymmetry is observed in the transmission of policy rate changes between the surplus and deficit liquidity conditions, particularly at the short end of financial market, suggesting that maintaining suitable liquidity environment is critical to yielding improved pass-through. There is also considerable asymmetry evident in the transmission of monetary policy to financial markets depending on the tight or easy cycles of monetary policy, which suggests the criticality of attaining a threshold level for the policy rate under each cycle to have desired pass-through. Medium to long term rates such as bank deposit and lending rates also exhibit asymmetrical response to policy rate changes under varied market conditions. The results from the VAR model reiterate that it is the strong presence of transmission lags that leads to higher degree of pass-through to financial markets, thus, underscoring the importance of a forward-looking approach.

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Introduction

Notwithstanding a rich theoretical foundation and large body of empirical literature on monetary policy transmission, policy makers continue to face considerable uncertainty about the impact of policy changes given the lack of direct interface of monetary policy actions with real economic activity, existence of complexities in financial

* Author is Executive Assistant to Deputy Governor and Director in the Department of Economic and Policy Research of the Reserve Bank of India, Mumbai. Views expressed in the paper are the sole responsibility of the author. The initial findings of the paper were presented in a seminar at the School of Communication and Management Studies at Cochin on October 21, 2011. The author was immensely benefitted from the comments offered by the participants and discussants at the Annual Research Conference of the Department of Economic and Policy Research of the Reserve Bank of India held at Mumbai on November 25, 2011. Author would also like to thank anonymous referees of the paper for providing technical comments which helped in further improving the paper. Author has also benefitted from technical comments offered by Dr. B. K. Bhoi, Adviser and Dr. Harendra Behera, Research Officer of the Monetary Policy Department of the Reserve Bank of India. Author's correspondence email is bhupal@rbi.org.in.

markets and presence of transmission lags. The presence of long transmission lags also make it challenging to disentangle the impact of monetary policy shocks from other exogenous shocks that may occur in the interregnum. This lack of certainty in actual magnitude and the timing of impact of policy changes on financial and real variables build in considerable caution in policy decisions. Bernanke and Gertler (1995), while raising the concern about the lack of understanding about the transmission mechanism observed that "the same research that has established that changes in monetary policy are eventually followed by changes in output is largely silent about what happens in the interim. To a great extent, empirical analysis of the effects of monetary policy has treated the monetary transmission mechanism itself as a 'black box'." Although this may not be true for many advanced economies where there are less imperfections in asset, labour and goods markets, many developing economies have not yet achieved the same degree of flexibility in such markets, and continue to face challenges in the assessment of monetary policy transmission. Given the considerable rigidities in goods and labour market in most developing economies and resultant complexities in the transmission mechanism, the motivation of this paper is to refrain from investigating the direct causation between the monetary policy shocks and macroeconomic aggregates, rather focus on clearer understanding of propagation of changes in monetary policy to various segments of financial markets.

Monetary policy affects output and prices through its influence on key financial variables such as interest rates, exchange rates, asset prices, credit and monetary aggregates, which is described as monetary transmission mechanism. The complete transmission mechanism of monetary policy to real variables could be understood as a two stage process. In the first stage of transmission, policy actions of central bank both current and expected, transmit through the money market to bond, credit and asset markets, which directly influence the savings, investment and consumption decisions of individuals and firms. This operates through the term structure of interest rates in financial markets; changes in short term rates affect the expectation of the future interest rates and thus, affect the long end of yield curve, which raises the marginal cost of funding long term assets. The second stage of monetary transmission involves propagation of monetary policy shocks from financial markets to goods and labour markets, which are ultimately reflected in aggregate output and prices[1]. Thus, clarity about the first stage of monetary transmission is vital to understanding the transmission to aggregate output and prices. This is vital in the direction of understanding the market behaviour and bringing about more clarity of the transmission channels. Needless to say that given the great deal of uncertainties surrounding the impact of monetary policy actions on real variables typically in economies where financial market imperfections are prevalent, we consciously resist the temptation of examining the second stage of transmission. The key question that we attempt to examine in this paper is the existence of asymmetries in the transmission of monetary policy rate changes to financial market prices. More precisely, adopting an agnostic approach, we examine how the same magnitude of policy rate change causes varied impact on financial asset prices during different phases of policy cycle, varied liquidity conditions and across the spectrum of maturity. Section II sets out a brief theoretical context to understanding the propagation of monetary shocks to financial markets. We postulate a model explaining asymmetries in response of financial markets to monetary policy shocks in section III. Empirical results on assessment of degree of asymmetries in the response of financial markets to policy shocks are presented in section IV and conclusion in section V.

Section II
Theory

Monetary policy actions are transmitted to the rest of the economy through changes in: (i) financial prices, mainly interest rates, exchange rates, bond yields, asset prices; and (ii) financial quantities primarily money supply, credit aggregates, supply of government bonds, foreign currency denominated assets. Policy changes work through financial markets, which act as interface between monetary policy and real economy and are considered to be the purveyors of monetary policy

1 Mainstream thinking on monetary policy transmission can be gauged from the work of Bernanke and Blinder (1992), Christiano *et al*. (1996), Kuttner and Mosser (2002), Loayza and Schmidt-Hebbel (2002) and Sims (1992).

shocks to real economy. Since monetary policy works through financial markets (by changing interest rates or quantity of money or liquidity), transmission is also contingent on the stage of development of domestic financial markets as also on the inter-linkages between financial markets, the degree of financial integration and inter-sectoral linkages between financial sector and real economy. Second, transmission to financial markets may also be affected by the degree of administrative interventions in determination of financial asset prices. Third, horizontal domestic integration and vertical integration with global market may also significantly affect the speed and efficiency of transmission. Fourth, exchange rate regimes may also have significant influence in determining the pass-through of external shocks on domestic assets and goods prices and may complicate the process of transmission. Further, in real world, trade-off between short run liquidity management and medium term price stability concerns may turn the policy communication challenging and in such situations managing expectations to guide the long run interest rates may turn complicated.

The effectiveness of monetary policy signals depends upon the speed with which policy rates are transmitted to financial markets. The speed and size of pass-through to financial asset prices depends on a number of factors such as volatility in money markets, the extent to which the policy changes are anticipated and maturity structure of banks' balance sheets. In some market segments, presence of structural rigidities in terms of imperfect competition, low integration with other market segments, regulatory norms and high cost of operations may impart inflexibility to market interest rates to respond contemporaneously to policy rate changes. Furthermore, differences in agents' expectations about short and long end of market may be a source of existence of lag in the transmission of policy rates. Understanding the behaviour and complexity of financial markets, thus, assumes critical importance in understanding the standard monetary policy transmission channels.

Section III
Model and Data

The following model is postulated to estimate the aggregate impact of monetary policy shocks on various segments of financial markets.

$$rt = \alpha + \sum \gamma i\ rp(t\text{-}i) + et \qquad where\ i = 1,....,\ n \qquad (1)$$

where, r = financial market interest rate, rp = policy rate, γ = parameter of lagged policy rate and i = lags.

Impact of changes in policy rates to a large extent can be conditioned by liquidity conditions in financial markets. The best measure of liquidity conditions can be central bank liquidity. Imposing liquidity constraint on equation (1) can yield different magnitude of pass-through of monetary policy rates. Thus, pass-through of policy rates to money markets with a liquidity constraint can be posited as:

$$rt = \alpha + \theta rpt + \lambda Lqt + et \qquad (2)$$

where, λ is the impact of change in liquidity (Lq) on market interest rate.

The net impact of a unit change in policy rate on money markets can be derived as

$$\frac{drt}{drpt} = \theta \ and\ \frac{drt}{dLqt} = \lambda \qquad (3)$$

where $\theta > 0\ and\ \lambda < 0$

Surplus liquidity conditions in domestic money markets would be ultimately reflected in the liquidity adjustment facility balances of commercial banks with the central bank[2]. Monetary transmission is argued to be substantially more effective in a deficit liquidity situation than in a surplus liquidity situation (RBI, 2011). It may, however, be of interest to understand how transmission of policy rates may differ under the surplus and deficit liquidity conditions. Transmission under surplus liquidity condition can be conceptualised in the manner that a change in the policy rate causes the following changes in market interest rates:

2 The LAF framework was such that the operating policy rate alternated between the repo rate and the reverse repo rate, depending on the prevailing liquidity condition. In a surplus liquidity condition, the reverse repo rate becomes the operating policy rate and in a deficit liquidity situation, the repo rate. Based on the recommendations of the Working Group to Review the Operating Procedure of Monetary Policy in India (Chairman: Shri Deepak Mohanty), the Reserve Bank in May 2011 decided to have only one independently varying policy rate, *i.e.*, the repo rate. The transition to a single policy rate is expected to more accurately signal the monetary policy stance. The reverse repo rate is pegged at a fixed 100 basis points below the repo rate.

$$\frac{drt}{drpt} = \gamma 1 * \delta \qquad (4)$$

and under the liquidity deficit situation:

$$\frac{drt}{drpt} = \gamma 1 * \theta \qquad (5)$$

where, γ1 is the impact of a unit change in policy rates on short term market interest rates in the absence of either significant liquidity deficit or surplus. In a situation of surplus liquidity (surplus above a certain threshold), a unit change in policy interest rate, *ceteris paribus*, would lead to δγ1 change in market interest rates given that δ<1. Extending the argument further, the opposite should hold in a situation when the banking system is in liquidity deficit. The transmission in a deficit liquidity situation (beyond a threshold) can be represented as $\phi\gamma 1$, where $\phi > 1$. Thus, differential impact of the liquidity surplus or deficit on transmission can be illustrated as:

$\delta\gamma 1 < \gamma 1 < \phi\gamma 1$

In a significant liquidity surplus situation with δ<1, the boundary case could be that an increase in policy rates may have negligible impact on short term target rates of the central bank. The magnitude of ϕ would also depend on the extent of deficit liquidity in the system. A deficit above the threshold would yield a higher ϕ.

We also attempt to estimate responses of various financial asset prices to policy shocks in a dynamic framework using a vector autoregression (VAR) model.[3] The objective of using a VAR model is to understand the dominance of liquidity *vis-a-vis* policy rate shock and the persistence of a shock across various market segments. A (reduced) p-th order VAR, denoted by VAR(p), is

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + e_t$$

where c is a k × 1 vector of constants, A_i is a k × k matrix (for every i = 1, ..., p) and e_t is a k × 1 vector of error terms satisfying: E $(e_t) = 0$, *i.e.*, every error term has mean zero; $E(e_t e_t') = \Omega$, *i.e.*, the contemporaneous covariance matrix of error terms is Ω (a k × k positive-definite matrix); E $(e_t e_{t-k}') = 0$ for any non-zero k, *i.e.*, there is no correlation across time, in particular, no serial correlation in individual error terms. The impulse

3 Most empirical studies use vector autoregression (VAR) models to examine the transmission mechanism of monetary policy

response generated from the model would help in understanding the nature of response of financial markets to policy shocks.

