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Interest Rate Volatility and Risk in Indian Banking

Ila Patnaik and Ajay Shah

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Prepared by Ila Patnaik and Ajay Shah[1]

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Abstract

The easing of controls on interest rates has led to higher interest rate volatility in India. Hence, there is a need to measure and monitor the interest rate exposure of Indian banks. Using publicly available information, this paper attempts to assess the interest rate risk carried by a sample of Indian banks in March 2002. We find evidence of substantial exposure to interest rates.

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Authors' E-Mail Addresses: ila@icrier.res.in; ajayshah@mayin.org

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I. Introduction

The major focus of prudential regulation in developing countries has traditionally been on credit risk. While banks and their supervisors have grappled with nonperforming loans for several decades, interest rate risk is a relatively new problem.

Under financially repressed regimes, interest rates are administered and exhibit near-zero volatility. The easing of financial repression that took place in many countries in the 1980s and 1990s has now generated some experience with interest rate volatility in these countries. Administrative restrictions on interest rates in India have been steadily eased since 1993. This has led to increased interest rate volatility. Figure 1 shows the recent time series of the long rate, which appears to exhibit high volatility.

Table 1 shows that India has one of the highest levels of interest rate volatility in the world. This interest rate volatility appears to be consistent with the crawling peg currency regime in the context of a capital account that is being slowly liberalized. Evidence from a number of studies that characterize India's currency regime suggests that the rupee has been nominally pegged to the U.S. dollar (Patnaik, 2003; Calvo and Reinhart, 2002; Reinhart and Rogoff, 2002).

Figure 1. The 10-year Spot Rate

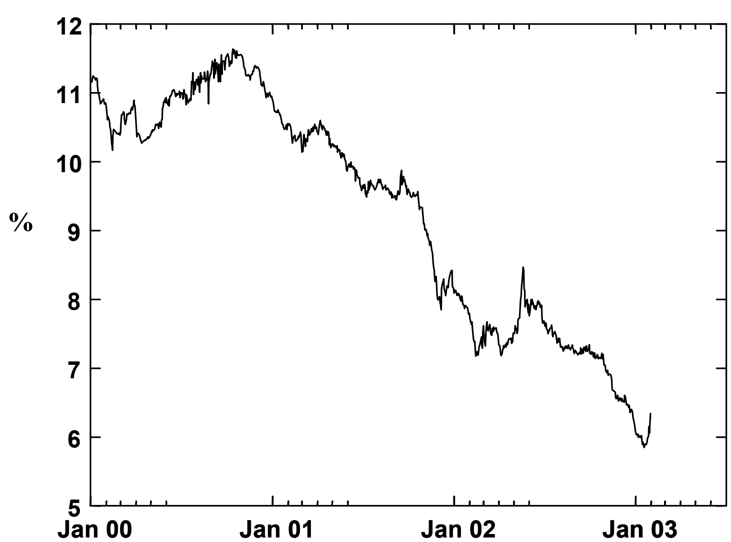

Table 1. Cross-Country Evidence on Interest Rate Volatility (2000) from Baig (2001)[2]

Rank	Country	Volatility
1	Turkey	32.93
2	Chile	1.74
3	India	1.72
4	Mexico	1.36
5	U.K.	0.91
6	Indonesia	0.88
7	Poland	0.81
8	Philippines	0.77
9	Hungary	0.56
10	Czech Republic	0.44
11	Thailand	0.41
12	Switzerland	0.36
13	Brazil	0.34
14	Singapore	0.24
15	South Africa	0.19
16	Israel	0.16
17	Canada	0.16
18	Australia	0.16
19	New Zealand	0.15
20	Sweden	0.11
21	Germany	0.11
22	Korea	0.08
23	Malaysia	0.06
24	Japan	0.05

Inflation rates have fallen sharply in recent years. This may be attributed partly to the liberalization of Indian industry and partly to lower monetization of public debt. Low inflation, opening up of financial markets, and falling international rates have resulted in a significant decline in interest rates in the last five years. Currently, interest rates in India are at historical lows. The drop in interest rates has generated substantial trading profits for banks that had a large investment portfolio.

[2] See Baig (2001): standard deviation of differences in short-term interest rates. For India, the interest rate is the call money rate.

Some of these banks may be exposed if interest rates were to rise. India's large fiscal deficit and signs of economic revival are factors that are expected to contribute to a rise in rates. In addition, as the fiscal situation is not improving, there is the possibility of higher monetization of public debt that could change inflationary expectations and push up the long rate.

This concern is reinforced by the relatively large fraction of assets held in government bonds by Indian banks. Government bond holdings of banks in India stood at 27.2 percent of assets as of March 31, 2001 (RBI, 2001). In contrast, government bonds comprised only 4.6 percent of bank assets in the United States and a mere 0.3 percent of bank assets in the United Kingdom. In the Euro area the ratio was a little higher at 6.9 percent (Study Group on Fixed Income Markets, 2001). Banks in India are required to hold 4.5 percent of their deposits as cash with the Reserve Bank of India (RBI). In addition to the cash reserve ratio, banks are required to hold a part of their deposits in the form of liquid assets, i.e., government securities. The statutory liquidity ratio (SLR) has remained unchanged at 25 percent since October 1997. This helps explain the major share of bank holdings of government bonds.

On the asset side of a bank balance sheet, the bulk of corporate credit in India tends to be in the form of floating-rate loans. These are effectively of a low duration. On the liability side of the balance sheet, for the commercial banking system as a whole in India, short-term time deposits and demand deposits, constitute about 50 percent of total deposits. Duration mismatches between loans and advances on the asset side and deposits on the liability side are typically not very large.

