

Duration Approach to Measure Bank's Risks

Kapil Sharma *

This paper makes an attempt to measure the risks of a bank using the duration gap measure approach, known as "duration ratio", which measures the duration gap between assets and liabilities of a bank. Duration gap can be considered to be a much better approach to measure a bank's risks, as it not only captures the effect of interest rate changes but also that of other shocks like market risk and exchange rate risk. As many as 16 Indian public sector banks have been examined for their risk management by using duration ratios. Data of assets and liabilities and interest income and expenses of these 16 public sector Indian banks were collected for the year ending March 31, 2004 for the analysis.

Introduction

The changing environment, in which banks find themselves, present major opportunities for banks but also entails complex, variable risks that challenge traditional approaches to bank management. Consequently, banks must quickly gain financial risk management capabilities in order to survive in an market-oriented environment and withstand competition. With so many hedging instruments and strategies it has become difficult not only to measure risks but also assess the quality of the risk management techniques used by financial experts for handling risks. Duration approach proposes a new risk measure that would help banks, investors and regulators in assessing the risks in banking industry.

Interest Rate Risk

It is the possibility of unexpected changes in revenues and/or costs (profit & loss) or changes in the value of assets and/or liabilities (balance sheet) caused by interest rate changes.

The interest rate risks faced by a bank is normally defined as the sensitivity of the value of capital/equity with respect to the interest rate changes. Where capital is the difference between assets and liabilities of the bank (Saunders 2000). In the form of a formula it can be represented as

$$\Delta C / \Delta I = \Delta A / \Delta I - \Delta L / \Delta I \text{ (Equ 1)} \quad (1)$$

Where

C = Capital of the bank

A= Assets of the bank

L = Liabilities of the bank

I = Interest rate.

* Faculty Member, The IBS, Indore. E-mail: kapils@ibsindia.org

Duration Approach

The basic duration model says that

$$\Delta A / A = -dA * \Delta I / (1+I) \quad (2)$$

$$\Delta L / L = -dL * \Delta I / (1+I) \quad (3)$$

where dA and dL represent duration of the bank's asset and liability portfolio.

Rearranging Equ 2 and 3 we get

$$\Delta A = -dA * A * \Delta I / (1+I) \quad (4)$$

$$\Delta L = -dL * L * \Delta I / (1+I) \quad (5)$$

Using Equ 1, 4 and 5 we can write

$$\Delta C = -\{dA * A - dL * L\} * \Delta I / (1+I) \quad (6)$$

Taking up Macauley's duration model assumption that interest rate and its shock have same effect both on assets and liabilities, we will get

$$\Delta C = -\{dA - dL * k\} * A * \Delta I / (1+I) \quad (7)$$

Here $k = L / A$ is the measure of bank's leverage

Also $\{dA - dL * k\}$ is known as duration gap

As per the traditional immunization strategy a firm should try to structure its balance sheet so that $dA = dL * k$ such that $\Delta C = 0$.

Duration Ratio

Instead of calculating the difference of Equ 2 and 3, if we divide Equ 2 by 3 we will get the ratio of asset value to liability value and can be considered as the elasticity of asset with liabilities.

$$(\Delta A / A) / (\Delta L / L) = dA / dL \quad (8)$$

Here in this paper an attempt has been made to provide an economic meaning to the above duration ratio in terms of interaction of assets and liabilities. Generally, risk management of banks tries to offset asset risks by liability risks in such a manner that risks faced by equity is immunized from the sources of the risks.

We already know that $\Delta C = \Delta A - \Delta L$

If both assets and liabilities of the firm are stochastic in nature and bank manages them in such a way that riskless equity is generated, then

$$\text{Var}(\Delta C) = \text{Var}(\Delta A) + \text{Var}(\Delta L) - 2 * \text{Cov}(\Delta A, \Delta L) \quad (9)$$

Where Var and Cov represent variance and covariance respectively.

Let us assume that $\text{Var}(\Delta A) = \text{Var}(\Delta L)$ then

$$\text{Var}(\Delta C) = (1 - (\text{Corr}(\Delta A, \Delta L))) * 2 * \text{Var}(\Delta A) \quad (10)$$

Here Corr = Correlation coefficient

Equation 10 suggests that if perfect correlation (i.e., correlation of 1) between assets and liabilities is there, then a bank can hedge the total portfolio against any type of risk. Correlation like elasticity also

measures linear relationship between assets and liabilities, thus duration ratio can be considered to measure overall risks rather than just interest rate risks faced by the banks.

