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by Sonali Das

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Monetary Policy in India: Transmission to Bank Interest Rates

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Authorized for distribution by Paul Cashin

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Abstract

This paper provides new evidence on the credit channel of monetary policy transmission in India. Using stepwise estimation of vector error correction models, the analysis finds significant, albeit slow, pass-through of policy rate changes to bank interest rates in India. There is evidence of asymmetric adjustment to monetary policy: the lending rate adjusts more quickly to monetary tightening than to loosening. In addition, the speed of adjustment of deposit and lending rates to changes in the policy rate has increased in recent years.

JEL Classification Numbers: E43, E52, G21, O16

Keywords: Monetary policy transmission, India, deposit rates, lending rates

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I. INTRODUCTION

Understanding the effects of monetary policy on the economy is central to the study of macroeconomics and practice of policy makers. The monetary policy framework of India's central bank has been evolving since the mid-1990s, and a path for a strengthened framework was laid out recently in the Patel Committee Report to the Reserve Bank of India (RBI).[2] The RBI has expressed concern over a lack of policy rate pass-through to lending rates and deposit rates, and certain changes to the monetary policy operating framework have been implemented with the aim of improving transmission. Recent RBI monetary policy statements mention pass-through of past policy rate cuts to lending rates as a prerequisite for further monetary easing (March 4, 2015), and discuss lending rate sensitivity to the policy rate (April 7, 2015). Concerns about transmission are not unique to India, as the strength of monetary policy transmission in developing countries as a whole has come into question (see Mishra and Montiel 2012; and Mishra et al. 2014).

Amidst the changes to the monetary policy framework, there is a need for empirical evidence on the effects of monetary policy in India (see also earlier work in IMF 2015a, 2015b). This paper provides new evidence on monetary policy transmission in India over the last twelve years. Of the potential channels through which monetary policy can affect output—the interest rate channel, the credit channel, the asset price channel, and the exchange rate channel—I focus on the credit channel, namely pass-through from the policy rate to bank deposit and lending rates.[3] Mishra and Montiel (2012) review the reasons why the credit (bank lending) channel is likely to be the dominant one for developing countries and previous

[2] Report to the Expert Committee to Revise and Strengthen the Monetary Policy Framework, Jan 21, 2014, www.rbi.in/scripts/PublicationReportDetails.aspx?UrlPage=&ID=743.

[3] In the credit channel of transmission, interest-rate decisions affect the cost and availability of credit by more than would be implied by the associated movement in risk-free interest rates. The credit channel has been broken down into two components or channels of policy influence: the balance-sheet channel and the bank-lending channel. The balance-sheet channel of monetary policy builds from the premise that changes in interest rates engineered by the central bank affect the values of the assets and the cash flows of potential borrowers and thus their creditworthiness, in turn affecting the external finance premium that borrowers face. The theory of the bank-lending channel holds that monetary policy works in part by affecting the supply of loans offered by depository institutions. See Bernanke and Gertler (1995).

studies of the different channels in India have found this to be the case (e.g. Sengupta 2014). The questions this paper seeks to shed light on are:

1. What is the extent and speed of pass-through from monetary policy to deposit and lending rates of Indian banks?
2. Is pass-through symmetric? Or do episodes of monetary tightening and loosening have different effects on bank interest rates?
3. Has pass-through changed over time, with changes to the monetary policy operating framework?

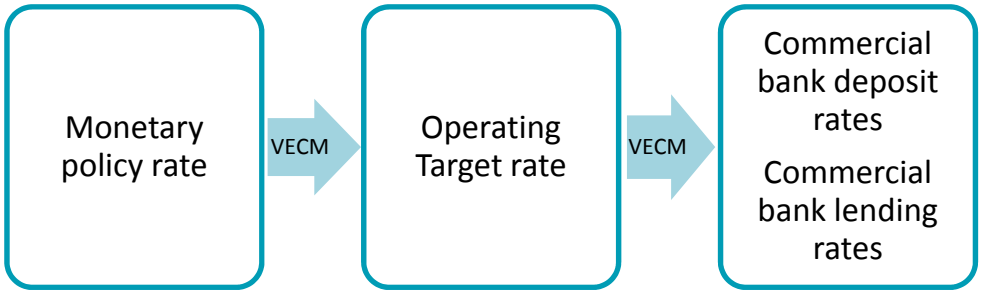
To answer these questions, I estimate the pass-through from monetary policy changes to bank interest rates in two steps:

(i) from the monetary policy rate to the interbank market rate that is the operating target of the framework; and then

(ii) from the target rate to bank interest rates (deposit and lending rates).

There are two advantages to this stepwise estimation. First, the results from the first step indicate how well the framework is setup to control its target market rate.[4] Second, the interpretation of relationships is clearer than it would be in a vector error cointegration model with multiple (three) cointegrating relationships.

Stepwise estimation of error-correction models



In each step, an error-correction model is used, which allows for the estimation of the long-run relationship between the policy and bank interest rates as well as the speed of adjustment to this long-run pass-through. The method also allows for the estimation of asymmetric

[4] Many studies on transmission in India and in other countries assume a correspondence between the policy stance and the target rate and use the target rate as the starting point in analyzing transmission.

adjustment parameters, to study whether there are differential responses to policy rate increases and decreases.

II. Related Literature

There is a vast literature studying the effects of monetary policy, which advances as improvements are made in the methods used to identify exogenous monetary policy shocks and is also updated as the implementation of monetary policy changes over time. Reviewing this literature is beyond the scope of this paper, but see Christiano et al. (2000) for a review of the literature on monetary policy transmission[5] and Beck et al. (2014) for a review of the role of financial intermediaries in monetary policy transmission. In this section, I focus on several recent cross-country studies of transmission in developing countries and studies of monetary policy transmission in India.