For empirical assessment of policy transmission, we use the following variables to estimating the series of models[4]: (i) Reserve Bank's repo rate (rRPO), (ii) weighted average call money rates (rCall), (iii) weighted average CBLO rates (rCBLO), (iv) weighted average market repo rates (rMRPO), (v) weighted average rates on commercial papers (rCP), (vi) weighted average rates on certificates of deposit (rCD), (vii) yield on 91-day treasury bills (rTB91), (viii) average interest rate on 1-month Mumbai Interbank Offer Rate (rMBR1m)[5], (ix) average interest rate on 1-year overnight index swaps (rOIS1y), (x) average secondary market yield on government of India 10-year bonds (r10y), (xi) average yield on AAA-rated 5-year corporate bonds (rCorp), (xii) average interest rates on 1-3 year deposit rates of commercial banks (rD3y), (xiii) average interest rates on lending rates of commercial banks (rLend)[6], (xiv) wholesale price index seasonally adjusted (Lwpi), (xv) banks' outstanding liquidity balances under the liquidity adjustment facility (LAF), (xvi) rupee-dollar exchange rate (EXR), (xvii) Bombay Stock Exchange Sensex (BSE). The data are sourced from Reserve Bank of India, Clearing Corporation of India Limited, International Finance Statistics, IMF, Thomson Reuters Eikon, Thomson Reuters Datastream and the Bloomberg. The sample period for the study is 2001:M3 to 2012:M6, however, a few variables have data beginning later than 2001:M3. The rationale for choosing monthly frequency of data for the analysis is guided by the fact that not all data used in the estimates are available at less than monthly frequency. The specific methodological issues involved in the empirical exercise are contained in Annex A.

Section IV
Empirical Results

Before embarking on empirical analysis of the transmission mechanism, it would be pertinent to understand the degree of integration

4 We have selected most representative benchmarks from each of the market segments.

5 MIBOR represents the interbank rate at which funds are available to the borrowing banks in the call money market. MIBOR is mostly active only in the overnight segment as the term money market in India is not developed.

6 The average lending rate series has been expanded for the recent period by including the base rates of banks. In the bank lending rate equation, we use suitable dummies to capture the shift in the process of determination of banks' lending rates.

Table 1: Correlation Matrix (Sample: 2001:M3 to 2012:M6)

	rCorp	rLend	dLwpi	EXR	LAF	rMBR1m	rOIS1y	r10y	rCall	rCBLO	rCD	rCP	rMRPO	rRPO	rTB91	rD3y
rCorp	1.00	0.36	0.48	-0.03	-0.42	0.75	0.62	0.36	0.57	0.49	0.81	0.75	0.52	0.72	0.68	0.86
rLend	0.36	1.00	-0.29	-0.33	0.42	0.04	-0.03	-0.25	0.00	-0.15	0.13	0.11	-0.10	0.38	-0.02	0.25
dLwpi	0.48	-0.29	1.00	0.04	-0.59	0.51	0.55	0.55	0.46	0.52	0.49	0.46	0.52	0.41	0.54	0.34
EXR	-0.03	-0.33	0.04	1.00	-0.17	0.04	-0.23	-0.12	0.05	0.10	-0.05	0.00	0.09	-0.15	-0.07	0.10
LAF	-0.42	0.42	-0.59	-0.17	1.00	-0.79	-0.69	-0.54	-0.69	-0.77	-0.72	-0.70	-0.77	-0.66	-0.81	-0.46
rMBR1m	0.75	0.04	0.51	0.04	-0.79	1.00	0.80	0.45	0.87	0.84	0.94	0.90	0.86	0.89	0.94	0.73
rOIS1y	0.62	-0.03	0.55	-0.23	-0.69	0.80	1.00	0.79	0.74	0.76	0.80	0.63	0.76	0.87	0.90	0.50
r10y	0.36	-0.25	0.55	-0.12	-0.54	0.45	0.79	1.00	0.45	0.52	0.48	0.30	0.50	0.55	0.62	0.28
rCall	0.57	0.00	0.46	0.05	-0.69	0.87	0.74	0.45	1.00	0.92	0.78	0.77	0.95	0.79	0.85	0.50
rCBLO	0.49	-0.15	0.52	0.10	-0.77	0.84	0.76	0.52	0.92	1.00	0.73	0.72	1.00	0.79	0.89	0.46
rCD	0.81	0.13	0.49	-0.05	-0.72	0.94	0.80	0.48	0.78	0.73	1.00	0.87	0.76	0.86	0.90	0.81
rCP	0.75	0.11	0.46	0.00	-0.70	0.90	0.63	0.30	0.77	0.72	0.87	1.00	0.76	0.76	0.81	0.75
rMRPO	0.52	-0.10	0.52	0.09	-0.77	0.86	0.76	0.50	0.95	1.00	0.76	0.76	1.00	0.81	0.90	0.49
rRPO	0.72	0.23	0.41	-0.15	-0.66	0.89	0.87	0.55	0.79	0.79	0.86	0.76	0.81	1.00	0.94	0.64
rTB91	0.68	-0.02	0.54	-0.07	-0.81	0.94	0.90	0.62	0.85	0.89	0.90	0.81	0.90	0.94	1.00	0.63
rD3y	0.86	0.25	0.34	0.10	-0.46	0.73	0.50	0.28	0.50	0.46	0.81	0.75	0.49	0.64	0.63	1.00

rCorp = yield on AAA-rated corporate bonds, rLend= average lending rates of commercial banks, dLwpi = inflation rate, EXR= rupee-USD exchange rate, LAF = outstanding liquidity under the liquidity adjustment facility, rMBR1m = 1-month MIBOR rate, rOIS1y = 1-year OIS yield, r10y= yield on 10-year govt. bond, rCall = weighted average call money rates, rCBLO = weighted average collateralised borrowing and lending rates, rCD = weighted average rate on certificates of deposits, rCP = weighted average rate on commercial papers, rMRPO = average interest rate on market repo transactions, rRPO = repo rate of the Reserve Bank, rTB91 = yield on 91-day treasury bills, rD3y = average interest rate on bank deposits of 1-3 year maturity.

Note: Some of the data series start later than 2001:M3.

of prices of various financial assets. A simple correlation analysis of the spectrum of interest rates in India presented in Table 1 exhibits a reasonably high degree of market integration. Broadly, the short end of the financial markets has higher degree of correlation with policy rates as well as with liquidity conditions in financial markets. Nevertheless, the long end of the market such as bank lending rates and interest rates on corporate bonds is also found to be correlated with the policy rate. Thus, Table 1 provides the starting point for further exploring the impact of policy rate changes on financial markets.

We estimate the pass-through of policy interest rates to financial asset prices in the framework of a distributed lag model as monetary policy may impact different segments of financial markets with varying lags[7]. Furthermore, from a policy perspective, it is important to assess the impact of policy changes in a forward looking manner. In other words, a realistic assessment of the impact of policy changes has to take into account (a) lags involved in the transmission, and (b) differences in the contemporaneous and the lagged impact of policy changes on market interest rates.[8]

(i) Monetary transmission to the short and long end of financial markets : A baseline case

Due to the presence of unit roots in the variables, differenced terms were used for estimation (See Annex Table 1). Only the significant lags were retained in the model. We use dummy variables in the models to control for the effects of extreme events in financial markets generated by unanticipated exogenous shocks and which cannot be explained by other variables.[9] All the models are tested for residual diagnostic tests by

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7 We face constraints in empirically replicating the theoretical model postulated in section III due to practical difficulties in transforming liquidity balances into log levels due to the presence of negative numbers.

8 The framework used in this section to assess the impact of monetary policy shocks seems to be akin to a closed economy model as external shocks, particularly fluctuations in capital flows, are not taken into account. We would, however, like to emphasise that domestic liquidity effects of capital flows are indirectly reflected in liquidity deficits or surpluses under the LAF for banks.

9 Controlling for such extreme events is vital to deriving unbiased estimates of the impact of policy rates changes on financial asset prices.

using Breusch-Godfrey Serial Correlation LM Test.[10] All the specified models are found to be free from serial autocorrelation problem. We begin with estimating models for assessing the impact of policy rate changes (repo rate) on financial markets without differentiating either between liquidity deficit and surplus conditions or tight and easy monetary policy phases (see Chart 1 and 2 and Annex Table 2 and 3).[11] Thus, the analysis below does not attempt to capture the impact of policy rate changes under different market conditions.

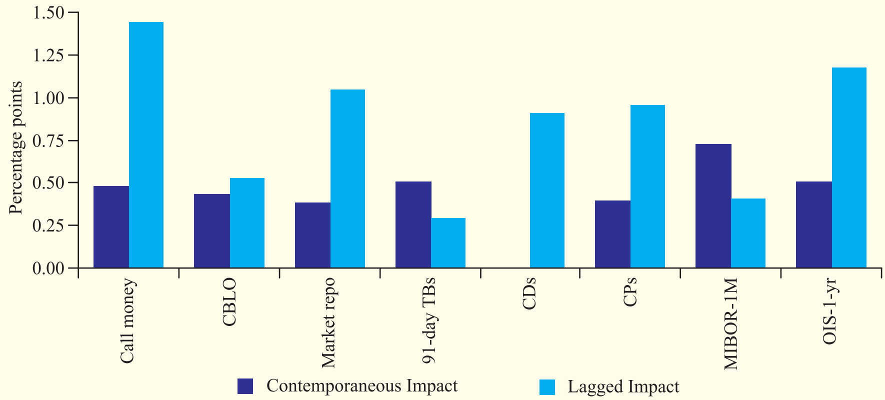
First, as expected, the transmission of policy rates is instantaneous and large for money market as compared with the longer end of financial market.[12] Transmission to financial markets improves significantly as the lagged impact of policy rate changes takes effect. Second, call money market seems to be highly sensitive to the policy rate changes and displays substantial pass-through with lag effects in response to policy rate shocks. Third, policy rate changes are likely to impact the working capital cost of the corporates significantly as a policy rate shock tends to cause considerable increase (decrease) in the interest rates on commercial papers. As the funding cost of banks in the overnight market increases significantly, banks may pass it on by raising short term lending rates for corporates. Fourth, expectations seem to play an important role in explaining the market behaviour in response to policy rate shocks, as an initial shock could be construed by the market as continuation of policy rate cycle of the central bank. This is reflected in relatively strong response of 1-month MIBOR and 1-year OIS markets to policy rate shocks. The assessment of the transmission process towards the short end of financial markets suggests that between 40 to 75 basis points pass-through of a percentage point change in policy rates is realised in the same month, indicating a high degree of instantaneous pass-through (Chart 1). This can be attributed to a reasonable degree of integration of money markets observed in India (see Bhoi and

10 The tests do not reject the null hypothesis of no serial correlation. We also use Newey-West HAC Standard Error criteria for heteroskedasticity robust standard error adjustment.

11 While changes in policy rate transmit to market interest rates including lending rates, monetary impact of changes in reserve requirements through cost of funds has separate transmission to bank lending rate. However, the major part of the changes in CRR is captured through liquidity changes, which is attempted in the subsequent analysis.

12 It is sometimes argued that short term money market rates typically factor in the expected changes in policy rates before the monetary policy announcements. Some segments of money market react to the buildup of expectations of policy rate changes a few days before the policy announcement. The impact of such expectations in an analysis of pass-through based on monthly average interest rates would be, however, captured contemporaneously.