From Equation 8 we can obtain a simple proxy for the overall duration ratio, i.e., the ratio of percentage change in the market value of assets to that of liabilities. In this paper two variables have been used: First, book value of assets and liabilities (from balance sheet) and second, interest revenues and expenses (from income statement). These variables have been used to determine their validity as a proxy for the duration ratio of some of the Indian banks.

Convexity

Duration model assumes a linear relationship between interest rate and bond price changes; in reality bond price-yield relationship exhibits a property which is called convexity, not linearity. Increase in the bond price due to a fall in interest rate is more than that determined by duration model, whereas prices fall more when interest rate increases. We shall then incorporate convexity factor in the duration model by adding curvature parameter

$$\Delta A/A = -dA * \Delta I / (1+I) + 1/2 * C * (\Delta I)^2 \quad (11)$$

The term underlined in the above equation is the curvature term.

The convexity property demands modification in the duration ratio and hence Equation 8 will be modified to

$$(\Delta A/A) / (\Delta L/L) = dA/dL + C_v \quad (12)$$

where C_v is a convexity factor with a property that greater curvature is associated with higher C_v . However, duration model implies that $C_v = 0$.

Duration, Capital Ratio and Immunization

In an environment of capital restriction we get interesting implications from equation 8. Where regulators set up a minimum target ratio for a bank's net worth, the simplest ratio used is the ratio of the bank capital to its assets, i.e., C / A . In a situation where banks want to immunize themselves against falling below this target ratio, i.e., $\Delta(C / A) = 0$. For achieving this immunization $\{\Delta(C / A) = 0\}$ banks should have $dA = dL$ instead of $dA = k * dL$ such that $\Delta C = 0$. Thus according to this, percentage change in assets should be the same as the percentage change in liability. Moreover, the risk management approach of banks will differ depending upon their objectives of risk management and also according to their capital requirement.

Empirical Investigation and Inferences

Data of assets and liabilities of 16 public sector Indian banks were collected for the year ended on March 31, 2004. For most of the banks under sample the interest revenue was more than the interest expense representing a profitable performance in 2003. Tire I capital was about 5.5% on average which was also quite comfortable. (Refer to Table 1 for the summary of the statistics of the sample.)

DUR1

Although book values of assets and liabilities have been used for calculating ratios (DUR1), the ratio may be used to capture the current market value changes as recent percent changes of assets and

Table 1: Summary Statistics of the Sample				
<i>Summary statistics of the major variables considered for 2003 INTAVG is the interest income per average assets. INTEXP is the Interest Expense per Average Assets. AA is the Average Asset size in cores of rupees. CAP is the ratio of Tire I capital, i.e., Equity to Total Assets. DUR1 ($\Delta A / A$) / ($\Delta L / L$) first proxy for Duration Ratio. DUR2 is the second proxy referred as ($\Delta int. rev. / int. rev$) / ($\Delta int. exp. / int. exp.$)</i>				
Variables	Mean	Minimum	Maximum	Std. Dev
INTAVG (%)	14.2	10.65	28.34	3.48
INTEXP (%)	7.1	3.66	11.53	1.96
AA(Rs. Crs.)	20,468	12,824	32,529	18,368
CAP (%)	14.6	10.06	31.84	4.8
DUR1	0.746	-1.169	2.415	0.8
DUR2	1.012	0.8846	1.89	0.06

liabilities have been used instead of changes in the levels. The average duration ratio based on assets and liabilities is 0.746. This ratio is close to 1 and indicates that banks of our sample are using good hedging strategies. However, on examining the results carefully it is observed that duration ratio may not be reliable for some individual banks as there is a negative ratio as high as -1.169 which is not acceptable because duration ratio is supposed to be positive.

DUR2

Duration ratio obtained using interest revenues and interest expense reflect price changes in assets and liabilities. Table 1 again shows that average duration ratio (DUR2) is 1.012 is again close to 1.0.