Mishra and Montiel (2012) survey the evidence on the effectiveness of monetary transmission in developing countries. They conclude that, despite methodological issues present in the literature, monetary transmission appears to be weak in developing countries. Mishra et al. (2014) find large variation in the response of bank lending rates to monetary policy shocks across countries, with weaker transmission in developing countries.

Mohan (2008) comprehensively surveys monetary policy in India, including the evolution of the operating framework, instruments used for liquidity management, and reforms. Sengupta (2014) uses a vector autoregression (VAR) to study the various channels of monetary transmission in India from 1993 to 2012. She finds a structural break in transmission corresponding to the introduction of the Liquidity Adjustment Facility (LAF) in 2000, with the bank lending channel remaining important since the introduction of the LAF but the interest rate and asset price channels becoming stronger. Singh (2011) uses a VAR model from March 2001 to June 2012 to estimate pass-through from the policy rate to a variety of

[5] For example, the literature spanning Bernanke and Blinder (1992) to Romer and Romer (2013) for the United States.

short and long term market interest rates.[6] He finds significant contemporaneous pass-through under deficit liquidity conditions as well as significant lagged effects.[7] A drawback of this method is that, while it estimates the effect of changes in the policy rate on other interest rates, it does not give a clear sense of the speed of transmission, which is a factor that policy makers must consider when making policy rate decisions. Mohanty (2012) also narrows in on the interest rate channel, studying policy rate changes through to their effects on output and inflation. Estimating a quarterly structural VAR model, he finds that policy rate increases have a negative effect on output growth with a lag of two quarters and a moderating impact on inflation with a lag of three quarters, with both effects persisting for eight to ten quarters.

Bhaumik et al. (2011), examine the impact of bank ownership on the reaction of banks to monetary policy from 2000 to 2007. The authors use the average prime lending rate (PLR) of large banks as a proxy for the monetary policy rate, and estimate the change in loans in response to changes in PLR at the bank level. They find that banks decrease loan supply in response to increases in PLR in tight money periods, and suggest that the bank lending channel of monetary policy is likely to be more effective in tight money periods than in easy money periods. Since the authors use the prime lending rate of banks themselves as the indicator of monetary policy, however, they implicitly assume complete and quick pass-through of changes in monetary policy to bank lending rates, thus missing a potential price response by banks to monetary policy and looking only for a quantity response.

III. MONETARY POLICY OPERATIONS IN INDIA

The monetary policy framework in India has undergone several changes in recent years.[8] An Interim Liquidity Adjustment Facility (ILAF) was introduced in April 1999 and then

[6] The study includes eleven interest rates, the exchange rate, a stock index return, the LAF balance, and the wholesale price index to measure inflation.

[7] For example, a one percentage point change in the repo rate leads to a 75–80 basis point change in several short-term rates, and a 50 basis points change in medium and long-term rates.

[8] See Mohanty (2011b) for a history of the framework up to 2011.

transitioned towards a full-fledged liquidity adjustment facility (LAF) through periodic modifications. The LAF helped in developing policy interest rates as the main monetary policy instrument. Since November 2004, the LAF has been operated using overnight fixed rate repos and reverse repos with banks. The LAF is the key element in the operating framework of the RBI and is meant to operate in a deficit liquidity mode to ensure more effective monetary transmission[9], with liquidity contained around +/- one percent of all banks' net demand and time liabilities (NDTL). Banks pledge government securities as collateral, most of which should be over and above the securities they must hold to comply with liquidity regulations (the statutory liquidity ratio (SLR)[10]. On May 3, 2011 the LAF was enhanced along several dimensions, an important component of which was the explicit recognition of the weighted average overnight call money rate as the operating target of monetary policy. The liquidity management framework has been fine-tuned recently, with liquidity provision to banks shifting from overnight repos to term repos of varying maturities.

A bank's prime lending rate (PLR) is the interest rate at which it lends to its most credit-worthy borrowers. In India, since some banks were pricing loans under their advertised prime lending rates, however, the transparency of lending rates became a concern. The RBI instituted a "base rate" system, effective July 1, 2010, with the aim of enhancing transparency in lending rates of banks and enabling better assessment of the transmission of monetary policy (RBI Circular 2009-10/390; dated April 9, 2010). In the new system, a bank's base rate is the minimum rate at which it can lend, as loans are to be priced from the base rate with the addition of borrower-specific charges to account for credit risk. Banks are expected to calculate their base rate taking their cost of funds, costs of complying with certain regulations (CRR and SLR), overhead costs, and profits into account. They use their own formula to calculate their base rate, under stipulation from the RBI that it must be calculated in a consistent manner and made available for supervisory review. The fact that

[9] The new framework is premised on the dominance of the interest rate channel of transmission (Mohanty 2011a), and this channel has been found to be more effective in deficit liquidity conditions (Singh 2011).

[10] Banks in India are subject to a statutory liquidity ratio—a certain share of net total time and demand liabilities that banks must invest in gold and/or government approved securities. This ratio was 25% in 2002, and was decreased from 22% to 21.5% in February 2015.

banks use different measures of their cost of funds as inputs to the calculation, including using an average cost of funds instead of the marginal cost of funds, has been noted as a potential reason for a lack of responsiveness of their base rates to policy rate changes. Another potential factor affecting transmission is the share of banks' loan portfolios that are made up of fixed interest rate versus variable interest rate products. With a higher share of outstanding variable rate loans that are benchmarked to the base rate, a bank's future stream of interest income will vary more with changes in the base rate.[11]

Chapter IV of the Patel Committee Report (RBI 2014) discusses likely impediments to monetary transmission in India and provides exploratory evidence[12] of an asymmetric effect of the policy rate on deposit and lending rates in India. It groups likely impediments to transmission into three broad categories: (i) fiscal dominance, (ii) the large informal sector, and (iii) financial and credit market frictions.