Chart 1: Transmission of policy rate changes to the short end of financial markets

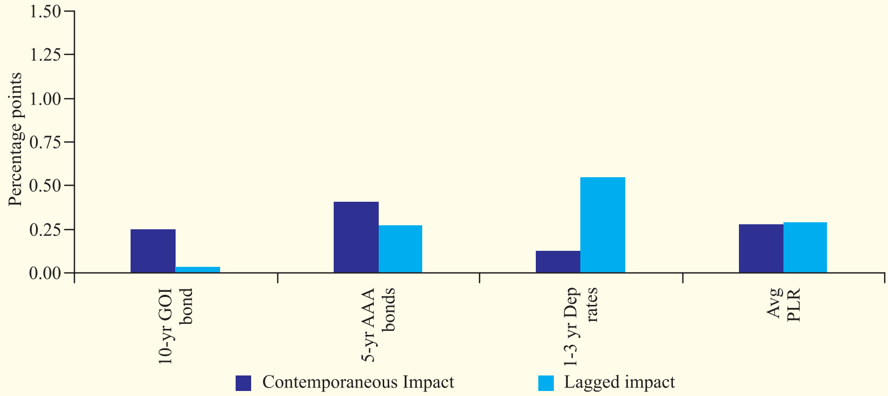


Dhal, 1998). The existence of the lag effects of policy rate changes is considerable across market segments.

Central banks often find it challenging to guide long-term interest rates, which basically directly impact the saving and investment decisions of economic agents and hence impact the macroeconomic aggregates such as output and prices. Therefore, for transmission to be effective, the short term interest rates should be significantly transmitted to long term interest rates. In theory, short end (money markets) and long end (capital markets) of financial markets are connected through expectations.13 Thus, transmission of changes in policy rates to long end of financial markets assumes critical importance. Empirical estimates suggest that bank deposit and lending rates exhibit longer lags in transmission (Chart 2 and Annex Table 3). The transmission of policy rates to deposit rates increases overtime. The presence of long lags may emanate from the fact that banks seem to be cautious about adjusting deposit rates in response to the central bank's policy rate signals due to a variety of reasons such as expectation formations regarding the likely path of future interest rates and the fear of losing their deposit base to small savings and other competing investment avenues. Regarding the long lags in lending rates, it could be possible that banks are unable to adjust their lending rates swiftly in response to policy signals until they

13 According to the expectations hypothesis of term structure, long term interest rates are an average of expected short term interest rates. The link between short and long term rates may, however, weaken due to a number of factors such as future uncertainty about the interest rate environment, time varying risk premia and structural changes in the financial market and the real economy.

Chart 2: Transmission of policy rate changes to the long end of financial markets



are able to adjust on the cost side by repricing the fixed-rate deposits in the next cycle. It is also possible that longer lags in deposit rates feed into lending rates adjustments. Besides these, adjustment cost of frequent revisions in lending rates and borrowers' aversion to recurrent fluctuations in cash flows may also be constraints on banks in adjusting lending rates frequently in response to changes in policy rates. Thus, due to the aforementioned structural rigidities in the deposit and credit markets, contemporaneous pass-through of policy rates to these segments seems to be low. Nevertheless, the lagged transmission of policy rate changes to deposit and lending rates seems to be reasonably significant, which has important implications for savings and investment activities.

Pass-through of policy rate changes to long term government bonds yield (*r10y*) though relatively low, is reasonably instantaneous. The corporate bonds yields (*rCorp*) show relatively faster contemporaneous transmission of policy rates changes as compared with bank lending rates due to differences in the structure of these two markets. This could also be attributed to the fact that capital markets price in market developments at a faster rate as compared with credit markets.

(ii) Does the monetary policy transmission improve during deficit liquidity conditions?

Central banks typically operate at the short end of financial markets by modulating liquidity (mainly overnight liquidity). It is argued that monetary transmission is substantially more effective in a deficit liquidity situation than in a surplus liquidity situation (RBI, 2011). We empirically test the hypothesis whether transmission is significantly different during the deficit liquidity from that of the surplus liquidity conditions. As liquidity position is either in surplus or deficit mode, represented in positive and negative values, normalising such series to log poses challenge. In order to empirically test the model $rt = \alpha + (\gamma 1 * \phi)\, rpt + et$ postulated for the liquidity deficit situation, we capture liquidity deficit impact through a dummy variable (*DLDef*) which assumes a value 1 for liquidity deficit conditions and 0 otherwise.[14] The empirical estimates from a standard distributed lag model for call money market based on the sample period 2001:M3 to 2012:M6 are presented in Table 2.

The estimates suggest that liquidity deficit has an important role in causing changes in money market rates. Thus γ1 assumes a value of 1.84 and ϕ a value of 0.82, indicating that liquidity has important role in propagating monetary policy transmission. It is evident from Table 2 that after controlling for liquidity deficit, the contemporaneous term turns insignificant and hence dropped from the model. This also seems to suggest that when there is absence of liquidity stress, overnight market rate responds gradually to policy rate changes. The limitation of this model is that deficit or surplus values of varying magnitudes which have significantly differential impact on market interest rates, are assumed to be the same.[15] In order to overcome this limitation, we split the sample into periods of surplus and deficit liquidity. Based on some broad empirical observation of sample, we treat LAF deficit as conditions of liquidity stress. The empirical estimates suggest significant asymmetric behaviour of call rates, commercial paper yield and short term treasury bill yield to changes in policy rates during the deficit liquidity conditions *vis-a-vis* surplus liquidity conditions (Chart

14 We use net LAF as a measure of overall liquidity deficit/surplus conditions in each of the money markets. Under the LAF window, banks can borrow or place funds with the central bank. Banks are players in all market segments, be it call money, market repo or CBLO. Their liquidity needs thus influence prices in each of the money market segments. This is also evident in the degree of correlation between LAF liquidity with interest rates in call money, market repo and CBLO ranging between 0.68-0.72. Call money is an interbank market. In CBLO segment, while banks are borrowers, Mutual Funds (MFs) are mainly the lenders. In market repo, while borrowings are mainly by banks and Primary Dealers, lenders are banks and MFs. Thus, it is the overall liquidity conditions prevailing in money markets on a particular day that affect the pricing in each of the segments.

15 If one uses dummy variable for periods of deficit/surplus liquidity under the LAF, the caveat is that it does not distinguish between the levels of liquidity, which could significantly alter the estimates of transmission to financial asset prices.

Table 2: Transmission of policy rate changes to short term interest rates after controlling for liquidity conditions (Dependent variable: call money rates)

Variable	Coefficient	t-Statistic
C	5.55	7.62
drRPO(-1)	0.61***	2.99
drRPO(-2)	0.70**	2.06
drRPO(-3)	0.53**	2.17
DLDef	0.96***	7.07
DLDef*drRPO	0.82***	5.41
DUM2007M3	6.17***	32.32
DUM2007M6M7	-5.04***	-19.78
DUM2008M9	0.99***	3.82
AR(1)	0.93***	23.18
R^2	0.94	
DW stats	1.95	
LM test stats	0.04(F-stats)	0.96(prob)

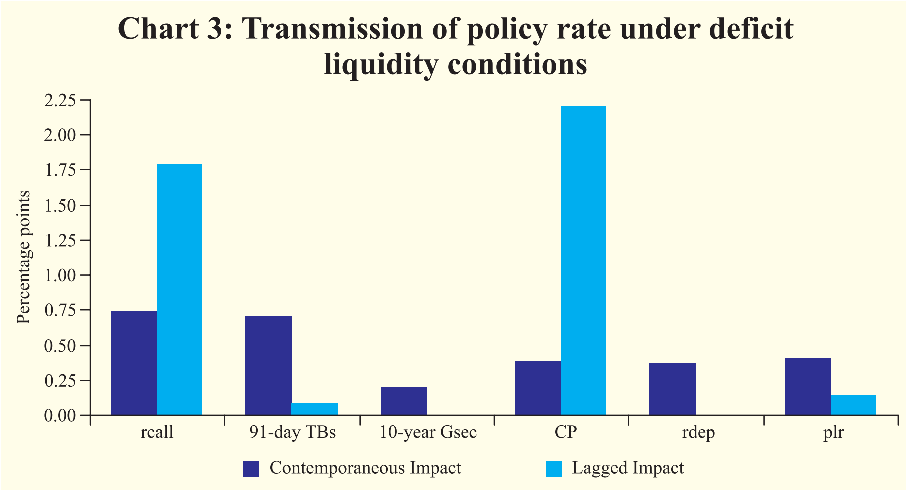
drRPO = changes in policy rates, DLDef = dummy variable representing periods of liquidity deficit conditions, DLDef*drRPO = interaction dummy variable to capture liquidity deficit impact, DUM2007M3, DUM2007M6M7, DUM2008M9 = dummy variables for extreme market volatility during particular months that are not explained by other variables.

3 and 4)[16]. The instantaneous pass-through of policy rate changes to call money rate during deficit liquidity conditions is nearly 75 basis points in response to a percentage point change in policy rate. More importantly, the lag impact is relatively much strong during the deficit than the surplus conditions, suggesting that one should take into account the persistence in the impact of policy rate change rather merely looking at the instantaneous change in order to assess the impact on financial assets and hence macro aggregates.

A distinct empirical observation is that transmission of policy rates is higher for bank deposit rates during liquidity surplus conditions. This could be a reflection of banks' behaviour of passing on to depositors the reductions in interest rates faster than the increases.[17] Overall, the

16 In empirical estimation, we used the approach of step-wise regression, *i.e.,* dropping the lags which turned out to be insignificant.

17 This is a preliminary observation which may require further empirical scrutiny.



persistence of shocks seems to be higher during the deficit liquidity conditions than during surplus conditions (see Annex Table 4 and 5 for detailed results).

(iii) How asymmetric is the transmission during tight and easy phases of monetary policy?

