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BANK RISK EXPOSURE: THE TIME-VARYING IMPACT ON INDIAN COMMERCIAL BANKS

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Abstract *'Time' and 'value' are the huge assets used by banks in risk management. This paper investigates the time-varying impact on the value of banks' asset-liability positions to the macroeconomic fluctuations in the bank risk factors, such as interest rate risk, credit risk, foreign exchange risk, and equity risk. The value positions of 110 Indian commercial banks, including foreign banks, at various asset-liability maturity patterns are considered for measuring their position exposures. Results show that bank deposits, bank investments, and loans and advances are highly significant to all the risk factors, while decisions on bank borrowings and hedge policies are based on the internal regulatory requirements. Hence, they are significant only with the interest rate risk factor. Deposits with a maturity period of 15-28 days; 29 days to three months; and over three to six months have shown high sensitivity, which might indicate the risk averse nature of bank clients with immediate liquidity requirements. This indicates deteriorating credit conditions, signalling an increase in the probability of default, which decreases the economic value of the deposits. The same bank deposits with a highly negative significance to equity risk supports the portfolio rebalancing activities of clients, from illiquid low-return long-term investments to liquid high-return market portfolios, as hypothesised in recent banking literature. The study reports that maintaining a safe level of maturity management and predicting risk tolerance levels are the best ways for banks to devise proper risk management approaches.*

Keywords: *Bank Risk Exposure, Position Exposures, Maturity Pattern, Time-Varying Impact, Corporate Risk Management*

MOTIVATION

Understanding the risk exposure of the banking industry helps in better financial reforms in a bank-driven economy like India. Awareness of time-varying changes in the value of banks' positions to fluctuations in interest rates, credit spreads, foreign exchange rates, and so on, helps in measuring the risk appetite of the banking sector. The overall asset-liability maturity pattern, which is synchronised to the duration of treasury bills, bonds, and innovative derivative instruments, plays a pivotal role in the bank risk management. Risk management not only encompasses uncertainties in the macroeconomic environment, but also includes the microeconomic issues like agency problem, managerial competitiveness, directorial shareholding, and so on. However, the liquidity and solvency of the banking industry is a major concern (Bessler & Kurmann, 2012) of any economy, at any given point.

The prime importance of revaluing the banks' risk exposure is to strengthen the stability of the financial sector (Agrawal & Sehgal, 2018), which in turn stimulates the economic growth of the country. The process of financial intermediation and maturity transformation of assets and liabilities exposes banks to different risk exposures, which majorly get aggregated into the systematic risk of banks. Hence, the regulatory banks of all nations prioritise assessment of risk at various time intervals, in strengthening their financial sector. These financial risks are primarily divided into credit risk and market risk. Market risk is further divided into equity risk, interest rate risk, and exchange rate risk (Agrawal & Sehgal, 2018). Apart from financial risks, banks like any other businesses do face non-financial risks like operational risk, liquidity risk, and reputational and regulatory risk.

The primary aim of the Bank for International Settlements (BIS) ensures the financial strength and independence of every bank. This is achieved with properly laid out Basel norms with the passing of each economic crisis that exposes banks to financial risks, especially capital adequacy and operational risks. Therefore, under the various Basel Accords, the compliance to risk management practices had been made strictly, rather legally, to ensure stability and independence of the banking sector. While discussing

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a few Basel norms, Agrawal and Sehgal (2018) reported that the 1998 Basel Accord required banks to hold capital with respect to the risk-weighted assets. The 1996 Market Risk Amendment to the Basel Accord of 1988 incorporated market risk along with credit risk. Basel II in June 2004 widened the horizon for the risks covered under the Accord, and included operational risk along with market and credit risk. Basel III now additionally recognises several other risks explicitly, such as liquidity risk, reputational risk, and regulatory risk.

Thus, the central bank of every country enforces revisiting the risk assessments at particular intervals to enhance financial stability. Under the guidelines of the Reserve Bank of India (RBI), credit risk is 'the risk that the obligor (borrower or counterparty) in respect of a particular asset will default in full or in part on the obligation to the bank in relation to the asset' (RBI, 2002a). Market risk is "the risk that the value of 'on' or 'off' balance sheet positions affected by changes in equity and interest rates, currency exchange rates, and commodity prices in an undesirable manner", as defined by the RBI (RBI, 2002a). The uncertain capital market and constant shifts in the economic environment needs an enhanced understanding of these risk exposures. There is enormous literature available in studying risk exposure of banks, but very few are extended to measuring the time-varying impact of these risk factors on the value of bank positions with regard to their asset-liability maturity pattern, which is an important phenomenon to avoid any major crisis. The aggregate bank risk exposure calculated through the market model is an easy replication of its systematic risk capacity. However, the breaking down of systematic risk of a bank into specific risk factors enhances an in-depth understanding of the various dimensions of bank risk exposure.