On the other hand, the bulk of government bonds are fixed-rate products. These have a higher duration than the typical credit portfolio. Movement of interest rates thus normally has a bigger impact on the investment portfolio of a bank. The relatively flat yield curve in recent years has reduced interest margins from the traditional 'maturity transformation' function of banking. This may have encouraged banks to look at their investment portfolios as a source of profit. This tendency, as well as difficulties in creating sound processes for handling credit portfolios, has led some banks to hold government securities in excess of reserve requirements. Moreover, capital adequacy requirements proposed by the Bank for International Settlements (BIS) for addressing interest rate risk have not yet been implemented in India. As a result, banks have incentives to alter their portfolios in favor of fixed-rate long-term government bonds. They, thus, have incentives to substitute interest rate risk for credit risk (Robinson, 1995).

Internationally, banks routinely use interest rate derivatives to hedge interest rate risk. In India, while the Reserve Bank of India (RBI) guidelines advise banks to use forward rate agreements and interest rate swaps to hedge interest rate risks, these markets are quite shallow. The market for exchange-traded interest rate derivatives has recently been started, but current regulations inhibit banks from using it.

These arguments suggest that interest rate risk is an important issue for banks and their supervisors in India. There is a need for measuring such exposure, and for an evaluation of associated policy issues.

The RBI has initiated two approaches for better measurement and management of interest rate risk. There is now a mandatory requirement that assets and liabilities should be classified by time-to-repricing, to create the 'interest rate risk statement' (RBI, 1999). This statement is required to be reported to the board of directors of the bank, and to the RBI (but not to the public). In addition, the RBI has created a requirement that banks have to build up an 'investment fluctuation reserve' (IFR), using profits from the sale of government securities, in order to better cope with potential losses in the future (RBI, 2002).

The measurement and monitoring of interest rate risk in most banks, especially in public sector banks which constitute 75 percent of the banking system, remains largely focused on the earnings approach. While some banks show an awareness of modern notions of interest rate risk, most banks appear to focus on the traditional 'earnings perspective.' The interest rate risk statement is also based on the earnings approach. Banks are required to submit this statement to the RBI.

In this paper we argue that measuring interest rate risk using GAP and DGAP analysis has limitations when interest rate volatility is high. Focusing on the impact of interest rate shocks on the net present value (NPV) of cash-flows on the assets and liabilities sides gives a significantly more accurate measure of the impact on equity when examining parallel shifts of the yield curve exceeding 100 bps.

This paper seeks to measure the interest rate risk exposure of banks in India, using publicly disclosed information. The questions addressed are:

- What are the interest rate scenarios in India on which banks should focus?

- How can the impact of large interest rate shocks on equity capital of banks be best measured?

- Are banks in India homogeneous in their interest rate risk exposure, or is there considerable cross-sectional heterogeneity?

The paper is organized as follows. Section II describes the methodology used and compares it to other ways of measuring interest rate risk for banks. Section III presents the results of our study for a sample of 42 banks in India. Section IV concludes and presents some policy implications.

II. Methodology

A mismatch of the maturity pattern of assets and liabilities exposes a bank to interest rate risk. If a bank has a well-matched maturity structure of assets and liabilities, then an interest rate shock would generate no residual impact if both assets and liabilities are marked-to-market.

A. Gap Analysis

Interest rate risk measurement can be done by inspecting assets and liabilities classified into maturity buckets, and computing the 'gap' between assets and liabilities, in each time bucket. A bank can compute the gap statement where each component is classified into a time bucket based on time to repricing.

In India, this 'interest rate risk statement' is computed by banks and submitted to the regulator, the Reserve Bank of India. The statement is, however, not required to be made public. Public disclosure consists of what is called 'the liquidity statement,' which shows the maturity distribution where each component is classified based on the time to maturity. If gap analysis had to be undertaken by independent analysts, then this would require imputation of the interest rate risk statement using public disclosures.

While gap analysis reveals mismatches at various maturities, it does not offer a mechanism for reducing them into a single scalar measure of the vulnerability of the bank, and in judging the economic significance of the vulnerability.

B. Sensitivity Analysis of the Market Value of Equity (MVE)

While the gap statement is a useful one, there is a need to reduce the gap statement into a compact depiction of the vulnerability of the bank.

One traditional approach, called the 'earnings perspective' consists of focusing on the flow of earnings. This would involve measuring the impact on the net interest income of a unit change in interest rates. However, changes in these flows tell an incomplete story, insofar as changes in interest rates could have a sharp impact upon the stock of assets and liabilities of the bank, on a marked-to-market basis.

This motivates the 'Net Present Value (NPV) perspective,' which seeks to measure the impact of interest rate fluctuations upon the net present value of assets, and liabilities, and hence equity capital. This approach is sometimes termed the 'Sensitivity Analysis of the Market Value of Equity' (MVE).

The NPV approach seeks to measure the impact of a given interest rate shock on the market value of equity. This reduces the exposure of the bank to a single scalar. The impact of a given shock on the market value of equity can be compared to the stock of equity capital on the balance sheet, so as to judge the economic significance of this exposure. In the literature, there has been a focus on one specific kind of interest rate shock: a parallel shift of the yield curve.

This method involves computing the NPV of assets and liabilities under a baseline scenario, and under alternative simulated scenarios. In order to compute NPV, the assets and liabilities in the maturity statement need to be expressed as cash flows, and not just face values. For example, a government bond which pays Rs.100 after *T* years also pays half-yearly coupons. Information on all these cash flows is required in computing the NPV.

In India, public domain disclosures show 'the maturity statement,' where components are classified by time to maturity. These disclosures show face values of various assets, and not intermediate cash flows. Hence, we undertake a complex imputation procedure, which starts from public domain disclosure of the maturity statement, reclassifies all components by time to repricing, imputes intermediate cash flows, and results in a statement of cash flows at future dates. This imputation procedure is described in more detail in Appendix I.