The transmission of policy rates to financial markets is also affected by the state of the monetary policy cycle. We believe that there exists a threshold level of policy rate that has significant bearing on prices of financial assets. For the purpose of empirical analysis, we assume that all (nominal) policy rate changes above 7 per cent, which is a long period

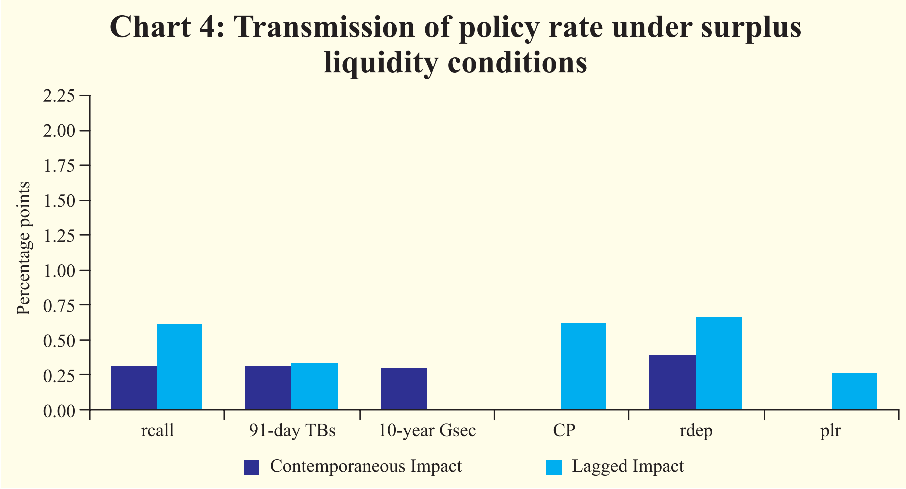
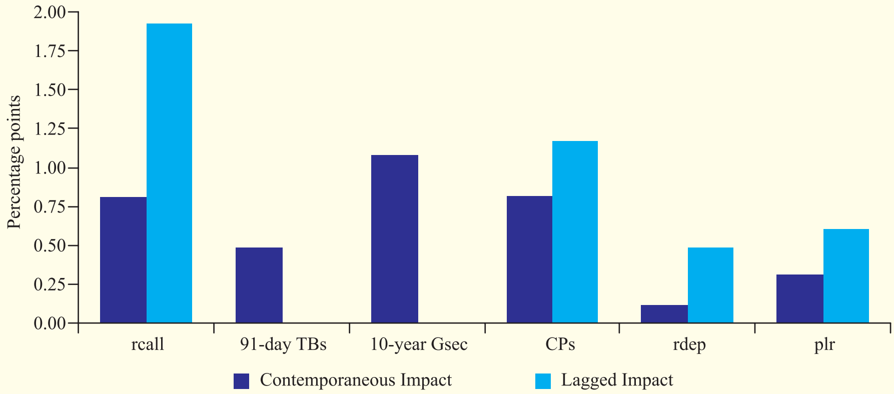
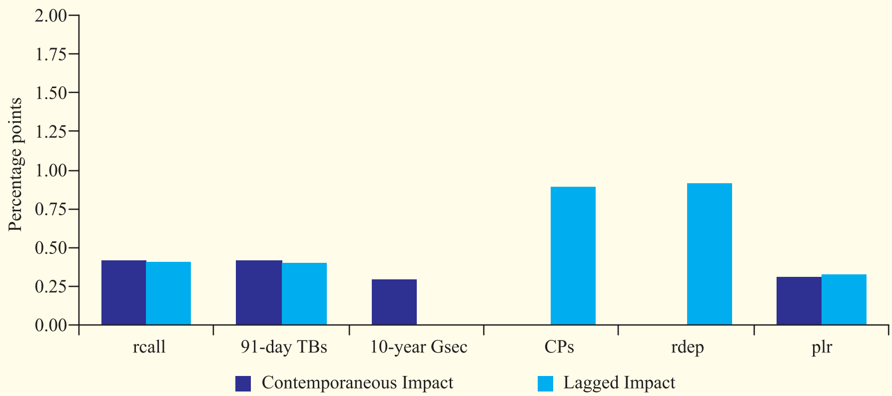


Chart 5: Transmission of policy rate under the tight cycle of monetary policy



average of policy rates during all cycles, imply that monetary policy is operating in a tight phase.[18] Thus, it is assumed that all policy rate changes above a threshold rate would have relatively strong impact on financial asset prices than the policy rate changes below this threshold. Charts 5 and 6 reveal that policy rate changes have a significantly higher impact during tight phase of monetary policy for call money, commercial papers and bank lending rates (detailed results in Annex Table 6 and 7). The instantaneous pass-through of a percentage point increase in policy rate to call money rates is 81 basis points during

Chart 6: Transmission of policy rate under the easy cycle of monetary policy



18 Some studies in the Indian context have found about 7 per cent as neutral policy rate (Singh, 2010).

tight monetary policy phase as compared with merely 41 basis points during the easy monetary policy. Further, the results indicate presence of procyclicality in the behaviour of interest rates facing the corporate sector as transmission is more pronounced during the tight phase of the policy cycle. Thus, achieving a threshold level of interest rate is critical to have desired impact of policy rate changes on financial markets and the real economy. However, there does not seem to be evidence of noticeable differences in the instantaneous transmission of policy rates to short term treasury yield. It is also observed from Charts 5 and 6 that transmission of policy rate is significantly higher during the tight phases of monetary policy due to presence of strong transmission lags. A reverse asymmetry is found with respect to bank deposit rates, which could be attributed to bank's behaviour of passing on decreases in interest rates faster than the increases.

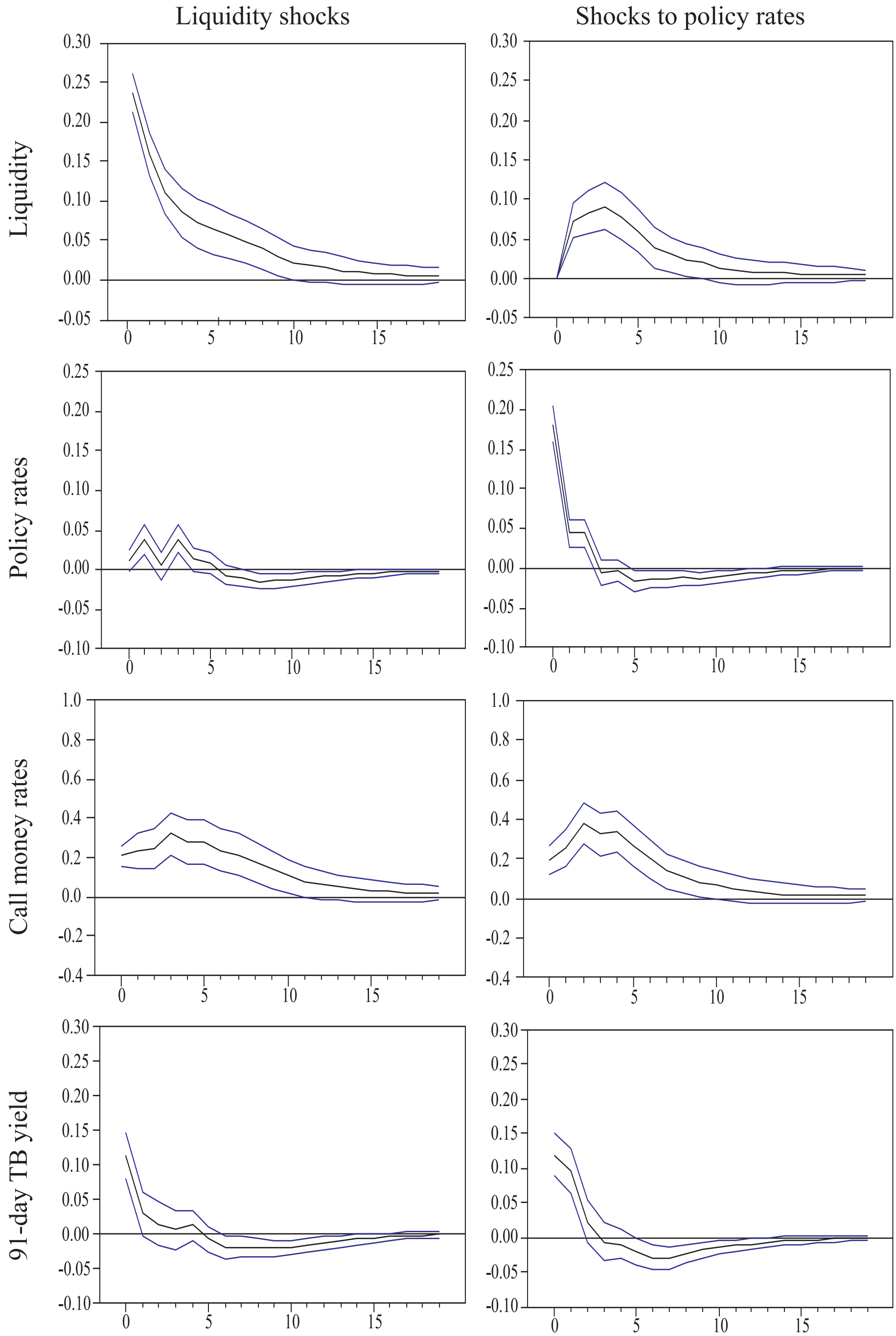
(iv) An assessment of liquidity and policy rate shocks during varied financial market conditions: Results from VAR models

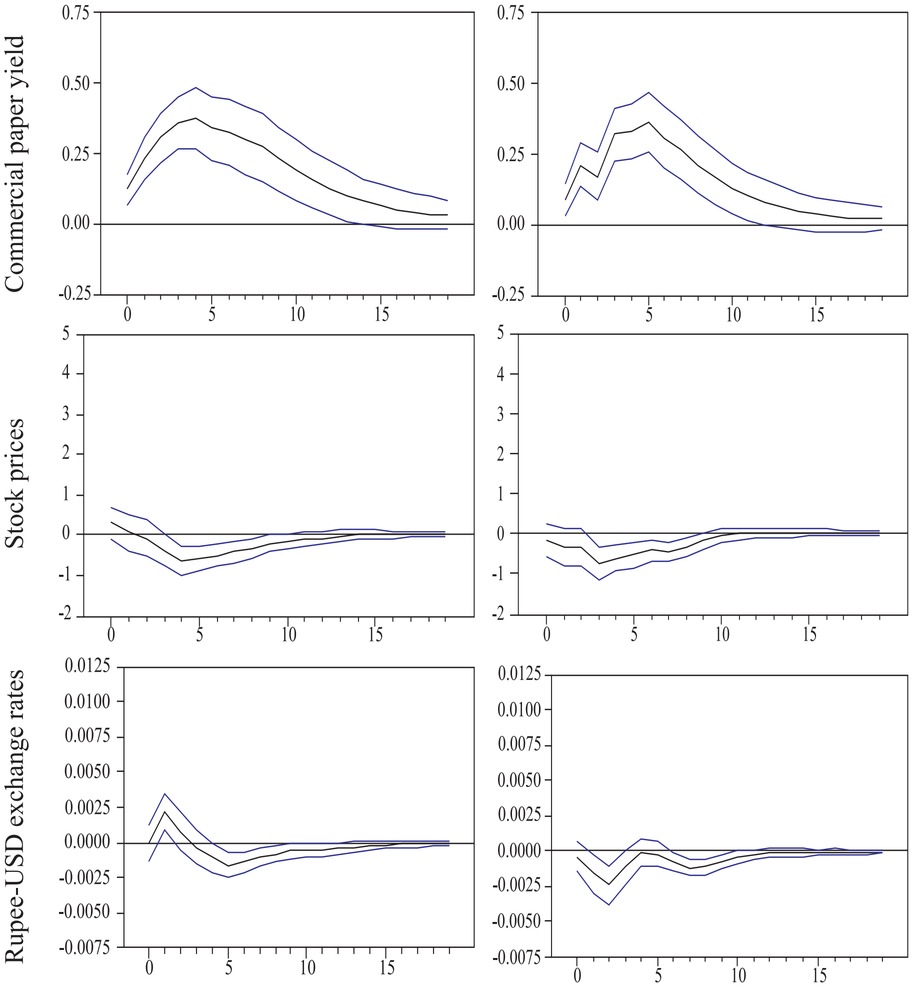
In view of structural changes as well as financial innovations, the size of the pass-through as well as the precise transmission lags may differ during the business cycles. In order to further explore monetary transmission to financial markets, we estimated two VAR models, one for the short end of financial market and the other for the long end.[19] First, a 7-variable VAR model is estimated based on monthly data for the period 2001:M3 to 2012:M6, in an attempt to assess the response of short term financial assert prices to policy rate and the liquidity changes.[20] The variables in the VAR model are: Liquidity under the LAF, changes in policy rates (rRPO), weighted average call money rates (rCall), yield on 91-day treasury bills (rTB91), weighted average rates on commercial papers (rCP), BSE Sensex and rupee-dollar exchange rate (EXR). In the model, the variable on deficit liquidity under the LAF (D=1 for liquidity deficit condition and 0 otherwise) is introduced so that the model does not lead to overestimation of the impact of

19 The optimum lag length for the models is chosen to be 3 months based on alternative information criteria. The lag length for most distributed lag models estimated also reveals that maximum significant lag is 3 months.