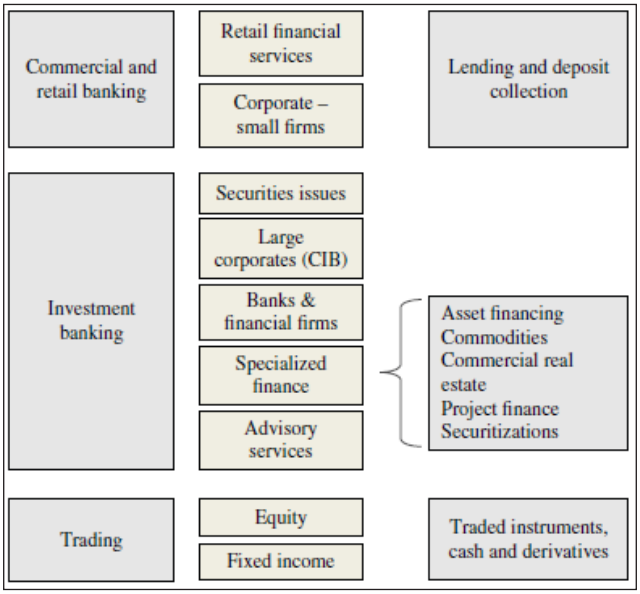
Hence, the initial purpose of this paper is the contemporaneous assessment of four major bank risks with publicly available market information. The second focus is to investigate the time-varying changes in the value of banks' positions to the fluctuations in the multi-dimensional bank risk factors, such as interest rate risk, credit risk, foreign exchange risk, and equity risk. This paper attempts to suggest that the changes in the capital market and the economic environment demand revaluation of banks' riskiness in the banking industry. We contribute to the banking literature by measuring the time-varying impact of bank risk factors, namely interest rate risk, credit risk, foreign exchange risk, and equity risk, on the value of banks' positions on various assets and liabilities. This can simply be called position exposures (Begenau, Piazzesi & Schneider, 2015).

THEORETICAL SUPPORT

Corporate risk management is an important element in a firm's overall business strategy (Guay & Kothari, 2003). Stulz (1996) argued that "the primary goal of risk management is to eliminate the probability of costly lower-tail outcomes, those that would cause financial distress or make a company unable to carry out its investment strategy". Therefore, uncertainty cannot be eliminated; however, the probable exposure to uncertainty can be changed.

Conceptualisation of Bank Risk Exposure

Bank risk management is an important practice to secure the macroeconomic stability in a country. The changing structure of banks' business line (Fig. 1) demands continuous risk assessment of its activities. There is no research paper in banking published without touching upon the two major developments of the banking sector, namely the deregulation and the technological innovation. Deregulation in the Indian economy, product/technological innovation, and increased volatility in the capital markets have considerably increased the risk exposure of commercial banks. Thus, it has forced banks to focus their attention on continuous risk management.



Source: Bessis (2015).

Fig. 1

The risks of any financial institution are classified into financial and non-financial risk. While describing the major

causes of serious banking problems, i.e., the bank risk or exposure, the Basel Committee on Banking Supervision (BCBS) lists lax credit standards for borrowers and counterparties, poor portfolio risk management, and the lack of attention to changes in economic or other circumstances that can lead to a deterioration in the credit standing of a bank's counterparties as the most pertinent banking problems (BCBS, 1999).

Credit/Default Risk

From the disclosure of BCBS, it can be noted that credit risk is the first and major risk a bank is exposed to. To define credit risk in the terms of BCBS, it is "the potential that a bank borrower or counterparty will fail to meet its obligations in accordance with agreed terms". Managing credit risk is highly imperative for the long-term success of any banking institution, and according to BCBS, they do so by maximising a bank's risk-adjusted rate of return by maintaining credit risk exposure within acceptable parameters. Till two decades ago, loans were considered to be the largest and obvious source of credit risk; however, with innovative banking practices and the use of innovative financial products, there are financial instruments other than loans which escalate banks' credit risk, including acceptance, interbank transactions, trade financing, FOREX transactions, financial futures, swaps, bonds, equities, options, and in the extension of commitments and guarantees, and the settlement of transactions (BCBS, 1999). Most of the credit risk factors, if noted, arise from off-balance sheet bank transactions.

On how to measure and analyse the credit risk of banks, there are several studies published after the Asian financial crisis of 1997, suggesting different models of credit risk evaluation. Fridson and Garman (1997) found that there was a moderate, significant positive correlation between credit default rates and real interest rate, and a strong positive correlation between default rate and lagged two-year real interest rate. Iscoe, Kreinin and Rosen (1999) suggest a joint market and credit risk model on the basis of the Merton model for the evaluation of risky debt.

Market Risk

Market risk is the negative deviations in the trading portfolio due to market movements and the risk of liquidation of the transactions during the period. The RBI defines market risk as the possibility of loss of a bank due to changes in the market variables. Therefore, market risk encompasses interest rate risk, foreign exchange risk, and equity price risk (RBI, 2002).

Market risk includes the negative impact on the value of on-/off-balance sheet positions due to the movements in equity and interest rate markets, currency exchange rates, and commodity prices. The issue is evident in the study by Fraser, Madura and Weigand (2002), which investigated bank stocks' sensitivity to changes in interest rates and the factors affecting this sensitivity. It focuses on whether the exposure of commercial banks to interest rate risk is conditioned on certain balance sheet and income statement ratios. It found a significantly negative relation between bank stock returns and changes in interest rates over the period 1991-1996. In addition, it found that bank characteristics measured from basic financial statement information explain bank stocks' sensitivity to interest rate changes. These results suggested that bank managers, analysts, and regulators can use this information to assess the relative risk exposure of banks.

Non-Financial Risk

Non-financial risk refers to those risks that may affect a bank's business growth, marketability of its products and services, possible failure of its strategies for business growth, and so on. The causes of non-financial risk are management failures, competition, non-availability of suitable products/services, external factors, and so on. Major types of non-financial risk in the banking business are operational risk, strategic risk, legal risk, reputation risk, and political risk.

Literary Support for Measuring Risk Exposures

The primary issue concerning this paper is how to quantify the risk exposures. Most of the existing studies have built their research on the fundamentals of capital market approach (Flannery & James, 1984; Choi & Elyasiani, 1997; Hirtle, 1997; Guay, 1999; Bernadette & Williamson, 2005; Shamsuddin, 2009; Sukcharoensin, 2013; Banerjee, Das, Jana & Shetty, 2017; Agrawal & Sehgal, 2018), which assumes that stock markets correctly capture bank risks. In this approach, the risk exposures are measured by identifying the sensitivity of equity returns to changes in various risk factors. There are few studies which take the idea of capital market approach, but mix them with orthogonal models (Klein & Chow, 2013; Bessler & Kurmann, 2014; Begenau, Piazzesi & Schneider, 2015) to enhance the accuracy of results.