IV. Data and Descriptive Statistics

The data used in the analysis come from CEIC[13] and Datastream and are made up of two groups of variables: those capturing the monetary policy stance and information on bank interest rates and balance sheets. The sample runs from end-March 2002 to end-October 2014, and each observation is a two week period. Daily data on interest rates and LAF transactions are averaged over two week periods, and the bank balance-sheet data is available on a bi-weekly basis. The monetary policy rates considered are the reverse repo rate and the repo rate. The daily net injection by the RBI to banks through the LAF is equal to the amount lent through the overnight repo facility (amount outstanding on a given day), plus the amount lent through the term repo facility, less the amount borrowed through the reverse repo

[11] The majority of loans made by Indian banks have variable interest rates that are benchmarked to the base rate. For example, about 70 percent of the largest banks' retail loan portfolios are floating rate loans. See the Report of the Committee to Assess the Feasibility of Introducing More Long-Term Fixed Interest Rate Loan Products by Banks (Jan 2013). www.rbi.org.in/scripts/PublicationReportDetails.aspx?ID=696

[12] Summary statistics of the policy rate, and deposit and lending rates over periods of monetary tightening and loosening (Table IV of the chapter).

[13] CEIC sources these data series from the RBI.

facility. The market interest rate targeted by the monetary policy framework is the weighted-average call money rate (WACMR), and the two main bank interest rates considered are the rate on three-month certificates of deposits and the prime lending rate (the average of five major banks).

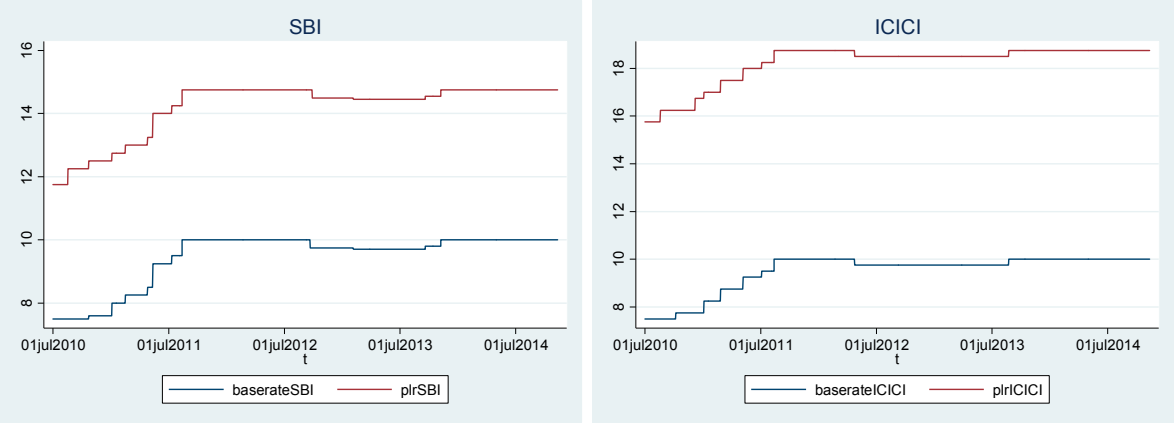
Table 1. Descriptive Statistics

	mean	std dev	min	max		mean	std dev	min	max
Reverse repo rate	5.56	1.14	3.25	7.5	WACMR	6.30	1.82	2.42	10.5
Repo rate	6.99	1.09	4.75	9	Deposit rate, 3-month	7.03	2.05	3.4	11.5
LAF net injection/NTDL (%)	0.22	1.26	-3.21	2.93	Prime lending rate	13.4	2.12	10.1	16.3
Cash reserve requirement	5.26	1.06	4	9	Bank Securities/Loans	52.0	15.6	36.9	85.7
Statutory liquidity ratio	24.4	0.83	22	25	Bank Loans/Assets	61.0	6.0	49.0	68.3

328 observations

Although banks now price loans from the base rate, they still report PLRs. In practice, the prime lending rate and base rate of banks move together. The figure below shows the PLR and base rate of State Bank of India (SBI), the largest publicly-owned bank, and ICICI, the largest privately-owned bank, respectively.

Figure 1. Bank Base Rates and Prime Lending Rates



V. EMPIRICAL METHOD

All of the variables used in this paper are I(1) with the exception of the LAF net injection, which is I(0).[14] A lag length of four two-week periods is used in both steps of the estimation, based on the Hannan and Quinn information criterion.[15]

A. Step 1—Pass-through to WACMR (target rate) from Monetary Policy

An error correction model which has two stages, corresponding to the long-run pass-through and short-run dynamics, is estimated as follows: [16]

$$(LR)\ WACMR_t = \beta_0 + \beta_1 \text{RepoRate}_t + \varepsilon_t$$

$$(SR)\ \Delta WACMR_t = \alpha ECT_t + \sum_{k=1}^{K} \delta_{2k} \Delta WACMR_{t-k} + \delta_{3k} \Delta(LAFnetinj / NDTL)_{t-k} + v_t$$

where the error correction term:

$$ECT_t = WACMR_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 \text{RepoRate}_{t-1}$$

is the residual from the LR equation, which measures period *t-1* deviations from the long-run stationary relationship.