20 We estimate the VAR by differencing the non-stationary series, wherever required. The stationarity conditions are satisfied by using diagnostic tests such as ADF test and Phillips-Perron test.

Chart 7: Impulse responses of the short end of financial markets in India to shocks to policy rates and liquidity (Model : DLDef, rRPO, rCall, rTB91, rCP, BSE, EXR)





interest rate shocks.[21] There is evidence of significant impact of policy rates shocks on the short end of the financial market, including stock prices and exchange rate (Chart 7).[22] The peak impact of policy rate shocks to money markets is realised after a lag of 1-5 months. An initial shock to liquidity and policy rates affects call money, treasury bill and commercial paper yield with persistence of shocks varying from 2-10

21 The usual limitation of using such formulation, as explained earlier, is that it does not differentiate between the levels of liquidity surpluses or deficits.

22 For the impulse responses, Bootstrapping method is used to generate confidence intervals. It is the empirical distribution function and not some pre-specified distribution such as the Normal that is used to generate the random variables. The bootstrap sample is a random sample of size T drawn with replacement from the observed data putting a probability of 1/T on each of the observed values.

months. A positive policy rate shock also leads to some moderation in stock prices with a lag and persists for a short period. Thus, asset price channel of monetary policy seems to be in operation.[23] It would however, be too early to conclude about the considerable wealth effect of monetary policy shocks given the limited household ownership of stocks in their asset portfolio in India. We also find some evidence of exchange rate channel of monetary policy. The nominal rupee-dollar exchange rate appreciates in response to policy rate shocks, though the impact is transitory.[24] Regarding the impact of liquidity shocks on financial assets, it is generally found that liquidity shocks are less pronounced *vis-a-vis* interest rate shocks. Overall, the results suggest varying persistence of monetary policy shocks across the short end of financial market. The counter-factuals on the impact of policy rate shocks on financial market prices with and without controlling for liquidity conditions are presented in Appendix 1 and 2.

We also estimate a 6-variable VAR model based on monthly data for the period 2002:M2 to 2012:M6 to examine how the long end of financial market responds to policy rate changes.[25] [26] The variables included in the VAR model are: Liquidity under the LAF, changes in policy rates (rRPO), average secondary market yield on government of India 10-year bonds (r10y), average interest rates on 1-3 year deposit rates of commercial banks (rD3y), average yield on AAA-rated 5-year

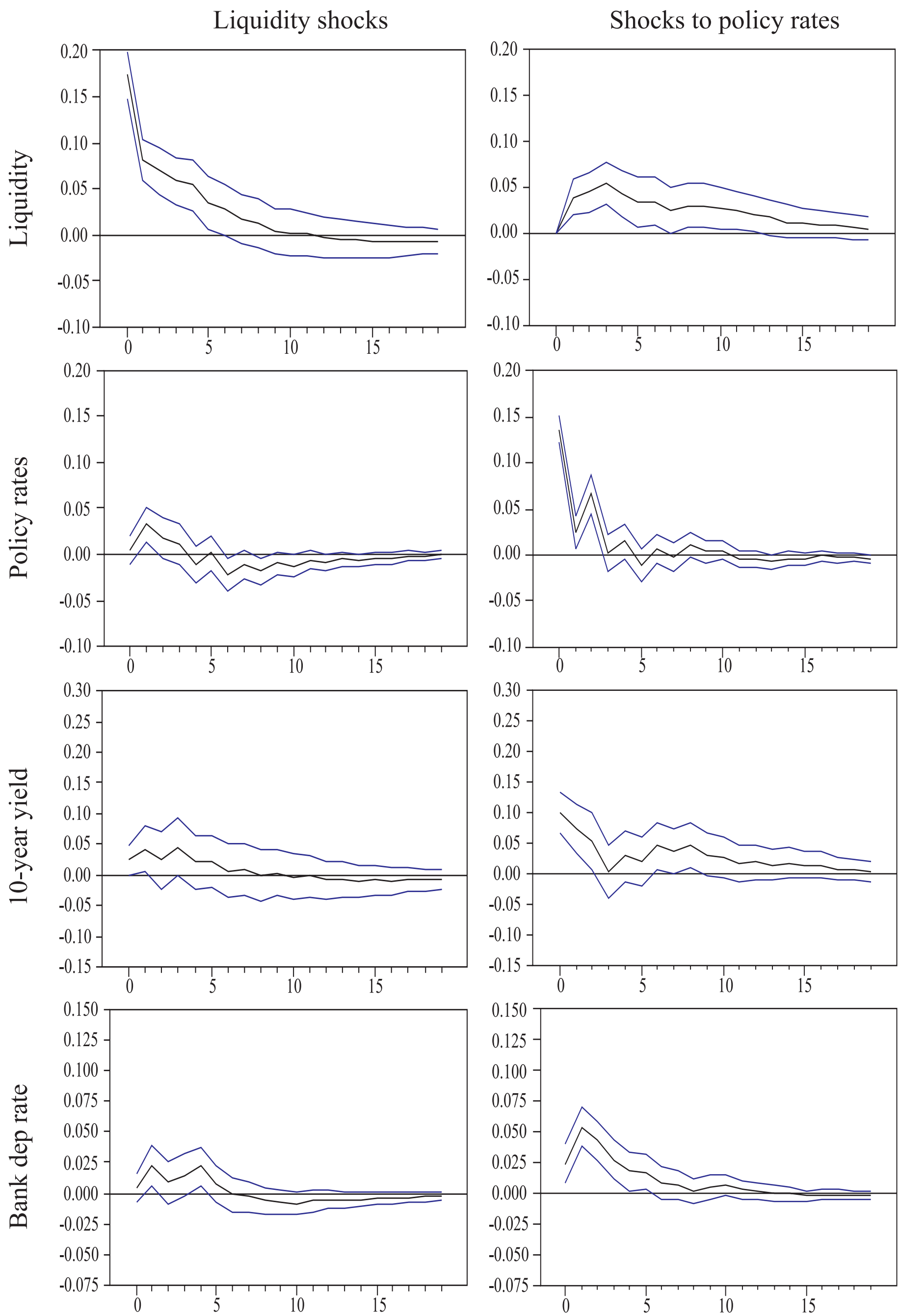
23 The argument of the paper is not that monetary policy shocks are able to explain the entire changes in asset prices but it is making the case that policy rates do cause changes in asset prices. There is a large body of theoretical as well as empirical literature on the subject and we avoid putting those details here.

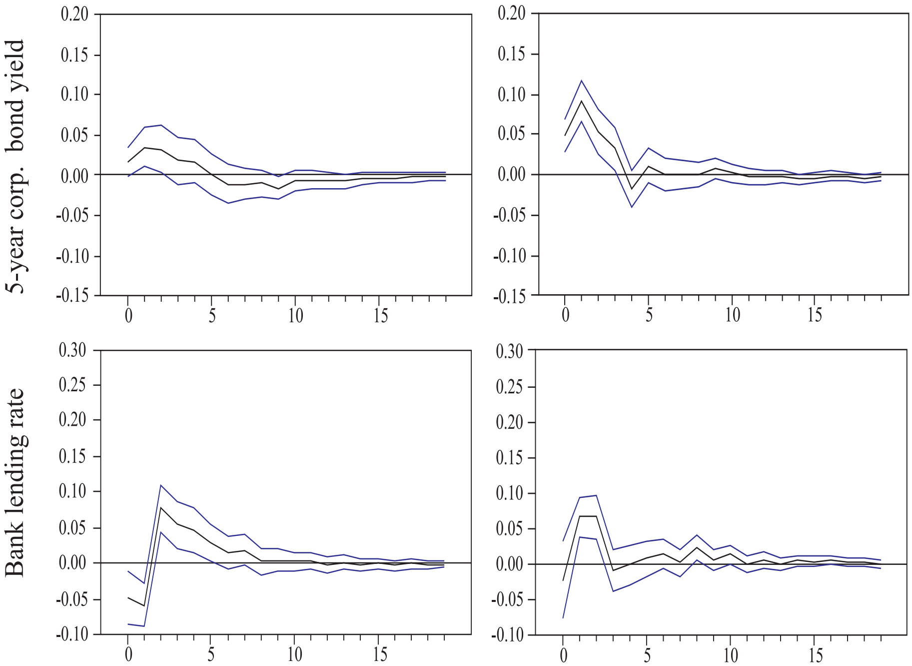
24 According to the Dornbusch overshooting model, when a change in monetary policy occurs, markets adjust to a new equilibrium between prices and quantities. Initially, because of the 'stickiness' of prices of goods, the new equilibrium level will first be achieved through shifts in financial market prices. Then, gradually, as prices of goods adjust to the new equilibrium, the foreign exchange market continuously reprices, approaching its new long term equilibrium level. Thus, foreign exchange market initially overreacts to a monetary change, achieving a new short term equilibrium. However, over time, goods prices eventually respond, allowing the foreign exchange market to dissipate its overreaction, and the economy to reach a new long run equilibrium price.

25 It is believed that policy rate changes first affect the short end of financial market, which in turn impacts long end of the market. In order to test this counter-factual, we estimated a VAR model including call money rates. The results of the model with and without call money rates do not seem to be significantly different.

26 Based on alternative information criteria, we choose a lag length of 4 months in this model.

Chart 8: Impulse responses of the long end of financial markets in India to shocks to policy rates and liquidity (Model : DLDef, rRPO, r10y, rD3y, rCorp, rLend)





corporate bonds (rCorp) and average interest rates on lending rates of commercial banks (rLend). The impact of policy rate shock on long term interest rates, though relatively less pronounced as compared to short end of the markets, is found to be significant. The interest rate channel rather than the quantity channel is found to be dominant towards the long end of the markets. There are also lags observed in transmission of policy rates shocks to long term interest rates.[27] Bank lending channel of monetary policy transmission seems to be evident as policy rates impact both deposit and lending rates. Nevertheless, there is greater persistence of policy rate shocks on deposit rates as compared with lending rates, reflecting the pricing behaviour. The less pronounced impact of policy rate shocks on lending rates can also be seen in the context of the fact that long term interest rates are also influenced by a number of other factors such as fiscal position of government, inflation expectations and

27 An important implication of this empirical finding is that given the lags in transmission of policy rate shocks to long end of financial markets, there are bound to be longer lags in transmission of monetary policy to real economy.

assessment of credit risk by economic agents (Chart 8).[28] A comparative assessment of the impulse responses suggests that a shock to policy rate leads to significant change in yield on 10-year government bonds. As the government bond yield acts as a benchmark for corporate bond pricing, changes in sovereign bond yields are instantaneously priced in the corporate bonds. While the changes in liquidity conditions have only transitory impact on corporate bond yields, there is some tendency of short run persistence in the response of corporate bond yields to policy rate shocks. A comparative picture of the responses of long end of financial asset prices to policy rate shocks with and without controlling for liquidity conditions is presented in Appendix 3 and 4.