Through this imputation procedure, we arrive at an estimate of the gap cash flows ($c_1 ... c_N$), with dates ($t_1 ... t_N$). The spot yield curve gives corresponding interest rates ($r_1 ... r_N$). The present value of these cash flows is:

$$\text{NPV} = \sum_{i=1}^{N} c_i e^{-r_i t_i} \tag{1}$$

We seek to understand the sensitivity of NPV to a parallel shift of the yield curve by λ. This motivates a function $P(\lambda)$, which yields the NPV under a parallel shift of λ:

$$P(\lambda) = \sum_{i=1}^{N} c_i e^{-(r_i + \lambda) t_i} \tag{2}$$

We define the function $\Delta(\lambda)$ as the market value impact of a parallel shift λ:

$$\Delta(\lambda) = \sum_{i=1}^{N} c_i e^{-(r_i + \lambda) t_i} - \sum_{i=1}^{N} c_i e^{-r_i t_i} \tag{3}$$

The above expression measures the impact upon market value of equity of a parallel shift in the spot yield curve, given a set of gaps c_i.

One approach which has been used in the literature consists of applying such computations to a range of shocks: -300 bps, -200 bps, -100 bps, 0, +100 bps, +200 bps and +300 bps. This shows the effect on market value of equity under a wide range of interest rate scenarios. However, it does not offer a statistical foundation or justification for any of these scenarios.

In this study, we implement the proposed BIS norms for measuring interest rate risk exposure of banks. As in the literature, the Basel Committee on Banking Supervision (2001) takes the view that the economic significance of parallel shifts substantially exceeds the significance of localized movements in certain parts of the yield curve.

BIS proposals suggest that a parallel shift of 200 basis points should be simulated in the absence of data analysis. Alternatively, it suggests that five years of daily data should be utilized in measuring the change in the long rate over 240-day holding periods and the 1st percentile and the 99th percentile should be used for the simulations.

In India a calendar year maps to 288 trading days. Table 2 shows summary statistics of the 288-day change in the 10-year rate in India. We see that over this period, i.e., from 1/1/1997 to 31/7/2002, the typical year has experienced a drop in the 10-year rate. For Indian data, the BIS procedure implies simulating parallel shifts of the yield curve using the 1^{st} and 99^{th} percentiles of the distribution of the 288-day rate. We see that these values are -320 basis points and +112 basis points, respectively.[3] Looking forward, there is no reason to expect asymmetry in movements of the yield curve. Hence, in this paper, we focus on the 320 basis point shock.

Table 2. The Change in the 10-year Rate Over 288 days: Summary Statistics

Mean	-0.8828
Std. Devn.	1.0411
1%	-3.2024
Median	-0.7164
99%	1.1233
Observations	1321

C. Duration

As mentioned above, we seek to understand the sensitivity of NPV to a parallel shift of the yield curve by λ. Hence, we focus on expression (3), the change in the price of a bond,

$$P(\lambda)= \sum_{i=1}^{N} c_i e^{-(r_i+\lambda)t_i}$$

Differentiating,

$$\frac{\partial P(\lambda)}{\partial \lambda} = -\sum_{i=1}^{N} t_i c_i e^{-rt_{i i}} \tag{4}$$

[3] These calculations use the database of daily spot yield curves from 1/1/97 to 31/7/2002 produced at NSE (Thomas and Pawaskar 2000, Darbha et al. 2002) and evaluate the interest rate at t=10 every day, thus giving us a time series of the ten-year rate. This paper is based on data for 2001–02. Hence, we have projections of future cash flows as of March 31, 2002. We, therefore, use estimates of the spot yield curve as of March 31, 2002 in reducing cash flows into NPV.

$$\frac{1}{P(0)}\frac{\partial P(\lambda)}{\partial \lambda} = -D_{FW} \tag{5}$$

where D_{FW} is the Fisher-Weil duration, defined as $\sum t_i c_i e^{-rt_i} / NPV$ (Fisher & Weil, 1971). This measures the percentage change in a bond price for a small parallel shift in the yield curve, and hence serves as a first order measure of interest rate risk. Roughly speaking, a 1 percent parallel shift in the yield curve generates a *D* percent drop in the price of a bond with duration D.

Duration reduces the cash flows on assets and liabilities of a bank into a single scalar metric. When duration is computed on the gap cash flows, it shows the sensitivity of the equity of the bank to a parallel shift of the yield curve. The phrase 'duration of equity' is hence used in the context of interest rate risk of banks. However, duration is a first-order Taylor approximation. It is inaccurate when measuring the impact of large interest rate shocks.

Figure 2. Impact of Interest Rate Shocks: An Example

This figure shows the impact on market value of equity of shocks ranging from –400 basis points to 400 basis points, for one bank. The duration-based linear approximation of the exposure is also superimposed. We see that for large shocks, such as 320 basis points, there is a significant error in duration-based analysis

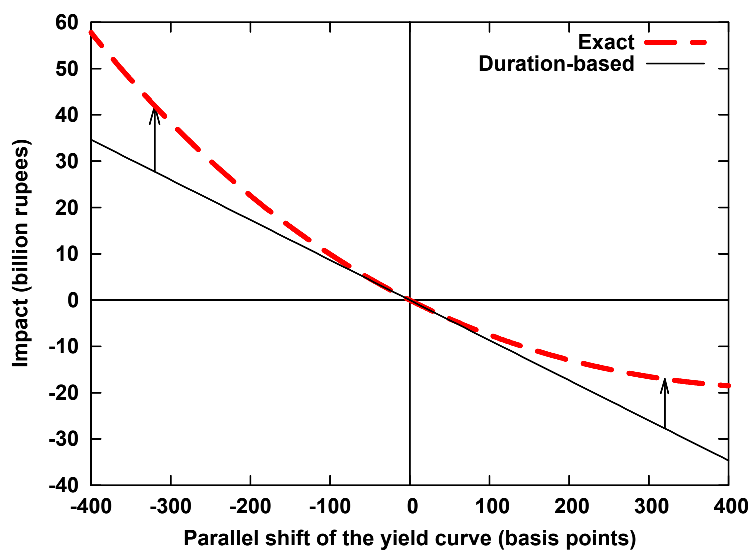

Figure 2 shows the exact impact of various interest rate shocks compared with the duration approximation for one large bank in India. The first order Taylor-approximation (using duration) is also shown in the figure. This shows that for shocks larger than 100 basis points, the divergence between the exact impact and the first-order Taylor-approximation is significant.