The identifying assumption that underlies this step of the empirical method is that the repo rate is weakly exogeneous to the WACMR. That is, that there is no feedback to the repo rate from the WACMR. This is a reasonable assumption in that the repo rate is a policy rate decided by the central bank.

The average elasticity of WACMR with respect to the repo rate is:

[14] Results of the modified Dickey-Fuller test (Elliott et al. 1996) and the Phillips and Perron (1988) test are available upon request.

[15] Schwarz's Bayesian information criterion suggests a lag length of 2, but post-estimation tests for autocorrelation of residuals indicate that a longer lag length is appropriate.

[16] The CRR was also included in unreported estimations, as it is an actively used policy tool in India unlike in most other countries (Vegh 2012). In this empirical framework, however, changes in the CRR do not add additional information beyond changes in the repo rate.

$$\eta = \beta_1 \frac{mean(\text{RepoRate})}{mean(\text{WACMR})}$$

and the α coefficient is the share of the deviation from the LR equilibrium that decays each month, representing the speed of adjustment.

Alternate specification. In principle, the repo rate is the one policy rate which signals the stance of monetary policy, with the reverse repo rate being a fixed distance under the repo rate and the marginal standing facility (MSF)[17] rate being a fixed distance above the repo rate. However, before the LAF became to be consistently operated in deficit mode, there were considered to be two effective policy rates depending on the liquidity situation:

- Reverse repo rate when in a liquidity surplus $(LAFnetinj < 0)$[18]
- Repo rate when in a liquidity deficit $(LAFnetinj > 0)$

To account for the effective policy rate depending on the liquidity situation, a specification is estimated where both the reverse repo rate and the repo rate are included in the long-run stage:

$$(LR1)\ WACMR_t = \beta_0 + \beta_{11}\text{RevRepoRate}_t \times LiqDef_t + \beta_{12}\text{RepoRate}_t \times LiqDef_t + \varepsilon_t$$

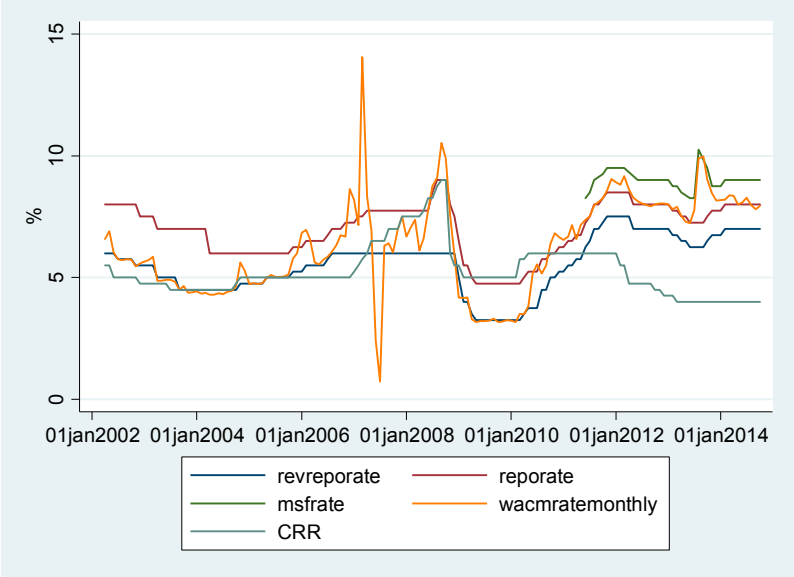
$$\text{where } LiqDef_t = \begin{cases} 0 & \text{if } LAFnetinj < 0 \\ 1 & \text{if } LAFnetinj > 0 \end{cases}$$

This allows us to ensure we are capturing the effects of policy rate changes throughout the sample period, and not missing information from focusing on the repo rate which is the single policy rate in the later years of the sample.

[17] The marginal standing facility (MSF) was introduced in April 2011, allowing banks to borrow overnight up to two percent of their respective NDTL at a margin above the repo rate. The MSF rate essentially replaced the bank rate as the upper bound of the policy corridor.

[18] In a surplus liquidity situation, the RBI would be absorbing liquidity from banks, at the reverse repo rate, making this the relevant policy rate. In a deficit liquidity situation, however, the RBI would be injecting liquidity at the repo rate.

Figure 2. Monetary Policy Rates



B. Step 2—Pass-through to Bank Interest Rates from WACMR

A vector error correction model is estimated with the following cointegrating relationships:[19]

$$(LRl)\ \ LendingRate_t = \theta_0^l + \theta_1^l WACMR_t + \varepsilon_{1t}$$

$$(LR2)\ \ DepositRate_t = \theta_0^d + \theta_1^d WACMR_t + \varepsilon_{2t}$$

The key short-run equations of interest in the VECM are represented as follows:

$$(SRl)\ \ \Delta LendingRate_t = \alpha_1^l ECT1_t + \alpha_2^l ECT2_t + \sum_{k=1}^{K} \delta_{3k} \Delta Rate_{i\,t-k} + \delta_{4k} \Delta WACMR_{t-k} + \delta_{5k} \Delta Loans/Assets_{t-k} + v_{lt}$$

$$(SRd)\ \ \Delta DespositRate_t = \alpha_1^d ECT1_t + \alpha_2^d ECT2_t + \sum_{k=1}^{K} \delta_{3k} \Delta Rate_{i\,t-k} + \delta_{4k} \Delta WACMR_{t-k} + \delta_{5k} \Delta Loans/Assets_{t-k} + v_{dt}$$

where the error correction terms are:

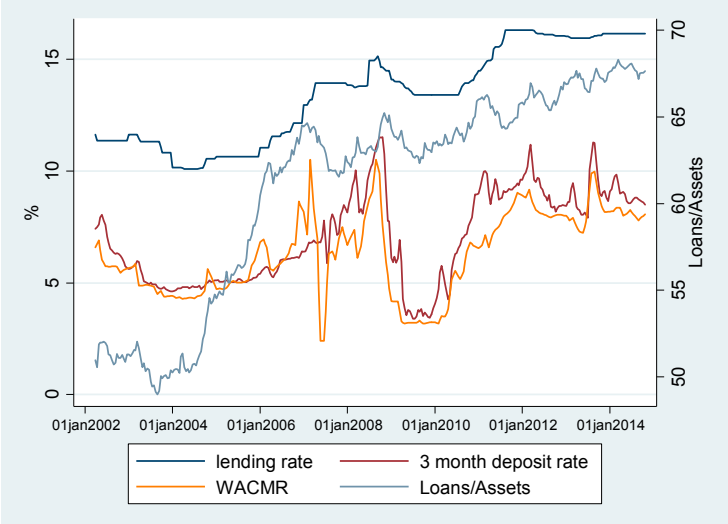
[19] Johansen's trace statistic method suggests the presence of two cointegrating relationships the WACMR, the deposit rate, the lending rate, which are represented here by (*LRl*) and (*LRd*). This will be discussed in the results section.

$$ECT1_t = \hat{\varepsilon}_{1t} \text{ and } ECT2_t = \hat{\varepsilon}_{2t}$$

The identifying assumptions that underlie this step of the empirical method are: (i) that the lending rate is weakly exogeneous to the WACMR, and (ii) that the deposit rate is weakly exogeneous to the WACMR. Assumption (i) is reasonable since changes in interest rates on bank loans, which will be of longer maturity, are unlikely to have feedback effects on overnight call money transactions. Assumption (ii) is perhaps more difficult in that an increase in the cost of deposits could make raising funds in the overnight market more attractive. With a preference for more stable and longer-maturity deposit funding, however, any feedback effects are likely small.

The coefficient on the first error correction term, $ECT1$, in (*SRl*) represents the speed of adjustment of the lending rate to a deviation in the relationship between the lending rate and WACMR. The coefficient on the second error correction term, $ECT2$, in (*SRl*) represents the speed of adjustment of the lending rate to a deviation in the relationship between the deposit rate and WACMR. Similarly, the coefficient on the first error correction term, $ECT1$, in (*SRd*) represents the speed of adjustment of the deposit rate to a deviation in the relationship between the lending rate and WACMR. Finally, the coefficient on the second error correction term, $ECT2$, in (*SRd*) represents the speed of adjustment of the deposit rate to a deviation in the relationship between the deposit rate and WACMR.

Figure 3. Interest Rates and the Aggregate Ratio of Bank Loans to Assets



C. Asymmetric Speed of Adjustment

The error correction terms in the step 2 estimation, $ECT1$ and $ECT2$, are then split into their positive and negative components (corresponding to a decrease in the WACMR, and an increase in the WACMR, respectively) to test whether the adjustment parameters are the same for instances of monetary loosening and tightening.

VI. RESULTS

The VECM estimation method is used due to the presence of cointegrating vectors in the variables. In the first step, trace statistics suggest the presence of a cointegrating vector between the repo rate and the WACMR. In the second step, no cointegrating vector between the deposit rate and the lending rate is found, but tests results indicate two cointegrating vectors between the WACMR, the deposit rate, and the lending rate.

Table 2. Summary of Cointegration Test Results

Variables	Maximum rank
WACMR, Repo rate	1
Lending rate, Deposit rate	0
Lending rate, Deposit rate, WACMR	2

Results from Johansen tests for cointegration, at 95% confidence level.

Deposit rates are expected to have an effect on lending rates, as deposit rates make up part of a bank's cost of funds, which should in turn affect the cost at which a bank lends out funds. The relationship between the rate on deposits of a particular maturity and the lending rate could be weak however, when deposit instrument under consideration does not make up an important part of the bank's borrowed funds and since lending rate decisions are determined only in part by the bank's cost of funds.

A. Step 1—Pass-through to WACMR (target rate) from Monetary Policy

Results from the first step of estimation show that there is a cointegrating vector between the monetary policy rate and the operating target rate. The coefficient on the repo rate in column (1) of Appendix Table 1A of 1.287 indicates a long-run elasticity between the repo rate and

the WACMR of 1.43. Another aspect of monetary policy, the CRR, was not found to have a significant relationship with the WACMR.[20] From the estimates of the alternate specification, where the effective policy rate is the reverse repo rate when there is a liquidity surplus and the repo rate when there is a liquidity deficit, we see that both rates are part of a cointegrating relationship with WACMR. The long-run elasticity of WACMR with respect to the reverse repo rate is 0.48 and the elasticity with respect to the repo rate is 0.99, shown in column (2), which together come to about the same elasticity with the WACMR as the repo rate does in the first specification. Thus, the repo rate appears to sufficiently capture the monetary policy stance of the RBI.

Turning to the estimates of the adjustment parameters and short-run coefficients, in Appendix Table 1B, we find an estimate of α equal to -0.06. This indicates that, when there is deviation from the equilibrium between the WACMR and the repo rate, the WACMR adjusts by 6 percent per time period towards the repo rate to re-establish equilibrium. At this rate, it would take 5.6 months (11.2 two-week periods) to achieve 50% of the pass-through from an increase in the repo rate.