Agrawal and Sehgal (2018) studied the dynamic interaction of risks in Indian commercial banks. The research suggested that quantifying risks with the capital market approach has some advantages to emerging economies, due to the availability of lower frequency accounting data with a short financial history. The study also supported the opinion of Martin and Mauer (2003) and Muller and Verschoor (2006), who considered capital market approach to be forward-looking and appropriate for policy analysis perspective. Hence, this study employs the capital market approach model used by Agrawal and Sehgal (2018) in quantifying the risk exposures, with a few changes in the proxies of risks.

In general, the research studies conducted on the Indian banking industry have primarily focused on either credit risk (Das & Ghosh, 2007; Bodla & Verma, 2009; Kumar, Arora & Lahille, 2011; Arora, 2012; Arora, 2013) or market risk (Sharma, 2012; Kumar, 2017), and some, on the components of market risk (Patnaik & Shah, 2004; Sy, 2005; Makkar & Singh, 2013; Prabhavathi, 2013). There was an Indian research article (Jagotra et al., 2019) based on univariate and VAR models, which found evidence of co-integration between banking stock prices and macroeconomic variables in India. Very few studies dealt with mutual interaction between all the types of risks (Sehgal & Agrawal, 2017; Agrawal & Sehgal, 2018). There are almost limited studies on measuring the position exposures with regard to asset-liability maturities of banks; and yet there is no study which measures both the factor risks and its time-varying impact on the asset-liability positions of banks in the Indian context.

OFF-BALANCE SHEET SCENARIO OF INDIAN BANKS

As mentioned in section 2, most of the credit risk factors arise from off-balance sheet bank transactions. Table 1 provides a detailed picture of the growing balance sheet exposure of Indian commercial banks for the past 15 years (2005-2019). The table is the consolidated balance sheet of all commercial banks, including foreign banks functional in the respective years, excluding the regional rural banks. Nevertheless, one can say that the liabilities in the form of deposits have grown approximately seven times in the recent year, compared to 2004-2005. Simultaneously, when the growth rate of forward contracts was calculated, which amounted to 38 per cent in FY 2019, it reflects the same conclusion that off-balance sheet transactions escalate risk exposure of banks.

This shows the efforts of banks to offset their on-balance sheet exposure with off-balance sheet contracts. The loans and advances of assets item shows a huge growth of 8.4 times in the recent year, compared to 2004-2005. This might reflect the increase in the number of banks over these 15 years and could possibly be viewed as a growth in their reach of business operations. One cannot ignore the default risk it collectively creates on the entire banking industry which is highly interconnected. Fig. 2 shows the steep growth of the items discussed.

DATA AND VARIABLE DESCRIPTION

The study uses annual data for 110 Indian commercial banks, including private, public, and foreign, and additionally, the recently started small finance banks. The period covers information from March 2005 to March 2019, incorporating the data of 15 years. The decision about the period of study was solely based on the availability of data in the domain of the RBI for a majority of the banks. All the publicly available information of assets and liabilities of banks, along with their maturity pattern, treasury bill rates, and exchange rates, have been collected from the RBI database; the bond rates and stock prices were taken from the National Stock Exchange database.

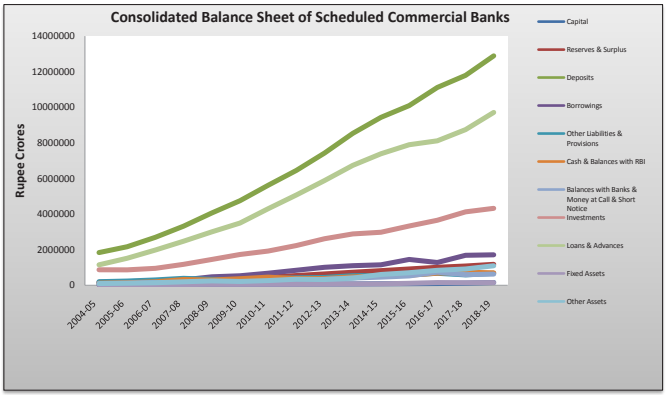
The Risk Factors

The independent variables of the study are the various risk exposures to be quantified for further analysis. They are denoted to be the risk factors affecting the bank positions at various levels. To quantify the risk exposure, it is important that we identify them first. Based on the capital market perspective, the risk factors are derived from the publicly available market domain. Each risk factor chosen for the study has an economic motive behind it, which is explained as follows:

Table 1: Consolidated Balance Sheet of Scheduled Commercial Banks

Year (End-March)	Liabilities (Rupee Crores)					Assets (Rupee Crores)						Total Liabilities and Assets
	Capital	Reserves & Surplus	Deposits	Borrowings	Other Liabilities & Provisions	Cash & Balances with RBI	Balances with Banks & Money at Call & Short Notice	Investments	Loans & Advances	Fixed Assets	Other Assets	Total Liabilities/ Assets
2004-05	25905	123705	1837559	168352	199989	118075	95357	869737	1150836	23051	98453	2355509
2005-06	25207	157975	2164682	203148	234853	144475	116444	866508	1516811	25082	116543	2785863
2006-07	29559	189619	2696937	243010	300837	195266	158303	950982	1981236	31363	142813	3459962
2007-08	39964	275524	3320062	302629	387987	322972	109109	1177330	2476936	42394	197425	4326166
2008-09	43289	324658	4063201	473597	333897	297267	196516	1449551	2999924	48361	247023	5238642
2009-10	48619	381542	4746920	531412	318433	365821	173629	1729006	3496720	49568	212181	6026925
2010-11	58975	450944	5615874	675527	382077	458783	184082	1923633	4297488	54092	265320	7183398
2011-12	63664	544898	6453549	843774	415006	373746	243676	2233903	5073559	56690	339316	8320890
2012-13	70310	638603	7429677	1010385	440976	375174	334879	2613051	5879773	63120	323956	9589952
2013-14	76067	729832	8533173	1101297	535559	471728	406304	2883262	6735213	75605	403817	10975929
2014-15	81839	822798	9433838	1149939	548578	528503	458292	2977592	7388160	80460	603984	12036992
2015-16	88222	913080	10092651	1448764	586571	563917	524812	3327835	7896467	112059	704199	13129288
2016-17	99292	1010786	11111448	1280708	672372	680542	737427	3652284	8116109	150685	837560	14174606
2017-18	116127	1079770	11794005	1682309	582822	730330	594797	4126237	8745997	141874	915797	15255033
2018-19	154427	1176531	12887262	1709670	673335	698613	629733	4320270	9709829	149137	1093641	16601224