Section V
Conclusion

The evidence suggests that transmission of monetary policy changes is instantaneous and large for money market as compared with the long end of financial markets in India. During deficit liquidity and tight phase of monetary policy, there is evidence of about 75-80 basis points contemporaneous pass-through to money market interest rate of a percentage point change in policy rate suggesting a reasonably high degree of pass-through. The pass-through improves significantly during the tight cycles of monetary policy. Bank deposit and lending rates exhibit longer lags in transmission with cumulative pass-through of about 50-70 basis points in response to changes in policy rate. Regarding the lags in the transmission of policy rates to lending rates, it could be possible that banks are unable to adjust their lending rates swiftly in response to policy signals until they are able to adjust on the cost side by repricing the fixed-rate deposits in the next cycle. To the extent that there exists significant wedge between the response of short term and long term interest rates to monetary policy changes, greater is the burden of adjustment on policy interest rates in order to have desirable effect on real variables. Across the maturity spectrum, there is existence of asymmetry in response of financial markets to policy

28 It is also believed by some that bank lending channel of transmission could be weakened in India due to access of large corporate to overseas markets through overseas commercial borrowings.

rates changes depending on the state of liquidity in financial markets and the cycle in which monetary policy is operating. The pass-through of policy rates is found to be significantly higher in deficit liquidity conditions and during the tight monetary policy cycle largely due to the presence of transmission lags. Such transmission lags also reemphasise the importance of forward-looking approach to the policy.

The results from a VAR analysis of policy rate and liquidity shocks suggest that the quantity channel operates along with the interest rate channel towards the short end of financial markets and both liquidity and interest rate shocks seem to be equally persistent. It is the interest rate channel of monetary policy transmission that is dominant towards the long end with persistence varying from 4 to 10 months. Thus, the dominant impact of interest rate channel in affecting long term interest rates brings out the stabilisation role of monetary policy. The estimates also exhibit that both the exchange rate and asset price channel of monetary policy are in operation. The exchange rate channel of transmission reveals that policy rate shocks and domestic liquidity tightening both lead to initial appreciation of nominal exchange rate, which does not seem to be persistent. There is some evidence of the wealth channel of monetary policy as positive interest rate shocks are found to cause a reduction in stock prices, which may impact on household wealth and hence consumption demand. This would, however, be limited, given the lower share of stocks in total household wealth in India.

References

Bernanke B. and Allan Blinder (1992). "The Federal Funds rate and the channel of money transmission." *American Economic Review*, 82: 901-21.

Bernanke B. and M. Gertler (1995). "Inside the Black Box: the Credit Channel of Monetary Policy Transmission." *NBER Working Paper No. 5146*.

Bhoi, B. K. and S. C. Dhal (1998). "Integration of Financial Markets in India: An Empirical Evaluation." *RBI Occasional Papers*, 19(4): 345-380.

Christiano, L. J., M. Eichenbaum and C. Evans (1996). "The effects of monetary policy shocks: Evidence from the flow of funds." *Review of Economics and Statistics*, 78: 16-34.

Kuttner, K. N. and P. C. Mosser (2002). "The Monetary Transmission Mechanism: Some Answers and Further Questions". *Economic Policy Review*, Federal Reserve Bank of New York: 15-26.

Loayza, Norman and Klaus Schmidt-Hebbel (2002). "Monetary Policy Functions and Transmission Mechanisms: An Overview", in Monetary Policy: Rules and Transmission Mechanisms (eds.) Loayza, Norman and Klaus Schmidt-Hebbel, in Series on Central Banking, Analysis and Economic Policies, Vol. IV, Central Bank of Chile.

Reserve Bank of India (2011). Report of the Working Group on Operating Procedure of Monetary Policy, March.

Sims, C. A. (1992). "Interpreting the macroeconomic time series facts: The effects of monetary policy." *European Economic Review*, 36: 975-1000.

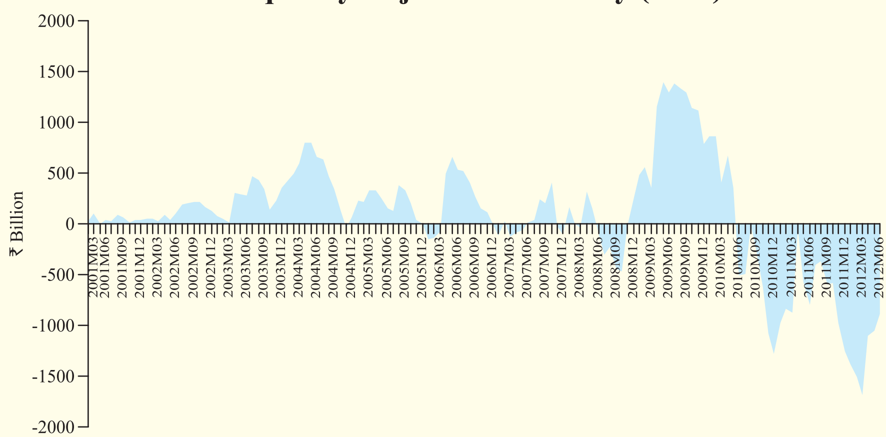
Singh, Bhupal (2010). "Monetary Policy Behaviour in India: Evidence from Taylor-type Policy Frameworks." RBI Staff Studies, SS(DEAP) 2/2010, Reserve Bank of India.

Annex A: Methodological Issues

(i) List of variables: rRPO = repo rate of the Reserve Bank, rCall = weighted average call money rates, rCBLO = weighted average collateralised borrowing and lending rates, rMRPO = average interest rate on market repo transactions, rTB91 = yield on 91-day treasury bills, rCD = weighted average rate on certificates of deposits, rCP = weighted average rate on commercial papers, rOIS1y = 1-year OIS yield, rMBR1m = 1-month MIBOR rate, rD3y = average unweighted interest rate on bank deposits of 1-3 year maturity, r10y= yield on 10-year govt. bond, rLend= avg. lending rates of commercial banks, rCorp= yield on AAA-rated corporate bonds, dLwpi = change in log of wholesale price index, EXR = rupee-dollar exchange rate, SENSEX = BSE Sensex. These notations have been referred to in the foregoing analysis. The data used are monthly averages rather than end month data as the end month figures could be subject to volatility and may not be appropriate to capture the underlying relationships between the variables. LAF outstanding for a month is the average of daily outstanding balances during the month. Average bank lending rate is the prevailing unweighted lending rate and not the average rate on outstanding credit. Rupee-dollar exchange rate and BSE 30 share SENSEX are average of daily closing rates/prices.

(ii) Identification of deficit and surplus liquidity samples: A month has been labelled as liquidity deficit or surplus depending on the average daily balances in deficit or surplus mode. However, we have also applied our judgement in defining some of the months as liquidity deficit or surplus depending on how many days the liquidity was in surplus or deficit and depending on the level of surplus or deficit so as to retain some element of time series properties while classifying the samples (see Chart A). Based on these properties, sample has been reclassified for the analysis.

Chart A: Net Liquidity Adjustment Facility (LAF) Balances



(iii) Identification of tight and easy monetary policy cycles: There are a few studies in the Indian context which point to a neutral nominal policy rate of about 6.5 to 7 per cent. Further, a preliminary alalysis reveals that the average WPI inflation rate during the period 2001-02 to 2011-12 was about 6.5 per cent (excluding some months with abnormally low or negative inflation rate during global financial crisis) and the average nominal policy rate of 6.8 per cent, implying a negligible real policy interest rate. It may be noted that although the concept of neutral rate is understood in terms of real interest rate in advanced economies, in case of emerging market economies like India, where there is relative volatility in inflation, a nominal measure of neutral rate may be more appropriate to assess the policy stance. Rather than going into the debate of the neutral policy rate, we assume that on an average above 7 per cent would indicate a tight monetary policy stance. Accordingly, the sample has been reclassified for the two sub periods.

Annex Table 1: Unit Root tests

Variables	Level/ First diff.	Augmented Dickey-Fuller test statistic	Phillips-Perron test statistic	Test critical values		
				1% level	5% level	10% level
rRPO	level	-2.6	-2.2	-3.5	-2.9	-2.6
	Δ	-4.8	-7.4	-3.5	-2.9	-2.6
rCall	level	-4.0	-3.9	-3.5	-2.9	-2.6
rCBLO	level	-3.2	-2.7	-3.5	-2.9	-2.6
rMRPO	level	-3.5	-3.1	-3.5	-2.9	-2.6
rTB91	level	-1.9	-2.3	-3.5	-2.9	-2.6
	Δ	-9.5	-9.5	-3.5	-2.9	-2.6
rCD	level	-1.9	-2.0	-3.5	-2.9	-2.6
	Δ	-10.9	-10.9	-3.5	-2.9	-2.6
rCP	level	-2.8	-2.8	-3.5	-2.9	-2.6
rOIS1y	level	-3.1	-2.5	-3.5	-2.9	-2.6
rMBR1m	level	-2.5	-2.3	-3.5	-2.9	-2.6
	Δ	-7.9	-7.9	-3.5	-2.9	-2.6
rD3y	level	-1.5	-1.5	-3.5	-2.9	-2.6
	Δ	-5.6	-5.7	-3.5	-2.9	-2.6
r10y	level	-2.8	-2.8	-3.5	-2.9	-2.6
rLend	level	-1.5	-1.4	-3.5	-2.9	-2.6
	Δ	-8.0	-8.1	-3.5	-2.9	-2.6
rCorp	level	-2.0	-2.1	-3.6	-2.9	-2.6
	Δ	-7.2	-7.2	-3.6	-2.9	-2.6

rRPO = repo rate of the Reserve Bank, rCall = weighted average call money rates, rCBLO = weighted average collateralised borrowing and lending rates, rMRPO = average interest rate on market repo transactions, rTB91 = yield on 91-day treasury bills, rCD = weighted average rate on certificates of deposits, rCP = weighted average rate on commercial papers, rOIS1y = 1-year OIS yield, rMBR1m = 1-month MIBOR rate, rD3y = average interest rate on bank deposits of 1-3 year maturity, r10y= yield on 10-year govt. bond, rLend= avg. lending rates of commercial banks, rCorp= yield on AAA-rated corporate bonds. These notations may be referred to in the subsequent analysis.