The shock that we seek to simulate (320 basis points) is a large one. When simulation of such large shocks is required, the first order approximation that duration offers is inaccurate. Hence, we do not use duration in this paper.

D. Value at Risk

Value at Risk (VaR) offers an alternative framework for risk measurement (Jorion, 2000). To calculate the VaR with respect to interest rate risk of a bank, at a 99 percent level of significance for a one-year horizon, we would need to go through the following steps:

1. Model the data generating process for the spot yield curve,

2. Simulate *N* draws from the yield curve on a date one year away,

3. Reprice assets and liabilities at each of these draws,

4. Compute the 1st percentile of the distribution of profit/loss seen in these *N* realizations.

This procedure is difficult to implement, primarily because the existing state of knowledge on the data generating process for the yield curve is weak. The procedure that we have adopted in this paper can be interpreted as a limited and much simplified version of VaR. First, we focus on parallel shifts of the yield curve as the prime source of risk. This is the assumption made in existing BIS proposals. It is a simplification because it ignores risks that arise from other types of fluctuations of the yield curve. Second, the BIS proposal suggests that the distribution of one-year changes in the long rate should be utilized to read off the 1st percentile point. This is again a simplification, given the fact that a daily time-series of overlapping one-year changes in the long rate exhibits violations of independence. Third, we compute the profit/loss consequences of this interest rate shock. Again, we are aware that the profit/loss associated with a 1st percentile event on the interest rate process is not the 1st percentile of the distribution of profit/loss, given the nonlinearities of transformation in computing NPV.

Thus, the procedure adopted here, while widely used in industry and consistent with existing BIS proposals, may at best be interpreted as a poor approximation of VaR at a 99 percent level of significance on a one-year horizon. If VaR is the correct tool for interest rate risk measurement, this framework clearly entails substantial model risk.

E. Issues in Estimating Interest Rate Risk Exposure of Banks

The methodology outlined above is a simplified but implementable path to obtaining estimates of the interest rate risk exposure of banks. However, it does involve many simplifying assumptions and is subject to certain criticisms.

(i) Nonparallel shifts of the yield curve

First, it proposes that we examine the impact of only a parallel shift of the yield curve. In practice, the exposure of banks can be larger or smaller under other types of fluctuation of the yield curve. For example, if the yield curve twists anticlockwise, with a higher rise in the long rate and a smaller rise (or even a drop) in the short rate, then the exposure of banks which have long assets and short liabilities would be even greater than those estimated under a parallel shift. Conversely, clockwise twisting of the yield curve would involve smaller losses to a bank with long assets and short liabilities.

(ii) Use of riskless yield curve in discounting all cash flows

The Government of India (GOI) yield curve for government paper is used in discounting all cash flows of assets and liabilities. This is, strictly speaking, incorrect, since the interest rates used in the real world for many elements are not equal to those faced by the government. However, our focus is upon the change in NPV when there are shocks to the yield curve. We do not seek to accurately measure the level of NPV of the bank. The error induced by using the riskless rate is hence of second-order importance.

(iii) Difficulties in imputation of cash flows

One major difficulty faced in this process is that of accurately estimating future cash flows using public information. There are primarily two areas where there are difficult issues in imputation—the treatment of savings and current accounts, and the extent to which assets have floating rates. Of these, the most important issue affecting the imputation of future cash flows lies in assumptions about the extent to which savings and current accounts can be viewed as long-term liabilities.

Technically, savings and current deposits are callable, and can flee at short notice. This suggests that they should be treated as short-dated liabilities. In practice, banks all over the world have observed that these deposits tend to have longer effective maturities or repricing periods (Houpt and Embersit, 1991). To the extent that these liabilities prove to be long-dated, banks would be able to buy long-dated assets, and earn the long-short spread, without incurring interest rate exposure.

The assumptions we use in this paper, which are loosely grounded in empirical experience in India, are as follows. We assume that 15 percent of savings accounts are volatile, and the remainder has a maturity of 1–3 years. We assume that 25 percent of current accounts are volatile, and the remainder has a maturity of 1–3 years. These assumptions are more optimistic than RBI's guidelines for the interest rate risk statement (RBI, 1999). The guidelines suggest that 75 percent of savings deposits be classified as 'stable,' and that these have an effective maturity of 3–6 months. This appears to be an unusually short time horizon, given (a) the stability of savings accounts in India, and (b) the stability of the savings bank interest rate in India. The RBI's guidelines suggest that 100 percent of current accounts should be considered volatile. This appears to be an unusually strong assumption, when compared with the experience of banks in India.

The extent to which savings and current deposits move when interest rates change is a behavioral assumption, and alternative assumptions could have a significant impact upon our estimates of interest rate risk.[4] Hence, in Appendix II, we engage in sensitivity analysis where these behavioral assumptions are altered, using one of the banks in our sample as an illustration.