Source: Annual report on trend and progress of banking in India by RBI (rbi.org.in).



Source: Annual Report on trend and progress of banking in India by RBI (rbi.org.in).

Fig. 2

Interest Rate Risk

'Interest', the main source of profit for banks, emerges out of the traditional role of banks to provide maturity transformation. Banks convert short-term deposits into long-term loans, since it is believed that banks are exposed to interest rate changes. Quantifying and having a check over interest rate risk exposure safeguards banks from losses arising out of abnormal levels of interest rate risk. Heavy fluctuations in interest rates impact capital and profitability of banks (Acharya, 2018) and are critical to the stability of banks. Hence, the relation between interest rate changes and bank stock prices is expected to be negative. This study estimates the interest rate risk factor by the changes in one-year treasury bill rates (Begenau, Piazzesi & Schneider, 2015).

Credit Risk

Credit risk or counterparty risk is the fundamental risk associated with the functioning of the banking business. The aim of every bank is to maximise its risk-adjusted rate of return by maintaining credit risk exposure within acceptable parameters. BIS reinforces the need for effective management of credit risk for a comprehensive approach to risk management in all risk management manuals. It recommends that tolerant levels of credit risk are essential to the long-term success of any banking organisation.

There are recent Indian studies (Goel, 2018; Ramesh, 2019; and Agarwal et al., 2021) on banks' performance and risk analysis, which use NPAs as the measure of credit risk. One has to consider that, though the repayment capacity of a borrower depends on his/her income level, it is also based on the rate of interest they are expected to meet on their borrowings. Credit risks which largely arise from the long-term loans (also from NPAs) of banks have an indirect and opportunistic association with the changing bond prices in the market. Since bond rates, which are often found to be competitive with lending and deposit rates, they have a huge impact on the central banks' decision on lending patterns. Hence, the market-based estimation of credit risk factor is the changes in the five-year bond rates (BB rated).

Exchange Rate Risk

Modern banking supports various fund-based and hedging transactions of huge corporates. This exposes the banks' balance sheet and hedging positions to currency risk exposures. Growth in derivative instruments provides banks not only with trading opportunities, but also allows them to hedge their direct exposure in foreign exchange markets (Bessler & Kurmann, 2012). Hence, significant exchange rate sensitivities may help banks identify the pre-captured exchange rate fluctuations in the assets of international transactions, hedged positions, sovereign bonds, and so on. To approximate the exchange rate risk factor the changes in the value of the Indian rupee against the US dollar has been taken.

Equity Risk

The stock prices and the equity exposure to its market are of high concern during periods of uncertainties. Though equity exposure is regarded as a systematic risk, its contagion leads to a systemic capital shortfall during a crisis. This study is concerned only with the systematic exposure of equity risk, since its significance is related to the value of the firm. Equity risk factor has been measured by the banks' exposure to the capital market sector, which includes both the direct and the indirect exposure (Sehgal & Agrawal, 2017). To quantify the equity risk, the stock returns of banks are taken into consideration.

METHODOLOGY

To calculate risk factors and position exposures, the study adopts a two-step method. The first equation, based on the capital market approach, is used to quantify the factor risks, namely equity risk, interest rate risk, credit risk, and exchange rate risk of all 110 banks over a period of 15 years. These factor risks are extracted bank wise and considered to be the predictor variables in the second step. In the second equation, the impact of the factor risks is measured on the value of asset-liability positions of Indian commercial banks for different maturity patterns, starting from 1-14 days to holdings of more than five years.

As mentioned previously under the heading 'Literary support for risk measurement', there has been two majorly different methods followed by studies in measuring risk exposures. Either they adopt the orthogonal regression or the GARCH models. Orthogonalising variables were predominantly used in studies with either huge multicollinearity among regressors or correlation above 0.9 between independent regressors. The GARCH was the model used in studies where there was more than 0.7 correlation among regressors, with significant autocorrelation in the series.

Since this study includes variables only with autocorrelation and below 0.9 correlation among regressors, it uses the second method of controlling, with conditional variance extracted with the GARCH model. This methodology of first step has been adopted from the studies of Sehgal and Agrawal (2017) and Agrawal and Sehgal (2018). This is a market-based model using a multivariate approach. It incorporates conditional volatility of stock returns, which was initially proposed by Elyasiani and Mansur (1998), to incorporate incremental information on macroeconomic volatility.

The model measures the risk exposures of the banks, where bank stock returns are regressed on market index return, interest rate changes, foreign exchange rate changes, change in the credit risk factor, and its conditional volatility. Conditional variance of bank stock returns is estimated by the GARCH (1, 1) process and a lagged interest volatility term, as proposed by Elyasiani and Mansur (1998).