Annex Table 2: Transmission of policy rate changes to the short end of financial markets

Variables	rCall	rCBLO	rMRPO	rTB91	rCD	rCP	rMBR1m	rOIS1y
C	6.11	5.80	5.68	0.01	0.04	7.99	-0.52	6.27
	(6.17)	(4.26)	(6.75)	(0.49)	(0.98)	(9.60)	(-2.78)	(8.33)
ΔrRPO	0.38**	0.43*	0.39*	0.51***		0.39*	0.73***	0.51***
	(2.35)	(1.90)	(1.87)	(4.36)		(1.92)	(4.83)	(3.55)
ΔrRPO(-1)	0.60***	0.53***	0.50**	0.29**	0.91***	0.51**	0.40***	0.58***
	(2.58)	(2.90)	(2.22)	(2.23)	(5.73)	(2.41)	(3.09)	(2.78)
ΔrRPO(-2)	0..62**		0.55*					0.34***
	(2.24)		(1.79)					(3.35)
ΔrRPO(-3)	0.45**					0.45**		0.25*
	(2.34)					(2.06)		(1.90)
rCall							0.09***	
							(3.16)	
DUM2004M6_2007M1					1.53***			
					(43.63)			
D2007M3_2008M9	6.27***							
	(32.63)							
DUM2007M6M7_2009M4		-4.57***		-1.52**	-1.56***			
		(-17.04)		(-2.53)	(-37.52)			
DUM2007M6M7	-5.04***		-3.14***					
	(-19.31)		(-6.40)					
DUM2007M8_2008M7				1.19***				
				(3.53)				
DUM2008M9M10	1.35***							
	(6.39)							
DUM2008M12							-0.63**	
							(-2.47)	
DUM2010M6_M10		0.92***				1.89**		
		(4.05)				(2.44)		
AR(1)	0.94***	0.93***	0.92***			0.90***		0.95***
	(34.22)	(27.74)	(19.82)			(21.34)		(26.15)
R^2	0.93	0.88	0.85	0.51	0.45	0.82	0.41	0.92
DW Statistics	1.96	1.98	1.83	1.89	2.02	2.07	2.07	1.84
BG-LM Test-F Stats	0.04	0.02	0.72	0.99	1.37	0.61	0.82	2.10
Prob.	(0.96)	(0.98)	(0.49)	(0.38)	(0.26)	(0.54)	(0.44)	(0.11)
Sample	2001 M3 to 2012 M6	2003 M2 to 2012 M6	2003 M2 to 2012 M6	2001 M3 to 2012 M6	2001 M5 to 2012 M6	2001 M8 to 2012 M6	2001 M5 to 2012 M6	2001 M8 to 2012 M6

*, **, *** represent significance level of 10%, 5% and 1%, respectively.

DUM: Dummy variables to capture extreme fluctuations in the series. Dummy variable defined to represent a particular month in a year.

Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.

The figures in brackets are t-statistics.

Annex Table 3: Transmission of policy rate changes to the long end of financial markets

Variables	r10y	rCorp	rD3y	rLend
C	7.02	0.01	0.02	0.01
	(9.78)	(0.27)	(0.90)	(0.39)
ΔrRPO	0.25 *	0.41 ***	0.12 **	0.27 ***
	(1.83)	(4.61)	(2.12)	(4.67)
ΔrRPO(-1)	0.22 *	0.27 ***	0.33 ***	0.15 ***
	(1.90)	(3.64)	(4.66)	(2.60)
ΔrRPO(-3)	-0.19 **			
	(-2.40)			
ΔrRPO(-4)			0.22 ***	0.14 ***
			(2.98)	(2.55)
dLwpi	0.07 ***			
	(2.70)			
DUM2003M2_2008M10		1.11 ***		
		(26.89)		
DUM2007M4				0.62 ***
				(5.41)
DUM2007M7_2008M12		-0.99 ***		
		(-5.28)		
DUM2008M6	0.62 ***			
	(11.85)			
DUM2008M12	-1.13 ***			
	(-8.42)			
DUM2010M7				-3.42 ***
				(-21.13)
DUM2011M2_2012M2			1.05 ***	
			(3.54)	
DUM2012M1			-1.75 ***	
			(-62.07)	
AR(1)	0.97 ***	-0.24 **		
	(31.84)	(-2.15)		
R^2	0.94	0.61	0.71	0.81
DW Statistics	1.76	1.97	1.98	1.82
BG-LM Test-F Stats	0.76	1.55	0.13	0.23
prob	(0.47)	(0.22)	(0.88)	(0.80)
Sample	2002M2 to 2012M6	2002M2 to 2012M6	2002M2 to 2012M6	2002M2 to 2012M6

*, **, *** represent significance level of 10%, 5% and 1%, respectively.
dLwpi = change in log of wholesale price level.
Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.
The figures in brackets are t-statistics.

Annex Table 4: Transmission of policy rate under deficit liquidity conditions

Variables	rCall	rTB91	r10y	rCp	rD3y	rLend
C	7.35	0.02	7.28	9.35	0.10	0.06
	(19.32)	(0.61)	(46.54)	(32.08)	(2.79)	(2.10)
ΔrRPO	0.74***	0.71***	0.20*	0.39**	0.38***	0.41***
	(5.82)	(11.86)	(1.87)	(2.15)	(3.85)	(3.33)
ΔrRPO(-1)	0.63***	0.14*		0.82***		0.14***
	(3.41)	(1.92)		(6.06)		(3.87)
ΔrRPO(-2)	0.63***	-0.19***		0.75***		
	(2.68)	(-2.93)		(4.32)		
ΔrRPO(-3)	0.53***	0.13***		0.63***		
	(2.64)	(2.87)		(3.30)		
dLwpi			0.11***			
			(5.70)			
DUM1	6.21***	1.24***	0.73***	2.18***	1.42***	
	(31.84)	(4.03)	(13.44)	(7.89)	(39.13)	
DUM2	-5.09***	-2.39***	-1.80***	-1.30***	-2.14***	-1.68***
	(-22.68)	(-56.54)	(-3.87)	(-4.96)	(-6.07)	(-5.84)
AR(1)	0.78***		0.63***	0.68***		
	(7.97)		(4.25)	(5.76)		
R^2	0.88	0.89	0.79	0.81	0.85	0.83
DW Statistics	1.95	1.74	2.22	1.93	1.97	1.57
BG-LM Test-F Stats	0.05	1.51	0.23	0.29	0.12	1.60
prob	(0.95)	(0.23)	(0.79)	(0.75)	(0.89)	(0.21)
Obs.	71	71	71	71	71	71

*, **, *** represent significance level of 10%, 5% and 1%, respectively.
DUM1 and DUM2 are dummy variables used for months with extreme price volatility either positive or negative.
Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.
The figures in brackets are t-statistics.

Annex Table 5: Transmission of policy rate under surplus liquidity conditions

Variables	rCall	rTB91	r10y	rCp	rD3y	rLend
C	0.03	0.02	6.79	6.31	-0.02	-0.01
	(1.43)	(0.93)	(8.91)	(11.90)	(-0.79)	(-0.86)
ΔrRPO	0.31**	0.32*	0.30*		0.39***	
	(2.41)	(1.85)	(1.89)		(3.08)	
ΔrRPO(-1)	0.35***	0.33***			0.42***	0.26**
	(3.32)	(2.75)			(3.49)	(2.08)
ΔrRPO(-3)	0.26**			0.62***	0.24**	
	(2.37)			(3.78)	(2.62)	
DUM1	0.96***	0.35***		2.12***	2.91***	1.76***
	(43.48)	(12.89)		(7.65)	(26.79)	(11.86)
DUM2	-1.06***	-0.81***	-1.10***		-0.37***	-0.74***
	(-6.15)	(-12.15)	(-4.20)		(-9.22)	(-39.71)
AR(1)			0.95***	0.85***		
			(26.38)	(10.18)		
R^2	0.76	0.57	0.90	0.81	0.95	0.76
DW Statistics	1.98	1.98	1.75	1.82	2.19	2.33
BG-LM Test-F Stats	0.63	0.40	0.58	0.93	0.67	1.19
prob	(0.54)	(0.67)	(0.56)	(0.40)	(0.52)	(0.31)
Obs.	65	65	65	65	65	65

*, **, *** represent significance level of 10%, 5% and 1%, respectively.

\Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.

The figures in brackets are t-statistics.

Annex Table 6: Transmission of policy rate under the tight cycle of monetary policy

Variables	rCall	rTB91	r10y	rCp	rD3y	rLend
C	5.49	-0.04	7.64	0.03	0.04	0.02
	(9.86)	(0.96)	(22.64)	(0.39)	(1.11)	(0.82)
ΔrRPO	0.81***	0.48***	1.08***	0.81***	0.12***	0.31***
	(4.03)	(8.36)	(6.26)	(3.31)	(3.46)	(5.01)
ΔrRPO(-1)	0.45**			1.17***	0.48***	0.73***
	(2.35)			(3.61)	(4.24)	(4.43)
ΔrRPO(-2)	0.76***					-0.12***
	(3.00)					(-2.74)
ΔrRPO(-3)	0.72***					
	(2.94)					
dLwpi	0.29*** (3.50)		0.07*** (12.37)			
DUM1	6.17***	1.05***	0.64***	2.05***	1.04***	0.35***
	(31.97)	(7.17)	(6.52)	(11.96)	(3.14)	(4.42)
DUM2	-5.03***	-1.22***	-0.62***	-1.73***	-1.71***	-2.80***
	(-18.19)	(-3.06)	(-3.55)	(-11.32)	(-52.07)	(-11.74)
AR(1)	0.65***		0.86***			
	(5.15)		(14.67)			
R^2	0.91	0.61	0.86	0.62	0.79	0.93
DW Statistics	1.99	2.21	1.65	1.96	1.85	1.78
BG-LM Test-F Stats	0.27	0.58	1.62	0.12	0.59	0.34
prob	(0.76)	(0.57)	(0.21)	(0.88)	(0.56)	(0.71)
Obs.	68	68	68	68	65	65

*, **, *** represent significance level of 10%, 5% and 1%, respectively.

Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.

The figures in brackets are t-statistics.

Annex Table 7: Transmission of policy rate under the easy cycle of monetary policy