Another problem concerns the extent to which assets or liabilities have floating rates. In the case of investments, which are made up of government bonds and corporate bonds, we make the assumption that all assets are fixed-rate. Floating rate assets appear to predominate among demand loans, term loans and bills. The prime lending rate (PLR) is linked to the bank rate usually announced by the RBI twice a year. We classify PLR linked loans in the 3–6 month time bucket. We further assume that all demand loans and term loans are PLR-linked and that 90 percent of bills are PLR-linked.

(iv) The usefulness of simple models

The approach taken here could be criticized on the grounds that it constitutes a highly oversimplified model of the true interest rate risk of a bank. There are, however, four main arguments in favor of our simple approach:

Interest rate derivatives: By world standards, Indian banks do not make use of interest rate derivatives to transform the balance sheet.[5]

Options: Banks in India do carry significant risk, in addition to that modeled by us, owing to prepayment options which are believed to exist for a significant fraction of the assets. In

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[4] One facet of this problem is linked to money market mutual funds (MMMFs), a product which competes with demand deposits. In countries where MMMFs are well established, a significant fraction of short-term funds are held in them. India has yet to create a significant MMMF industry. Hence looking forward, banks will have to deal with increased competition from MMMFs.

[5] From 1999 onwards, RBI regulations have permitted banks to engage in interest rate swaps and forward rate agreements. In June 2003, exchange-traded interest rate futures were available. However, both these markets have thus far acquired negligible open interest. Hence, for all practical purposes, we can assume that banks are not altering their interest rate risk exposure using interest rate derivatives.

particular, this is an important issue in the treatment of home loans. However, as of March 31, 2002, home loans were a relatively small fraction of bank assets.[6]

Basis risk: In this paper, we assume that all interest rates, on both assets and liabilities, move synchronously with parallel shifts in the government yield curve. In practice, most rates do exhibit idiosyncratic variation. This implies that banks carry basis risk, over and above that measured in this paper. In particular, banks carry significant basis risk in terms of the lack of adjustment of the savings bank rate to fluctuations in the yield curve. The savings deposit rate continues to be an administered rate. The RBI, which fixes this rate, has not been reducing it in alignment with the downward shift of the yield curve. This is inconsistent with the baseline assumptions, that 85 percent of savings deposits have a maturity of 1–3 years.

Requisite information: An effort could, in principle, be made using much more detailed information about bank assets and liabilities. Banks do have access to much more information compared to the limited information which is placed in the public domain.

Wright and Houpt (1996) describe a comparison of a simple model, similar to that presented here, against a much more extensive modeling effort at the U.S. Office of Thrift Supervision. The comparison reveals that the simple model yields values which are fairly close to those obtained using the more complex effort. This helps encourage us on the usefulness of simple models.

Our conservative treatment of optionality and basis risk suggests that the estimates of interest rate risk shown here contain a downward bias. In reality, banks in India are likely to be much more vulnerable to interest rate fluctuations.

F. Data Description

Our data set of 42 banks covers around 80 percent of bank deposits. For the purpose of monitoring liquidity risk, since 1999, the RBI requires banks to disclose a statement on the maturity pattern of their assets and liabilities classified in different time buckets. This ‘liquidity table’ reports assets and liabilities of the bank classified according to when they are expected to mature. Liabilities consist of deposits and bank borrowing classified into different time buckets. While bank borrowings and time deposits are grouped according to their time remaining to maturity, current and saving deposits that do not have specific maturity dates are classified according to RBI’s asset liability management guidelines. Assets consist of loans and advances and investments. Investments in corporate and government debt are combined into one category and classified according to their time to maturity. Similarly, loans are classified according to their maturity patterns.

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[6] It should be noted that home loans are experiencing extremely high growth rates in India. In the future, a more thorough treatment of embedded options will become more important in the measurement of the interest rate risk of Indian banks.

As mentioned before, the RBI requires banks to additionally submit an ‘interest rate risk statement,’ where assets are classified by their time to repricing. However, this statement is not released to the public and hence not available to us for analysis.

Apart from the liquidity statement, we utilize some other information from the balance sheet. Table 3 provides an example of the information in the public domain about one bank in our sample.

In this paper, ‘equity capital’ is measured as the sum of paid up capital and reserves. Existing RBI rules do not require banks to do a full marked-to-market of all securities. As a consequence, many banks had unrealized gains on their government bond portfolios as of March 31, 2002. To the extent that this is the case, our estimate of their equity capital is understated. However, our estimates of the rupee impact of a given interest rate move should be reasonably accurate.

III. Results

Before reporting the results of our methods for all the banks in our data set, we show their application of our methodology to one large bank in the sample:

1. Table 3 shows the maturity statement, and auxiliary annual report information.

2. Table 4 applies the methods of Appendix I to this information. It gives us vectors of cash flows for assets and liabilities.

3. Table 5 shows the NPV impact of simulated interest rate shocks under our assumptions. This calculation suggests that on March 31, 2002, the bank would lose 11.2 percent of equity capital in the event of a 320 bps parallel shift of the yield curve.

Table 5 shows the effect of a hypothetical parallel shift of the yield curve as of March 31, 2002. For a 320 bps shock, we see that the impact would be Rs.1,704 crore[7] on equity capital. This impact works out to 11.19 percent of equity capital and 0.49 percent of assets. To the extent that the bank has unrealized gains on government bonds, and the balance sheet does not reflect a full marking to market, our estimate of equity capital is an underestimate. Our estimate, that the bank could lose roughly Rs.1,704 crore in the event of a 320 bps parallel shift of the yield curve, however, is unaffected.

In Appendix II, we also do a sensitivity analysis for this bank using four sets of assumptions about the extent to which savings and current accounts are long dated.

[7] Crore equals 10 million.