Step – 1

Mean equation:

$$R_{j,t} = \beta_0 + \beta_m R_{m,t} + \beta_r R_{r,t} + \beta_c R_{c,t} + \beta_f R_{f,t} + \gamma \sqrt{h_{j,t}} + \varepsilon_{j,t}$$
$$\varepsilon_{j,t} \Omega \sim N(0, h_{j,t}) \quad (1)$$

Where, $R_{j,t}$ is the weekly stock return of bank j at time t; $R_{m,t}$ is the annual rate of return on the market index (Nifty 500) at time t; $R_{r,t}$ is the annual rate of change in the one-year treasury bills at time t; $R_{c,t}$ is the annual change in the five-year corporate bond at time t; $R_{f,t}$ is the annual rate of change of the Indian rupee against the US dollar at time t; $h_{j,t}$ is the conditional variance of bank stock returns; and $\varepsilon_{j,t}$ is a serially uncorrelated normally distributed random error term. Coefficients β_m, β_r, β_c, and β_f represent equity, interest rate, credit, and exchange rate risks, respectively, and β_0 is a constant term.

Variance equation:

$$h_{j,t} = \alpha_0 + \alpha_1 \varepsilon^2_{j,t-1} + \alpha_2 h_{j,t-1} + \alpha_3 CIV_{t-1}$$

Conditional variance, $h_{j,t}$, is determined by the past behaviour of the lagged squared error terms obtained from the mean equation, $\varepsilon^2_{j,t-1}$, and the previous period conditional variance, $h_{j,t-1}$, and preceding period's conditional interest rate volatility, CIV_{t-1}. α_1 and α_2 are the ARCH and GARCH terms, respectively, and α_3 is the coefficient of lagged interest rate volatility. α_0 is the constant. This process results in annual estimates of beta coefficients, which are used as a measure of risks.

Step – 2

The second step is again a multivariate function, wherein the bank regulatory data on values of asset-liability positions of banks are regressed against the newly quantified factor risks.

The equation of the second step is as follows:

$$R^i_{j,t} = \alpha_0 + \beta^m_i R^m_{j,t} + \beta^r_i R^r_{j,t} + \beta^c_i R^c_{j,t} + \beta^f_i R^f_{j,t} + \varepsilon_{j,t} \quad (2)$$

The derived coefficients of this regression equation are the time-varying position exposures of the assets and liabilities of banks for various maturities.

RESULTS OF EMPIRICAL ANALYSIS

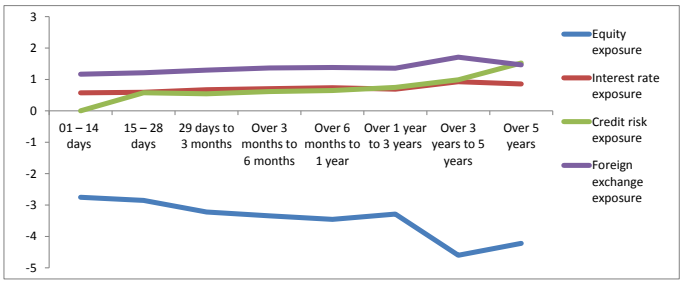
The empirical results of the methodology adopted reveal that bank deposits, bank investments, and the loans and advances are highly significant to all the risk factors, irrespective of the maturity pattern. The bank borrowings are found to be the least significant among the balance sheet factors. It is highly significant only with the interest rate risk factor, and is then observed to be significant with equity (over five years) and credit risk (over one to three years), specific to the maturity pattern.

Risk Exposure vs. Deposits

As mentioned earlier, the bank deposits have been positively significant to the interest rate risk, credit risk, and exchange rate risk, indicating that an increase in exposure of deposits leads to increasing fluctuations in interest rate, credit levels, and exchange rate.

Specifically, the deposits with a maturity period of 15-28 days, 29 days to three months, and over three to six months show high sensitivity at five per cent significance level, which might indicate the risk-averse nature of bank clients with immediate liquidity requirements. Drehmann, Sorensen and Stringa (2006), in their study to BIS, reveal

that "as a bank's credit conditions deteriorate, its probability of default increases and, ceteris paribus, the economic value of its deposits decreases". This supports our evidence of increasing exposure of deposits to increasing credit risk.



Source: Authors' calculation using report on trend and progress of banking in India by RBI (rbi.org.in).

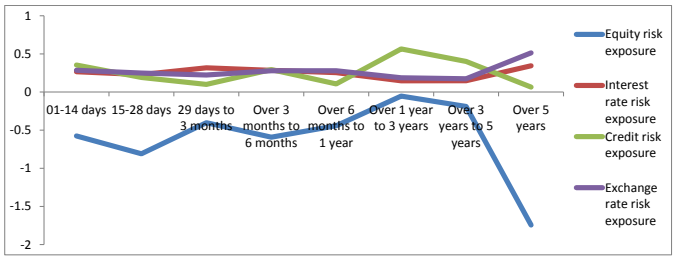
Fig. 3: Deposits of Indian Commercial Banks (Exhibit of Position Exposure Regression from Table 2)

The same bank deposits are negatively significant to equity risk at the market at one per cent significance level. This shows the portfolio rebalancing activities of clients from illiquid low-return long-term investments to liquid high-return market portfolios. The deposits with a maturity of over three to five years and over five years seem to be supporting the explanation with high coefficient values.

The recent literature (Lin, 2020) on bank deposits and stock market does support this evidence with their tested hypothesis, that ".... stock market fluctuations have important spill over effects on the real economy through their impact on the banking sector. Specifically, when households rebalance their portfolios towards stocks after a positive shock to the stock market, they reduce their holdings of bank deposits, which then have a negative impact on bank lending and the financing and investment of bank dependent firms". This crucial evidence is true to our results on the relationship between bank risk factors and bank investments and loans and advances, wherein the same negative significant relationship is observed, as shown in Fig. 3.