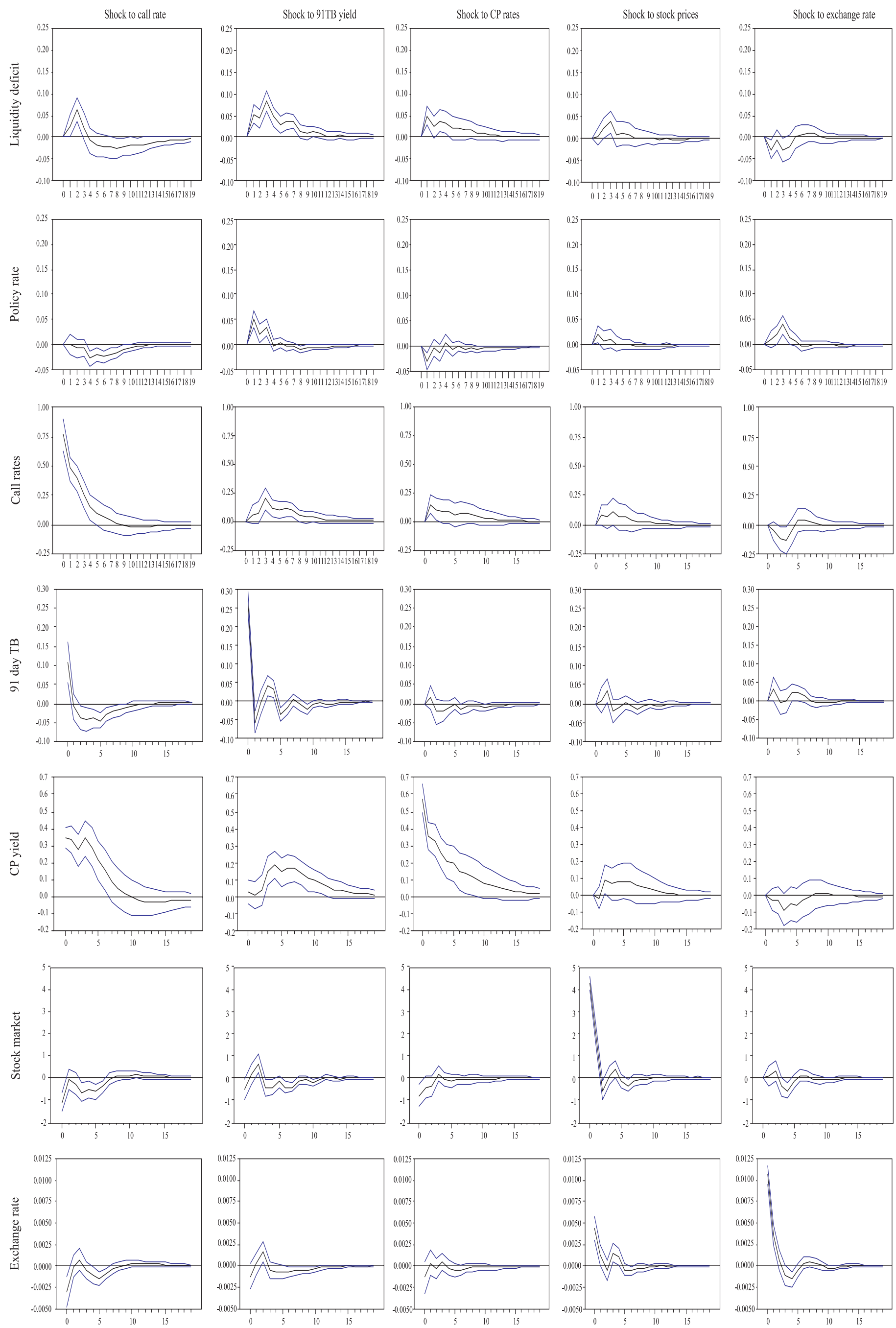
Variables	rCall	rTB91	r10y	rCp	rD3y	rLend
C	0.03	0.05	0.00	0.01	0.00	-0.02
	(1.00)	(2.24)	(0.06)	(0.09)	(0.04)	(-1.34)
ΔrRPO	0.41***	0.41**	0.30***			0.31*
	(2.62)	(2.32)	(2.71)			(1.70)
ΔrRPO(-1)		0.40***		0.89**	0.53***	
		(2.86)		(2.32)	(3.80)	
ΔrRPO(-3)	0.41***				0.38***	0.33***
	(2.95)				(3.40)	(2.72)
rCall				0.68***		
				(3.31)		
dLwpi			0.05***			
			(3.13)			
DUM1	0.86***	0.66***	0.60***	3.04***	3.12***	0.44***
	(6.38)	(5.42)	(8.12)	(8.60)	(70.30)	(13.51)
DUM2	-1.04***	-0.73***	-2.42***	-1.49***	-0.62***	-3.45***
	(-5.62)	(-6.90)	(-23.44)	(-5.35)	(-12.96)	(-38.38)
AR(1)			-0.39***	-0.27**		
			(-2.24)	(-2.01)		
R^2	0.74	0.63	0.75	0.70	0.91	0.89
DW Statistics	2.07	2.05	1.81	1.95	1.63	1.98
BG-LM Test-F Stats	0.89	0.36	1.90	0.92	1.35	0.22
prob	(0.42)	(0.70)	(0.18)	(0.40)	(0.27)	(0.81)
Obs.	67	67	67	67	66	66

*, **, *** represent significance level of 10%, 5% and 1%, respectively.

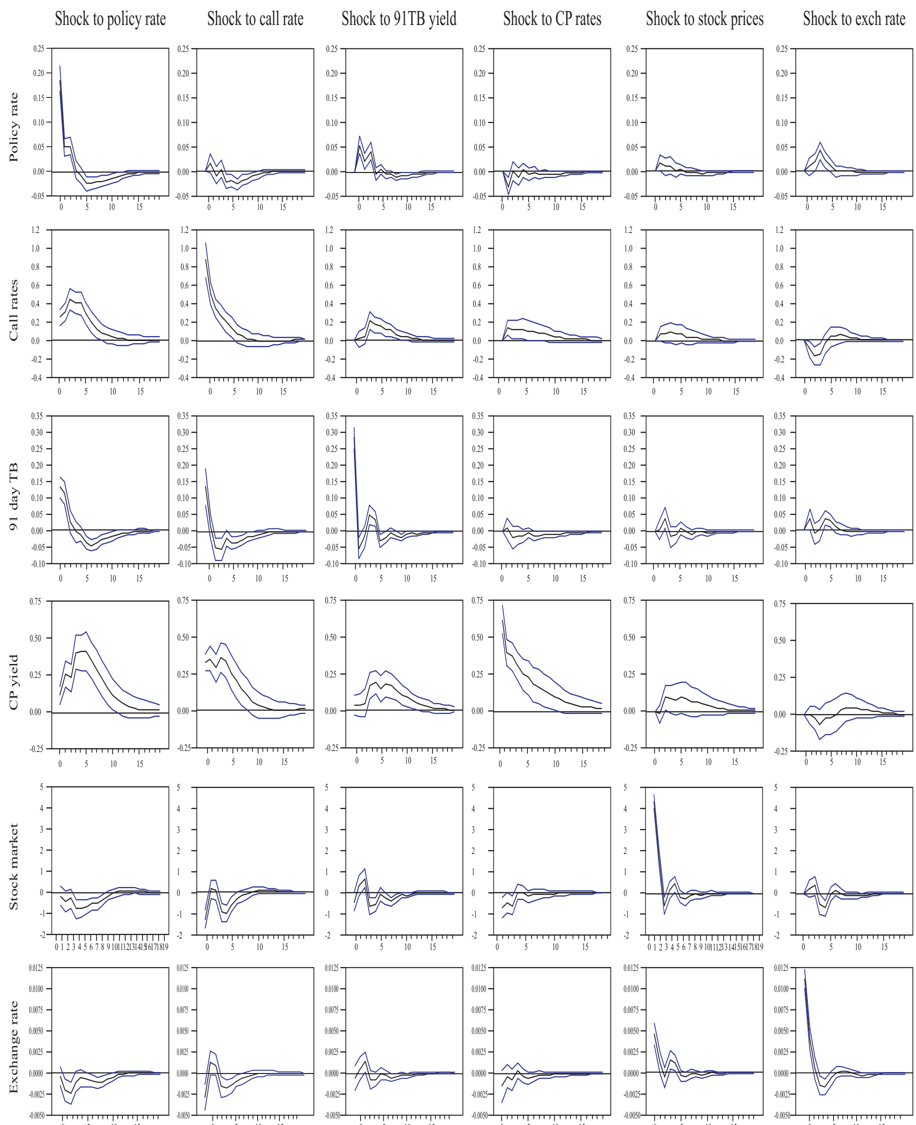
Note: The Newey-West estimator (bartlett kernel, fixed bandwidth) is used to estimate covariance matrix of parameters of the models. The estimator improves OLS estimation in the presence of heteroskedasticity/autocorrelation.

The figures in brackets are t-statistics.

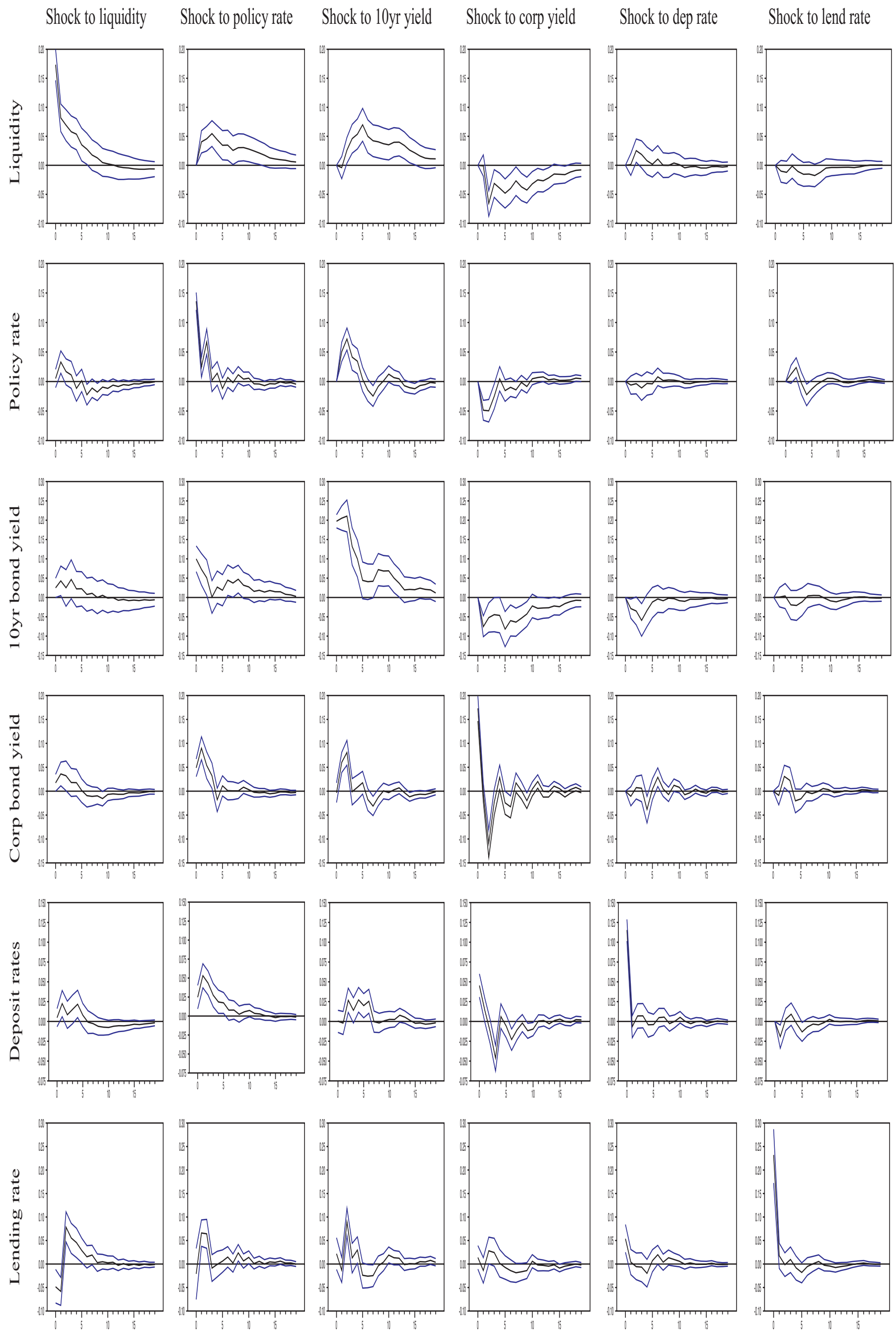
Appendix 1: Impulse response of short end of financial markets to various shocks after controlling for liquidity conditions



Appendix 2: Impulse response of short end of financial markets to various shocks without controlling for liquidity conditions



Appendix 3: Impulse response of long end of financial markets to various shocks after controlling for liquidity conditions



Appendix 4: Impulse response of long end of financial markets to various shocks without controlling for liquidity conditions