Table 3. Accounting Information: Example

The maturity pattern of assets and liabilities is derived from the 'liquidity statement' which is disclosed in the annual report of banks. In addition, we also require other information from the annual report, which is used in estimating the maturity pattern of cash flows. For example, equity capital calculated as the sum of paid up capital and reserves, is equal to Rs.15,224 crore.

Liquidity Statement
(in Rs. Crore)

	1-14d	15-28d	29d-3m	3m-6m	6m-12m	1-3y	3-5y	>5y	Sum
Advances	21,425	9,935	10,967	1,293	2,274	27,898	9,766	154,07	98,965
Investments	7,635	879	4,494	7,151	5,361	30,085	22,269	625,99	140,473
Deposits	17,414	1,593	3,105	4,532	9,407	159,207	46,804	7,253	249,315
Borrowings	0.1	0.9	26.1	33.2	338.9	732.8	907.2	114.7	2,153.9

Other Information from Annual Report
(in Rs. Crore)

Parameter	Value
Schedule 9 Bills	11,555
Schedule 9 Demand loans	64,178
Schedule 9 Term loans	45,073
Cash in hand	1,053
Balance with RBI	20,820
Savings deposits	56,396
Demand Deposits	42,313
Paid up Capital	526
Reserves	14,698

Table 4. Imputed Maturity Pattern of Cash Flows: Example
(in Rs. Crore)

Bucket	Assets	Liabilities
Zero	12,409	34,262
0–1mth	41,659	8,053
1–3mth	18,382	5,113
3–6mth	21,927	7,483
6–12mth	87,411	15,421
1–3yrs	43,282	174,229
3–5yrs	31,882	55,414
> 5yrs	80,285	9,944

Table 5. Impact of a 320 bps Shock
(in Rs. crore)

Impact	Value
Impact on assets, ΔA	-17,079
Impact on liability, ΔL	-15,375
Impact on equity, ΔE	-1,704
ΔE/E	-11.19 (%)
ΔE/A	-0.49 (%)

A. Cross Sectional Heterogeneity

Table 6, 7, and 8 present the results for the 42 banks in our sample. They show the effect of two shocks: one of 200 bps and the other of 320 bps.

Table 6. Banks with 'Reverse' Exposure
(in percent)

	ΔE/E		ΔE/A	
	200 bps	320 bps	200 bps	320 bps
Bank 1	39	58.9	1.3	1.9
Bank 2	35	53	2.3	3.5
Bank 3	33.3	52.1	1.1	1.7
Bank 4	22.2	34.4	1.1	1.7
Bank 5	17.3	27.4	0.6	0.9
Bank 6	17.2	27	0.7	1.1
Bank 7	13.8	21.1	1.2	1.9

Table 6 shows that seven banks in our sample have a significant 'reverse' exposure, in the sense that they stand to earn profits in the event that interest rates go up. The exposures here range from a gain of 58.9 percent of equity capital in the event of a +320 bps shock to a gain of 21.1 percent. While this would be profitable in the event of a rise in interest rates, it would generate losses in the event of a fall in interest rates, as was the case between 31/3/2002 and 31/12/2002. Table 7 indicates that nine banks appear to be hedged, in the sense of having an exposure in the event of a +320 bps shock which is smaller than 25 percent of equity capital.

Table 7. Banks that Appear to be Hedged
(in percent)

Sr.No.	ΔE/E		ΔE/A	
	200 bps	320 bps	200 bps	320 bps
Bank 8	3.5	6.3	0.1	0.3
Bank 9	2.1	3.3	0.2	0.3
Bank 10	0.1	0.5	0	0
Bank 11	-0.7	0	0	0
Bank 12	-0.5	-0.5	0	0
Bank 13	-0.8	-1.1	-0.3	-0.5
Bank 14	-7.1	-10.2	-0.3	-0.5
Bank 15	-8.5	-11.2	-0.4	-0.5
Bank 16	-10.3	-15.4	-0.7	-1

Table 8 suggests that 26 banks in the sample have significant interest rate exposure. These banks could lose 25 percent or more of their equity capital in the event of a +320 bps shock. Of these, there were 15 banks which stood to lose more than 50 percent of equity capital.

These results raise interesting questions about the behavior of banks in India. Mismatches which might appear benign in countries with low interest rate volatility are likely to be much more damaging in India's high interest rate volatility setting. Thirty-four of the 42 banks do have significant exposure, in the sense of standing to lose over 25 percent of their equity capital in the event of a 320 bps shock.

Traditionally, it is believed that a maturity mismatch is innate to the business of banking, and that banks tend to borrow short and lend long. However, we see seven banks in the sample that actually have a 'reverse' exposure.

It is important to emphasize that the level of interest rate risk exposure is a choice that banks in India do control. Even though interest rate derivatives are absent, and even though most corporate credit is floating rate, there are two important instruments which a bank does control. On the asset side, banks choose the duration of the government bond portfolio. As observed earlier, banks in India hold substantial amounts of government bonds, owing to high reserve requirements, and the duration of the government bond portfolio is an important factor affecting interest rate risk. On the liabilities side, banks choose the interest rates offered on time deposits at various maturities, and thus influence the duration of liabilities. Through these two channels, banks do have substantial control over their own interest rate risk exposure.