Risk Exposure vs. Borrowings

As explained above, the results of bank borrowings are in the least significant to bank risk factors, except interest rate risk. Since the decisions on bank borrowings and hedge policies are based on internal regulatory requirements, its exposure might hugely depend on the interest rate risk rather than credit, equity, and foreign exchange rates. Though the borrowings are internally managed, as the credit quality decreases with increase in maturity level, their interest rate and exchange rate exposure grow steadily after five years of maturity (Fig. 4).



Source: Authors' calculation using report on trend and progress of banking in India by RBI (rbi.org.in).

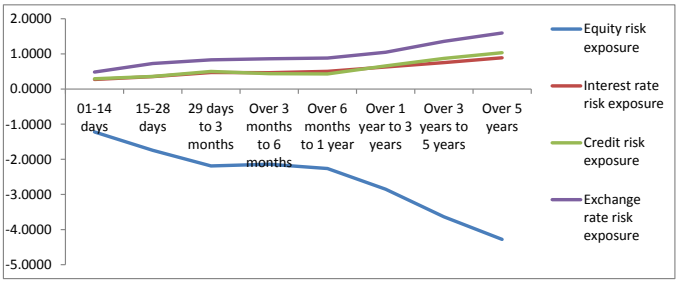
Fig. 4: Borrowings of Indian Commercial Banks (Exhibit of Position Exposure Regression from Table 2)

This provides evidence for external market influence on the internal policies. Borrowings over three to five years and over five years are exposed to credit risk (positive at 5%) and equity risk (negative at 10%), respectively. Such a relationship can indicate the possibility of default risk that might arise if the credit risk and equity risk are the causes of external spillover.

Risk Exposure vs. Investments

Investments similar to deposits show a high positive exposure to interest rate fluctuations, exchange rate fluctuations, and credit risk in the market. This can fairly be related to the need of the bank to earn non-interest income. The results show an in increase exposure value, along with increase in maturity of investments. Greater the maturity period, higher the exposure to interest rate and exchange rate fluctuations.

On the other hand, investments of banks are negatively exposed to equity risk, indicating the withdrawal of bank investments during market booms, leading to maintaining required capital adequacy ratio for risk weighted assets. From Fig. 5, it can be observed that as the credit quality of investments worsens with increasing maturity, there seems to be a steady growth in the interest rate and credit and exchange rate exposures. Hence, banks need to be focused on identifying investments with lower counterparty risks to make safer investment portfolios.



Source: Authors' calculation using report on trend and progress of banking in India by RBI (rbi.org.in).

Fig. 5: Investments of Indian Commercial Banks (Exhibit of Position Exposure Regression from Table 2)

Risk Exposure vs. Foreign Current Assets

Foreign currency assets include loans to residents/non-residents, outstanding export bills, FC lending to banks in India, FC deposits with banks in India, overseas FC assets, remittable profits of foreign branches of Indian banks, and so on (RBI, 2004). The results show a high credit risk exposure on the foreign current assets of banks. This might have been the outcome of the risk management policy of RBI on the investment of foreign exchange reserves. The RBI, being sensitive to credit risk, maintains foreign reserves with the twin objective of safety and liquidity on its investments, along with the motive of return optimisation (RBI, 2019). Hence, the maintenance of foreign current assets is designed in synchronisation with the credit risk/counterparty risk in the market. Such rates might also reflect the cost of hedging, since reserves are nothing but hedge covers for default risk.

Risk Exposure vs. Foreign Current Liabilities

The foreign current liabilities include non-resident deposits, own bonds (e.g., RIB/IMD), loans, other liabilities, off-balance sheet exposure, and so on. The slightly high exposure of foreign current liabilities in comparison to foreign current assets indicates the growing deficit levels of foreign reserves in Indian banks to meet the demands. On an average, the foreign current liabilities up to three years tend to have a high and consistent exposure to all risk factors. This shows the need behind the creation of such liabilities. The foreign current liabilities predominantly created for NRI deposits and currency derivatives for client needs are basically designed with high cost and short- to medium-maturity levels. Hence, the liabilities with maturity up to three years are found to be highly exposed to all risk factors. In particular, the foreign current assets and foreign current liabilities are highly exposed to the interest rate, credit risk, and the exchange rate risk factors. This hints on the relationship between the creation of foreign assets and liabilities, and its link to the hedge exposure of banks.

Risk Exposure vs. Loans and Advances

If observed closely, the loans and advances of banks show a high similarity to bank deposits, in terms of its significance to the risk factors, but slightly lower levels of exposure to the different types of risks. This situation is favourable, since the loan rate implicitly adding the hedge cost is less exposed to interest rate and credit and exchange rate risks, leading the bank with return optimisation. This condition might favour asset-liability maturity, if improved with proper hedging policies.

Table 2: Position Exposure Regressions

Balance Sheet Factors with Maturity	Maturity Classification	Equity Risk Exposure (β_{MR})	Interest Rate Risk Exposure (β_{INTR})	Credit Risk Exposure (β_{CR})	Exchange Rate Risk Exposure (β_{EXR})	R^2
Deposits	01 – 14 days	−2.751607* (−4.84)	0.5736672* (4.73)	0 .6350324* (2.67)	1.167277* (4.56)	0.3022
	15 – 28 days	−2.850903* (−5.06)	0.590992* (4.92)	0.5754233** (2.44)	1.213399* (16.50)	0.2928
	29 days to 3 months	−3.222597* (−5.67)	0.6730445* (5.54)	0.5430979** (2.29)	1.296875* (5.07)	0.3344
	Over 3 months to 6 months	−3.34484* (−5.65)	0.7054203* (5.58)	0.6139231** (2.48)	1.364851* (5.11)	0.3722
	Over 6 months to 1 year	−3.456896* (−5.85)	0.7360637* (5.84)	0.6467671* (2.63)	1.380769* (5.20)	0.3919
	Over 1 year to 3 years	−3.286885* (−5.30)	0 .6900333* (5.21)	0.7469085* (2.88)	1.358449 * (4.86)	0.3796
	Over 3 years to 5 years	−4.59884* (−5.59)	0.9271006* (5.33)	0 .987779* (2.86)	1.708692* (4.64)	0.3695
	Over 5 years	−4.219215* (−4.38)	0.8566401* (4.21)	1.52293* (3.81)	1.464522* (3.41)	0.3135
	Total Deposit	−3.298041* (−5.47)	0 .6912474* (5.37)	0 .7096995* (2.82)	1.307167* (4.81)	0.3760