B. Step 2—Pass-through to Bank Interest Rates from WACMR

The long-run results of the VECM estimated in the second step are shown in Appendix Table 2a. The first panel shows the cointegrating vector between the lending rate and the WACMR. The elasticity of the lending rate with respect to the WACMR is 0.30, meaning that, on average, only 30% of a change in the WACMR gets passed on to the lending rate. The coefficients in the lower panel indicate an elasticity of the three month deposit rate with respect to the WACMR of 1.11.

The estimates of the (symmetric) adjustment parameters and short-run coefficients are shown in Appendix Table 2b. The adjustment coefficients are as expected: the coefficient in the differenced lending rate equation on the lending error correction term is negative and

[20] The CRR was not found to have a cointegrating vector with WAMCR, nor was the CRR found to Granger-cause WAMCR after a simple VAR with both variables.

statistically significant, the coefficient in the differenced deposit rate equation on the deposit error correction term is negative and statistically significant, and the other adjustment parameter coefficients are statistically insignificant. The coefficient of -0.042 indicates that the lending rate adjusts by 4.2 percent per time period towards the WACMR after a deviation from equilibrium, resulting in 8.1 months to achieve 50 percent of the pass-through from a change in the WACMR. This estimate does not allow us to distinguish between instances of monetary tightening and loosening, which we will explore in a later section with estimates of asymmetric adjustment parameters. The deposit rate adjusts to deviations between the deposit rate and WACMR more quickly, with the coefficient of -0.081 indicating 4.1 months to achieve 50 percent of pass-through.

C. Cumulative Pass-through and Adjustment

This section combines the results of the two steps of estimation to give an overall picture of the transmission of monetary policy to deposit and lending rates. Over the two-steps of the analysis, the cumulative long-run elasticity of the deposit rate with respect to the repo rate is 1.58. This indicates that a 1 percentage point increase in the repo rate is associated with a 1.58 percentage point increase in the deposit rate over time. Pass-through to the lending rate is partial – the cumulative long-run elasticity of the lending rate with respect to the repo rate is 0.43. A larger pass-through to the deposit rate than to the lending rate is as expected, since the deposit rate in the analysis is a 3 month rate while loans tend to have longer maturities, and consistent with previous studies that find greater pass-through to interest rates with shorter maturities.

Table 3. Cumulative long run pass-through elasticities

Elasticity of lending rate with respect to repo rate	0.43
Elasticity of deposit rate with respect to repo rate	1.58

Author's calculations, using appendix tables 1a and 2a.

Next, we consider the speed of adjustment under the assumption that adjustment to a monetary tightening or loosening is symmetric. This assumption is relaxed in the next section to estimate potential asymmetric adjustment speeds. Pass-through to deposit and lending rates is relatively slow, with the deposit rate adjusting more quickly to monetary policy changes than does the lending rate (see Table 4). In the first step of transmission, it takes 5.6 months for 50% of the pass-through from a change in the repo rate to the WACMR. In the

second step, 50 percent of the pass-through from a change in WACMR to the deposit rate occurs in 4.1 months while it takes 8.1 months to pass-through to the lending rate.

Table 4. Speed of adjustment: Number of months required to complete 50% pass-through of repo rate increase

Lending Rate

	Repo-WACMR	WACMR-Lending	Total
Adjustment coefficient	-0.060	-0.042	
Number of periods	11.2	16.2	34
Number of months	5.6	8.1	17

Deposit Rate

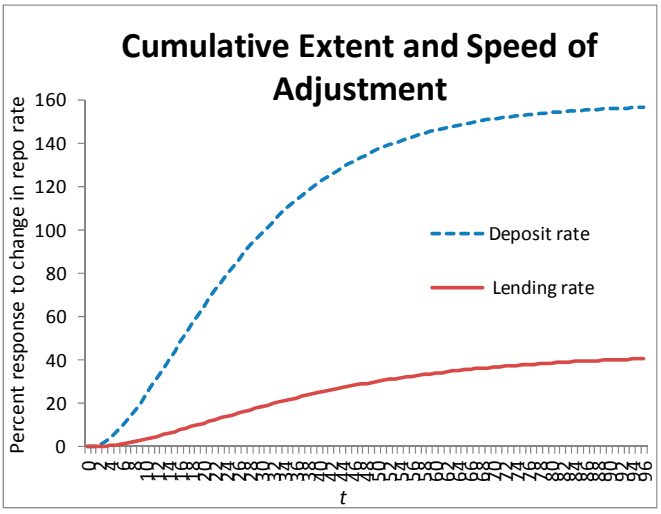
	Repo-WACMR	WACMR-Deposit	Total
Adjustment coefficient	-0.060	-0.081	
Number of periods	11.2	8.2	24
Number of months	5.6	4.1	12

Author's calculations, using appendix tables 1b and 2b.

The pass-through is non-linear with more of the adjustment taking place in earlier periods than later. It takes considerably longer for a pass-through of, say, 80 percent to occur.

The figure below shows the path of adjustment to the long-run equilibrium over time. The y-axis denotes the percent response of the bank interest rate to a change in the repo rate, and each tick on the x-axis denotes a two week period.

Figure 4. Cumulative Extent and Speed of Adjustment



Sørensen and Werner (2006), apply a similar method to estimating monetary policy transmission in the Euro Area. Across Euro Area countries, they estimate speeds of adjustment of short-term lending rates ranging from -0.027 to -0.925, with an average elasticity of 0.7 with respect to the policy rate. For deposit rates, they estimate adjustment parameters from -0.054 to -0.320, with an average elasticity of 0.145. While the results are not exactly comparable to the estimates in this paper,[21] it is interesting to note that pass-through to deposit and lending rates in India are within the ranges of pass-through estimates for a variety of maturities of Euro area deposits and loans found by Sørensen and Werner.