Table 8. Banks with Significant Exposure
(in percent)

	ΔE/E		ΔE/A	
	200 bps	320 bps	200 bps	320 bps
Bank 17	-16.8	-24.6	-1	-1.4
Bank 18	-18.1	-26.1	-0.9	-1.2
Bank 19	-19.9	-29.4	-1.2	-1.7
Bank 20	-20.2	-30.1	-1.8	-2.6
Bank 21	-22.9	-33.6	-0.7	-1.1
Bank 22	-23.6	-34.8	-1.5	-2.2
Bank 23	-23.9	-35.4	-1.5	-2.2
Bank 24	-25.4	-37.7	-1.6	-2.4
Bank 25	-26.8	-39.8	-1.1	-1.6
Bank 26	-27.8	-41.5	-1.5	-2.2
Bank 27	-28.2	-42.8	-1.6	-2.4
Bank 28	-34	-49.8	-1.4	-2.1
Bank 29	-35.3	-52.6	-1.7	-2.5
Bank 30	-35.6	-52.7	-1.5	-2.2
Bank 31	-35.3	-53.8	-1.6	-2.4
Bank 32	-37.9	-56	-1.7	-2.5
Bank 33	-37.5	-56.3	-2.4	-3.6
Bank 34	-38.6	-57.1	-1.9	-2.9
Bank 35	-41.6	-61.9	-1.8	-2.7
Bank 36	-44.5	-66.6	-2.2	-3.3
Bank 37	-50.3	-74.7	-1.9	-2.8
Bank 38	-49.9	-74.9	-2.2	-3.4
Bank 39	-51.7	-77.1	-2.9	-4.4
Bank 40	-53.5	-80.1	-2.2	-3.3
Bank 41	-64.6	-95.9	-2	-3.0
Bank 42	-70.3	-104.7	-2.2	-3.4

There may be a relationship between the build up of interest risk exposure and the problems of credit risk management in Indian banking. In the 1990s, many Indian banks have experienced significant increases in nonperforming loans. At the same time, capital requirements and supervision were tightened. Given the difficulty of obtaining profits from lending operations, banks may have tried to earn profits by speculating on interest rate movements. This reasoning is consistent with the fact that in our data, the largest banks, which (in India) tend to fare better on credit risk management, do not carry substantial interest rate risk.

While India’s banking system is known to have relatively small problems with non-performing loans, our results suggest that many banks do carry substantial interest rate risk. This has implications for many aspects of public policy, including rules governing disclosure, rules about interest rate risk management, and fostering the interest derivatives market.

IV. Conclusions and Policy Implications

This paper is based on a relatively complex imputation procedure which uses ‘the liquidity statement’ in bank annual reports to estimate future cash flows. There is a case for improving rules governing disclosure, so that the ‘interest rate risk’ statement and estimates of future cash flows are released by banks at higher frequency.

One striking feature of our results is the heterogeneity seen across banks. Banks holding similar portfolios of government securities seem to have rather different interest rate risk exposures. This suggests that the RBI’s ‘investment fluctuation reserve,’ which is computed as a fraction of the investment portfolio without regard for the extent to which risk is hedged, is an unsatisfactory approach to addressing interest rate risk.

I. Estimating the Maturity Pattern of Future Cash Flows

Indian banks are required to disclose a statement on the maturity pattern of their assets and liabilities classified in different time buckets. We use this data, along with data on the composition of their assets and liabilities, to arrive at an assessment of future cash flows in different time buckets.

As a general principle, the accounting procedures of banks associate the face value on a stated asset or liability to the terminal (maturity) date *T*. We need to go beyond this, to enumerate the complete list of cash flows. Hence, for each class of assets reported by banks, we impute a certain 'coupon rate;' using this rate, cash flows are imputed for the time intervals between date 0 and date *T*.

The time bands used in the 'statement of structural liquidity' are 1–14 days, 15 to 28 days, 29 days to 3 months, 6 months to 1 year, 1 to 3 years, 3 to 5 years and greater than 5 years. We impute a statement of cash flows that corresponds to the time bands in the 'statement of interest rate sensitivity' as specified by RBI. The time bands used for the time to repricing are zero, 0 to 1 month, 1 to 3 months, 3 to 6 months, 6 months to 1 year, 1 to 3 years, 3 to 5 years and greater than 5 years. This imputation proceeds as follows:

Assets

On the asset side, *Loans and Advances* can be broken up into two parts: (a) bills and (b) demand loans and term loans. We observe the maturity structure of loans and advances, but we do not separately observe the maturity structure of bills, demand loans and term loans. We assume that the maturity structure of each of these is identical to the maturity structure of Loans and Advances.

In the case of demand loans and term loans, we assume these are entirely floating rate loans, linked to the Prime Lending Rate. We assume that PLR revisions can take place in 3 months. Hence, demand loans and term loans up to 3 months are classified according to their maturity. The remainder is placed into the 3–6 month bucket. The cash flows generated from the interest earned at the PLR rate is distributed in the 0 to 1 month bucket and the 1 to 3 month bucket, while the 3 to 6 month bucket has both the interest earned and the principal.

In the case of bills, short-dated bills are directly classified. Beyond the 3–6 month bucket, we assume that 90 percent of the bills are floating rate products (which are classified into 3–6 months) while we assume that the remainder 10 percent is fixed rate products that are repriced at the time to maturity. Hence these are placed in corresponding time bucket.

For *Investments*, both government and corporate bonds are assumed to be fixed rate and are classified as per the liquidity statement.

Cash and Balances with the RBI are assumed to be insensitive to interest rates. Balances with the RBI up to 3 percentage points of Cash Reserve Ratio (CRR) are also assumed to be zero maturity as no interest is paid on them. The CRR balance in excess of 3 percentage points, which earns interest, is classified into the 3–6 month bucket.

Liabilities

The liquidity statement shows a single maturity pattern of deposits. We need to unbundle time deposits as opposed to savings deposits and current deposits from this statement.

RBI's Asset-Liability Management (ALM) Guidelines suggest that in the liquidity statement, current and savings deposits are divided into their core and volatile portions through the following mechanism. A 'volatile portion' (15 percent of current accounts and 10 percent of savings accounts) may be classified in the liquidity table in the 1–14 days bucket. The remainder is classified in the 1–3 year bucket of the liquidity statement.