Balance Sheet Factors with Maturity	Maturity Classification	Equity Risk Exposure (β_{MR})	Interest Rate Risk Exposure (β_{INTR})	Credit Risk Exposure (β_{CR})	Exchange Rate Risk Exposure (β_{EXR})	R^2
Borrowings	01 – 14 days	−0.57575 (−1.01)	0.2661999** (2.23)	0.3539831 (1.49)	0 .284956 (1.16)	0.0264
	15 – 28 days	−0.8095314 (−1.43)	0.2288625 (0.26)	0.1906482 (0.54)	0.2488002 (1.41)	0.0534
	29 days to 3 months	−0.4024699 (−0.70)	0.3173559* (2.73)	0.1002311 (0.43)	0.2229716 (0.99)	0.0437
	Over 3 months to 6 months	−0.5919918 (−1.17)	0.2839816* (2.68)	0.2938401 (1.33)	0.2789693 (1.29)	0.0620
	Over 6 months to 1 year	−0.4416862 (−0.74)	0.2541699** (2.06)	0.1064217 (0.42)	0.2783947 (1.10)	0.0427
	Over 1 year to 3 years	−0.0532741 (−0.09)	0.1472781 (1.22)	0.565346** (2.28)	0.1866997 (0.76)	0.0655
	Over 3 years to 5 years	−0.1889561 (−0.29)	0.1481253 (1.17)	0.4005251 (1.48)	0.1740331 (0.73)	0.0594
	Over 5 years	−1.7436*** (−1.73)	0.3442279*** (1.87)	0.0646483 (0.16)	0.5129656 (1.59)	0.0298
	Total Borrowings	−1.435971* (−2.73)	0.3620381* (3.25)	0.5053882** (2.32)	0.5746117** (2.47)	0.1101
Investments	01 – 14 days	−1.219943** (−2.31)	0.2735214** (2.45)	0.2927344 (1.33)	0.4841091** (2.08)	0.0405
	15 – 28 days	−1.743292* (−3.79)	0.3525026* (3.60)	0.3584993*** (1.88)	0.7270526* (3.57)	0.1275
	29 days to 3 months	−2.18912* (−4.08)	0.4698987* (4.11)	0.5002751** (2.24)	0.8304433* (3.46)	0.2033
	Over 3 months to 6 months	−2.140978* (−4.40)	0.4659237* (4.50)	0.4368996** (2.15)	0.8611206* (3.97)	0.2128
	Over 6 months to 1 year	−2.261717* (−4.46)	0.5033266* (4.68)	0.4287007** (2.03)	0.882736* (3.93)	0.2071
	Over 1 year to 3 years	−2.851047* (−4.80)	0.6268294* (4.96)	0 .6589969* (2.62)	1.047196* (3.89)	0.3164
	Over 3 years to 5 years	−3.636533* (−5.52)	0.7532473* (5.39)	0.8726704* (3.15)	1.355739* (4.58)	0.3882
	Over 5 years	−4.279774* (−5.46)	0.8893141* (5.34)	0 1.034936* (3.14)	1.59424* (4.52)	0.4108
	Total Investments	−2.611733* (−5.17)	0.5589758* (5.17)	0.6278334* (2.97)	1.026221* (4.48)	0.3593
Foreign Current Assets (FCAs)	01 – 14 days	−1.530901** (−2.55)	0 .4142712* (3.29)	0.700239* (2.87)	0.642126** (2.48)	0.1920
	15 – 28 days	−0.1451891 (−0.24)	0.1833613 (1.50)	0 .8743623* (3.59)	0.2499055 (1.00)	0.1173
	29 days to 3 months	−1.028757*** (−1.77)	0 .3513915* (2.89)	0.8703005* (3.65)	0.5603022** (2.23)	0.2020
	Over 3 months to 6 months	−0.8402567 (−1.60)	0 .3391313* (3.12)	0.6985137* (3.25)	0 .4070892*** (1.81)	0.1756
	Over 6 months to 1 year	−0.606806 (−1.12)	0.2971944** (2.58)	0 .8399669* (3.65)	0 .4592311** (2.05)	0.1362