D. Asymmetric Speed of Adjustment

There is evidence of asymmetry in the pass-through to bank interest rates. The estimates of the speed of adjustment coefficients indicate that the lending rate adjusts more quickly to an increase in WACMR than to a decrease. In Table 5, the coefficient on ECT1 pos (lending) corresponds to a decrease in WACMR and the coefficient on ECT1 neg (lending) corresponds to an increase in WACMR. Also, the estimated speed of adjustment coefficients indicate that the deposit rate adjusts downwards when WACMR falls, but not upwards to a monetary tightening. On the right-hand side of Table 5, the coefficient on ECT2 pos (deposit) corresponds to decrease in WACMR, while the coefficient on ECT1 neg (deposit) corresponds to increase in WACMR. The adjustment coefficient on ECT2 pos (deposit) is negative and statistically significant, indicating that the deposit rate adjusts downward in response to a monetary loosening. The insignificant coefficient on ECT2 neg (deposit) indicates, however, that it does not adjust upwards after a tightening.

[21] Instead of focusing on a particular monetary policy indicator, their analysis is of the pass-through from different market interest rates to bank interest rates of comparable maturity. The paper is focused on studying interest rates of different maturities and heterogeneity in the Euro area.

Table 5. Bank interest rates and WACMR: Asymmetric SR VECM results

	Lending rate		***Deposit rate***
	D.Lending rate		D.Deposit rate
	Full sample		Full sample
ECT1 pos (lending)	-0.033	ECT1 (lending)	0.014
	(0.022)		(0.025)
ECT1 neg (lending)	-0.042***		
	(0.009)		
ECT2 (deposit)	0.010	ECT2 pos (deposit)	-0.111***
	(0.007)		(0.029)
		ECT2 neg (deposit)	-0.033
			(0.032)
Observations	324	Observations	324
F test: lending ECT asymmetry (*p-val*)	0.73	F test: deposit ECT asymmetry (*p-val*)	0.07

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Constant and lags of differenced WACMR, lending rate, deposit rate, loans/assets also included.

VII. ROBUSTNESS

As changes have been made to the monetary policy operating framework and the base rate system was put into place in 2010, it may be the case that monetary policy transmission has strengthened in recent years. In this section, the sample is split into two periods: (i) from end-March 2002 to end-August 2010; and (ii) from September 2010 to end-October 2014, and the long and short-run relationship between monetary policy and deposit and lending rates is estimated for both periods. The LAF has been in deficit for the duration of the second period.[22] The overall result is that, the extent of pass-through to the deposit rate has decreased somewhat in the later period, but the pass-through to the lending rate has increased. The speed of transmission to both the deposit rate and lending rate has increased.

[22] After alternating between liquidity deficit and surplus since the start of the LAF, liquidity has been in deficit continuously since September 9, 2010.

Appendix Table 3A shows the results of the long-run stage of the VECM estimated over the two periods. The extent of pass-through from the WACMR to the lending rate appears to have risen since 2010, with an elasticity of 0.20 in the first part of the sample and at 0.32 in the period since September 2010. The extent of pass-through to the deposit rate appears to have fallen, from an elasticity of 1.33 in the first eight years of the sample to an elasticity of 0.71 in the last four years. Appendix Table 3B shows the results of the short-run stage of the VECM estimated over the two periods. The estimated speeds of adjustment of both the deposit rate to the WACMR and the lending rate to the WACMR are higher in the second period than the first. In the recent period, the estimated adjustment coefficients indicate that it takes 2.1 months for 50 percent of the pass-through from a change in WACMR to the deposit rate to occur, and 5.3 months for 50 percent of the pass-through to the lending rate to occur.

Finally, estimation of separate adjustment parameters for monetary loosening and tightening was also done for both sample periods. Appendix Table 4A shows the results. The asymmetric adjustment of the lending rate to monetary tightening and loosening is present in both periods. For the deposit rate, the asymmetry whereby deposit rates adjust downward to loosening but not upwards to tightening is present in the first period but, in the recent period, the estimated adjustment coefficients suggest the deposit rate adjusts similarly to both loosening and tightening.

Several other specifications of the two steps of the analysis were estimated, as robustness checks. Namely, the average deposit rate on deposits with a one year maturity was used in the estimation instead of the three month deposit rate. Also, the prime lending rates of individual large banks were used in the estimation in turn, instead of the average prime lending rate. The results are quantitatively very similar to those presented.

VIII. CONCLUSION

This paper provides new evidence on monetary policy transmission in India from end-March 2002 to end-October 2014, using a two-step vector error correction model, to estimate the pass-through from (i) changes in the monetary policy stance to the operating target rate, and (ii) from the target rate to bank deposit and lending rates. The main findings are as follows:

First, there is significant, albeit slow, pass-through of policy changes to bank interest rates in India. The extent of pass-through to the deposit rate is larger than that to the lending rate, and the deposit rate adjusts more quickly to changes in the policy rate.

Second, there is evidence of asymmetric adjustment to monetary policy: throughout most of the sample period, deposit rates do not adjust upwards in response to monetary tightening, but do adjust downwards to loosening; and the lending rate adjusts more quickly to monetary tightening than to loosening.

Third, the extent of pass-through to the lending rate has increased in the later part of the sample period to a cumulative elasticity of 0.46 with respect to the policy rate. For both the deposit rate and lending rate, the speed of adjustment to changes in the policy rate has increased in the later part of the sample.