Even though RBI regulations also suggest that banks are free to use alternative modeling frameworks in arriving at estimates of core versus volatile demand deposits, we estimate the maturity pattern of time deposits while assuming that all banks are using RBI guidelines. In this fashion, we subtract current and savings deposits from the maturity pattern of total deposits as shown in the liquidity statement.[8]

In the case of both current accounts and savings accounts, we have an imputation scheme where some fraction is placed into a near bucket and the remainder is placed into a far bucket. The fractions are varied in producing multiple sets of assumptions (see Table A.1). The maturity pattern of time deposits directly goes into imputed future cash flows on the liabilities side.

Equity capital and reserves are placed in the zero-maturity time bucket.

Assumptions used in this imputation

For the accounting year 2001–02, the following assumptions are made:

- Interest rate on savings bank deposits: 3.54 percent.

- Interest rate on time deposits: 7 percent.

[8] Let C represent current accounts and S represent savings accounts. RBI's ALM guidelines suggest that 0.15C+0.1S is added to time deposits (if any) in the 1–14 days bucket, and 0.85C+0.9S is added to time deposits (if any) in the 1–3 year bucket. In our dataset, we find 6 banks where this imputation procedure yields a negative value for time deposits in the 1–3 year bucket. This would suggest that these banks use other models for estimation of core versus volatile demand deposits.

- Interest rate on the liabilities side for borrowings by the bank: 6.58 percent.
- Interest rate earned on bills purchased by the bank: 10 percent.
- Prime Lending Rate of the year: 11 percent.
- Level of CRR: 5.5 percent.
- Interest rate that RBI paid beyond three percent points on CRR: 6.5 percent.
- Average interest rate for imputing intermediate cash flows on all investments: 5.58 percent.
- Time bucket to place PLR-linked investments: 6 months to 1 year.
- Fraction of bills (in higher buckets) which are actually PLR linked: 90 percent.
- Duration of assets and liabilities classified as 'greater than five years': 10 years. The rationale for this is as follows. The bulk of bank assets with maturity over 5 years are government bonds. Bonds beyond 5 years stretch out to 20 years. Hence 10 years appears to be a plausible assumption.

II. Alternative Assumptions About Treatment of Demand Deposits

As emphasized earlier, a major factor which affects estimates of interest rate risk of banks is the extent to which demand deposits can be viewed as being 'stable.' While our main focus has been on one particular set of assumptions, we also explore the sensitivity of our results by examining four alternative sets of assumptions.

Table A.1. Four Sets of Assumptions for Behavior of Current and Savings Deposits

Behavioral assumptions about savings accounts and current accounts have a significant impact upon the results. Hence, in addition to the rules specified by RBI for the interest rate risk statement, we have three sets of assumptions, labeled *Pessimistic*, *Baseline* and *Optimistic*.

Parameter	**Optimistic**	**Baseline**	**Pessimistic**	**RBI**
Savings accounts				
Short fraction	0%	15%	30%	25%
Short maturity	0	0	0	0
Long fraction	100%	85%	70%	75%
Long maturity	1–3 years	1–3 years	1–3 years	3–6 months
Current accounts				
Short fraction	10%	25%	50%	100%
Short maturity	0	0	0	0
Long fraction	90%	75%	50%	0%
Long maturity	1–3 years	1–3 years	1–3 years	

First, we have a set of assumptions titled *RBI*, which uses the RBI's requirements for the interest rate risk statement. It involves assuming that 75 percent of savings deposits are 'stable,' and that these have an effective maturity of 3–6 months. This appears to be an unusually short time horizon, given (a) the stability of savings accounts and (b) the stability of the savings bank interest rate in India. RBI's guidelines suggest that 100 percent of current accounts should be considered volatile. This appears to be an unusually strong requirement, when compared with the empirical experience of banks in India.

As an example, we report calculations for one large bank using the *RBI* assumptions. In addition, we have *Baseline* assumptions, where 15 percent of savings accounts are assumed to be volatile, and the remainder has a maturity of 1–3 years. We assume that 25 percent of current accounts are volatile, and the remainder has a maturity of 1–3 years. We perturb these assumptions to produce two additional sets of assumptions: *Optimistic* (from the viewpoint of a bank seeking to hold long-dated assets) and *Pessimistic*. This gives us four sets of assumptions in all, which are summarized in Table A.1.

Table A.2. Imputed Maturity Pattern of Cash Flows: Example
(in Rs. crore)

Bucket	Assets	Liabilities: Optimistic	Liabilities: Baseline	Liabilities: Pessimistic	Liabilities: RBI
Zero	12,409	19,456	34,262	53,300	71,636
0–1mth	41,659	8,078	8,053	8,028	8,037
1–3mth	18,382	5,163	5,113	5,063	5,079
3–6mth	21,927	7,558	7,483	7,408	49,730
6–12mth	87,411	15,571	15,421	15,272	14,573
1–3yrs	43,282	189,635	174,229	154,593	91,164
3–5yrs	31,882	55,414	55,414	55,414	55,414
5yrs	80,285	9,944	9,944	9,944	9,944

Table A.2 shows the consequences of applying these four scenarios to one major bank. It shows the four cash flow vectors for liabilities that obtain under these alternative assumptions.

Table A.3. Impact Upon Equity Capital Under Four Sets of Assumptions: Example

Our definitions of Pessimistic, Baseline and Optimistic correspond to an impact upon equity capital of 17.83%, 11.19% and 5.98% respectively, for a 320 bps shock. The RBI assumptions imply a decline of 36.28% in equity capital.

	Optimistic		Baseline		Pessimistic		RBI	
Δ	ΔE/E	ΔE/A	ΔE/E	ΔE/A	ΔE/E	ΔE/A	ΔE/E	ΔE/A
0.032	-5.98	-0.26	-11.19	-0.49	-17.83	-0.78	-36.28	-1.58

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