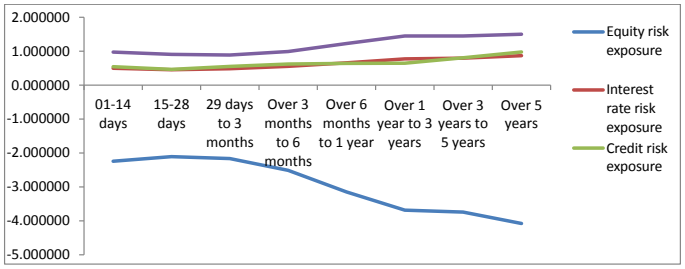
Balance Sheet Factors with Maturity	Maturity Classification	Equity Risk Exposure (β_{MR})	Interest Rate Risk Exposure (β_{INTR})	Credit Risk Exposure (β_{CR})	Exchange Rate Risk Exposure (β_{EXR})	R^2
	Over 1 year to 3 years	−0.2663136 (−0.37)	0.1731917 (1.12)	0.7985396* (2.81)	0.2705925 (0.89)	0.1133
	Over 3 years to 5 years	−0.1870149 (−0.25)	0 .2393287 (1.48)	0.8870804* (2.75)	0.234429 (0.72)	0.1272
	Over 5 years	0 .2123456 (0.18)	1.087543 (0.55)	0 .4671387 (0.61)	0.4015569 (1.22)	0.1025
	Total FCAs	−1.519279** (−2.32)	0 .4389338* (3.20)	0 .862893* (3.24)	0 .7295175** (2.57)	0.2258
Foreign Current Liabilities (FCLs)	01 – 14 days	−1.365964** (−2.23)	0 .4130339* (3.24)	0 .7014809* (2.81)	0.6108926** (2.32)	0.1658
	15 – 28 days	−0.6058039 (−1.00)	0 .2986212** (2.37)	0.6541413* (2.64)	0.3731054 (1.44)	0.0995
	29 days to 3 months	−1.208384** (−2.09)	0.3644209* (3.02)	0.636146* (2.72)	0 .5139604** (2.07)	0.1427
	Over 3 months to 6 months	−1.599408* (−2.63)	0.4648882* (3.67)	0 .566276** (2.31)	0.681107* (2.61)	0.1708
	Over 6 months to 1 year	−1.601123* (−2.76)	0.4559381* (3.78)	0 .5009897** (2.14)	0.7000598* (2.82)	0.1583
	Over 1 year to 3 years	−1.281887*** (−1.90)	0 .3993855* (2.83)	0 .6573882** (2.42)	0 .6731235** (2.32)	0.1173
	Over 3 years to 5 years	0 .0171963 (0.02)	0.2387845 (1.54)	0 .6403678** (2.15)	0.2832904 (0.89)	0.0897
	Over 5 years	−1.003621 (−0.57)	−0.4181011 (−0.16)	0.7254089 (0.63)	1.266102** (2.36)	0.1051
	Total FCLs	−1.606716* (−2.67)	0.4540353* (3.61)	0 .627799** (2.57)	0 .7421381* (2.85)	0.1847
Loans and Advances	01 – 14 days	−2.242031* (−4.18)	0.4961099* (4.33)	0.5437077** (2.43)	0 .9731736* (4.02)	0.2643
	15 – 28 days	−2.108251* (−4.18)	0.4541939* (4.23)	0.4633538** (2.20)	0.9059063* (4.02)	0.2279
	29 days to 3 months	−2.165153* (−4.23)	0 .4846404* (4.44)	0 .549883** (2.57)	0.8885174* (3.86)	0.2677
	Over 3 months to 6 months	−2.512493* (−4.48)	0.5546693* (4.64)	0.6217047* (2.66)	0.9897636* (3.93)	0.2956
	Over 6 months to 1 year	−3.147415* (−5.11)	0 .6558377* (4.99)	0 .6414281** (2.50)	1.224972* (4.43)	0.3286
	Over 1 year to 3 years	−3.685558* (−5.35)	0 .7730222* (5.25)	0.6467611** (2.25)	1.448133* (4.65)	0.3520
	Over 3 years to 5 years	−3.742295* (−5.68)	0.7959013* (5.66)	0.8057265* (2.94)	1.446931* (4.88)	0.3823
	Over 5 years	−4.078913* (−6.04)	0 .8692415* (6.05)	0 .9769304* (3.46)	1.498718* (4.93)	0.4100
	Total Loans & Advances	−2.932179* (−5.53)	0 .6373564* (5.62)	0 .654584* (2.95)	1.153634* (4.81)	0.3757

Source: Authors' calculation using report on trend and progress of banking in India by RBI (rbi.org.in).

Results of random effects regression between balance sheet factors with maturity classification and the risk factors, namely equity risk factor, interest rate risk factor, credit risk factor, and exchange rate risk factor. The beta coefficients β_{MR}, β_{INTR}, β_{CR}, and β_{EXR} denote the risk exposure of relevant balance sheet factors to the corresponding risk factors.

Notes: Z-statistics are presented in parentheses, 1%, 5%, and 10% levels of significance are indicated by *, **, and ***, respectively.

From Fig. 6, we can identify the role of maturity in exposing the bank assets to credit risk exposure. Till five years of maturity, the loans and advances were found to have approximately the same interest rate risk and credit risk exposure. As time of maturity increases, there is a sudden increase in credit risk exposure visibly impacting the loans and advances to default risk. Such time-varying effects need special treatment due to huge capitals associated with long-term maturity assets.



Source: Authors' calculation using report on trend and progress of banking in India by RBI (rbi.org.in).

Fig. 6: Loans & Advances of Indian Commercial Banks (Exhibit of Position Exposure Regression from Table 2)

The consistent negative equity exposure, backed by the portfolio rebalancing activities of customers and banks at the market, provide similar results at all balance sheet factors. This evidence might help banks in policy making, since huge deposit withdrawals might lead to decrease in investments and lowering of lending activities.

CONCLUSION

Banks with time and value as their huge assets play a pivotal role in shaping the economic condition of our country. Nevertheless, banks spend more efforts on their risk management, to keep the economy safe, liquid, and revenue generating. Still, the dynamism in the market environment, with the rising need for global trade and innovation in financial instruments, reveals the financial intermediaries to unfavourable risk exposures.

From the above risk quantifications and measurement of exposures, it can be summed up that, irrespective of economic conditions, the maturity mis-management can always expose banks' balance sheet to various losses. Along with the ill-management of assets-liabilities, the dynamism of market variables adds to the risk levels of banks. Hence, maintaining a safe level of maturity management and predicting risk tolerance levels might help banks devise proper risk management approaches.

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