As changes in lending rates are only one part of the bank lending channel, future research on bank lending behavior is needed to better understand transmission through the bank lending channel in India.

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Appendix Tables

Table 1A. WACMR (target rate) and policy rate: LR VECM results

	(1) WACMR Full sample	(2) WACMR Full sample
Repo rate	1.287***	
	(0.213)	
Reverse repo rate * Liq deficit dummy		1.815***
		(0.379)
Repo rate * Liq deficit dummy		1.285***
		(0.244)
Observations	324	324
Pass-through elasticity (Reverse repo rate)		0.48
Pass-through elasticity (Repo rate)	1.43	0.99
Mean dep. variable	6.30	6.30

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 1B. WACMR (target rate) and policy rate: SR VECM results

	(1)	
	D.WACMR	D.RepoRate
	Full sample	Full sample
ECT	-0.060***	0.009
	(0.015)	(0.006)
LD.reporate	0.510***	0.401***
	(0.147)	(0.054)
L2D.reporate	0.080	-0.121**
	(0.160)	(0.059)
L3D.reporate	-0.148	0.264***
	(0.144)	(0.053)
LD.WACMR	0.746***	0.049**
	(0.055)	(0.020)
L2D.WACMR	-0.305***	-0.029
	(0.066)	(0.025)
L3D.WACMR	0.133**	0.037*
	(0.058)	(0.021)
R2	0.449	0.329
Observations	324	324

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Specification includes constant and lags of differenced netlafNTDL.

Table 2A. Bank interest rates and WACMR: LR VECM results

Lending rate	Lending rate Full sample
WACMR	0.638***
	(0.100)
Observations	324
Pass-through elasticity (WACMR)	0.30
Mean dep. Variable	13.4

Deposit rate	Deposit rate Full sample
WACMR	1.235***
	(0.116)
Observations	324
Pass-through elasticity (WACMR)	1.11
Mean dep. Variable	7.01

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2B. Bank interest rates and WACMR: SR VECM results

	Lending rate	***Deposit rate***
	D.Lending rate	D.Deposit rate
	Full sample	Full sample
ECT1 (lending)	-0.042***	0.031
	(0.008)	(0.022)
ECT2 (deposit)	0.010	-0.081***
	(0.008)	(0.022)
LD.WACMR	0.007	0.311***
	(0.024)	(0.065)
L2D.WACMR	-0.053*	-0.177**
	(0.030)	(0.081)
L3D.WACMR	0.084***	0.195***
	(0.026)	(0.071)
Observations	324	324

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Specifications include constant, and lags of differenced lending rate, deposit rate, and loans/assets.

Table 3A. Bank interest rates and WACMR: LR VECM results, Split Sample

Lending rate	Lending rate Apr2002-Aug2010	Lending rate Sep2010-Oct2014
WACMR	0.442***	0.637***
	(0.123)	(0.095)
Observations	216	108
Pass-through elasticity (WACMR)	0.20	0.32
Mean dep. Variable	12.2	15.8

Deposit rate	Deposit rate Apr2002-Aug2010	Deposit rate Sep2010-Oct2014
WACMR	1.466***	0.806***
	(0.129)	(0.166)
Observations	216	108
Pass-through elasticity (WACMR)	1.33	0.71
Mean dep. Variable	6.00	9.03

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 3B. Bank interest rates and WACMR: SR VECM results, Split Sample

	Apr2002-Aug2010		Sep2010-Oct2014	
	Lending rate	***Deposit rate***	***Lending rate***	***Deposit rate***
	D.Lending rate	D.Deposit rate	D.Lending rate	D.Deposit rate
ECT1 (lending)	-0.045***	0.046	-0.063***	-0.160
	(0.015)	(0.033)	(0.016)	(0.102)
ECT2 (deposit)	-0.002	-0.067**	0.025**	-0.153***
	(0.012)	(0.026)	(0.011)	(0.056)
LD.WACMR	-0.002	0.248***	0.025	1.076***
	(0.029)	(0.067)	(0.045)	(0.227)
L2D.WACMR	-0.067*	-0.153*	0.041	-0.575**
	(0.037)	(0.084)	(0.055)	(0.281)
L3D.WACMR	0.089***	0.219***	-0.053	-0.119
	(0.033)	(0.075)	(0.046)	(0.233)
Observations	216	216	108	108

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Specifications include constant, and lags of differenced lending rate, deposit rate, and loans/assets.

Table 4A. Bank interest rates and WACMR: Asymmetric VECM results, Split Sample

Lending rate	D.Lending rate Apr2002-Aug2010	D.Lending rate Sep2010-Oct2014
ECT1 pos (lending)	0.009	0.004
	(0.033)	(0.053)
ECT1 neg (lending)	-0.053***	-0.061***
	(0.015)	(0.019)
ECT2 (deposit)	0.000	0.030**
	(0.010)	(0.012)
Observations	216	108
F test: lending ECM asymmetry (*p-val*)	0.08	0.28

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Constant and lags of differenced WACMR, lending rate, deposit rate, loans/assets also included.

Deposit rate	D.Deposit rate Apr2002-Aug2010	D.Deposit rate Sep2010-Oct2014
ECT1 (lending)	0.036	-0.215**
	(0.034)	(0.083)
ECT2 pos (deposit)	-0.113***	-0.117*
	(0.033)	(0.091)
ECT2 neg (deposit)	-0.023	-0.221***
	(0.026)	(0.130)
Observations	216	108
F test: deposit ECM asymmetry (*p-val*)	0.01	0.04

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Constant and lags of differenced WACMR, lending rate, deposit rate, loans/assets also included.