Table 2: Immunization Strategies				
<i>Summary statistics of the major variables considered for 2003 for the banks with different immunization strategies. INTAVG is the interest income per average assets. INTEXP is the Interest Expense per Average Assets. AA is the Average Asset size in cores of rupees. CAP is the ratio of Tire I capital, i.e., Equity to Total Assets. L / A is the leverage ratio. dA / dL is the duration ratio. Plan I is to set $dA = k*dL$ while Plan II is to set $dA = dL$</i>				
Variables	Plan I		Plan II	
	Mean	Median	Mean	Median
INTAVG (%)	3.445	3.485	3.82	3.715
INTEXP (%)	1.67	1.675	1.795	1.755
AA (Rs. Crs.)	23,151	7,766	14,871	6,670
CAP (%)	3.25	3.18	3.885	3.62
dA / dL	91.4 %	92.6%	101.3%	98.9%
L / A	91.2%	91.8%	93.4%	93.9%

Also the standard deviation is 0.06 smaller than DUR1. Furthermore, all duration ratios calculated are positive which is another indication of its reliability for the proxy for the duration ratio

Examining $dA = dL$ vs. $dA = k*dL$

The earlier section discussed two different risk management objectives $dA = dL$ and $dA = k*dL$

If the firm wants to hedge the level of equity against risks (i.e., $\Delta C = 0$) then managers need to adopt $dA = k*dL$ (Plan I). Here the duration ratio is close to leverage ratio. But if the firm wants to hedge capital ratio {i.e., $\Delta (C / A) = 0$ } then managers need to set $dA = dL$ (Plan II). Table 2 shows summary statistics for the two different sets of banks based on their strategies. There are eight banks using Plan I and eight banks using Plan II (Refer Table 3). Banks whose strategy is $dA = k*dL$ (Plan I), desire to keep

Plan I	Plan II
New Bank of India	Syndicate Bank
Bank of India	Indian Bank
Bank of Baroda	United Commercial Bank
Canara Bank	Allahabad Bank
Punjab National Bank	Indian Overseas Bank
Central Bank of India	United Bank of India
Union Bank of India	Dena Bank
Oriental Bank of Commerce	Corporation Bank

their level of equity stable. These banks are larger in size but produce less interest revenues than those banks using Plan II. It is also observed that the capital leverage ratio for the banks using Plan I seems to be lower than the banks using Plan II.

Conclusion

Two proxies for the duration ratios have been used here: One based on assets and liabilities and the other based on interest revenues and expenses and it

has been observed that the second measure based on interest revenues and expenses seems to be a more reliable one. Also an interesting pattern exists among our sample banks in terms of immunization strategies, i.e., banks using Plan I seem to be larger in size, have lower capital leverage ratios and produce less interest revenues than those banks using Plan II. This analysis can be extended to much longer time series data and be observed how duration ratio evolves over time. Also we may examine smaller banks of different capital ratios to see whether different duration ratios are associated with these banks in a systematic way.★

Reference # 10J-2005-11-03-01

References

1. Allen, Mark, Christoph B Rosenberg, Christian Keller, Brad Setser, and Nouriel Roubini, 2002, "A Balance Sheet Approach to Financial Crises," IMF Working Paper 02/210 (Washington: International Monetary Fund).
2. Basel Committee on Banking Supervision (2001), Principles for the Management and Supervision of Interest Rate Risk, Bank for International Settlements.
3. Bhala R (1989), Risk-based Capital: A Guide to the New Risk-based Capital Adequacy Rules, Bank Administration Institute, Rolling Meadow, Illinois.
4. Bierwag G (1987), Duration Analysis, Ballinger, Cambridge, MA.
5. Bierwag, G O and George G Kaufman, "Duration Gap for Financial Institutions," *Financial Analysts Journal* 41, March/April 1985, pp. 68-71.
6. Dermine J (1985), "The Measurement of Interest Rate Risk by Financial Intermediaries", *Journal of Bank Research*, Summer.
7. Deshmukh S D, Greenbaum S I and Kamatas G (1983), "Interest Rate Uncertainty and the Financial Intermediary's Choice of Exposure", *Journal of Finance*, 38, March, 141-147.
8. Dew, J, 1981, "The Effective Cap-A More Accurate Measure of Interest Rate Risk", *American Banker*, June 10.
9. Howe D M (1992), A Guide to Managing Interest Rate Risk, New York, Institute of Finance, New York.
10. Khahane Y (1997) "Measuring and Managing Interest Rate Risk: A Primer Economic Perspectives", Federal Reserve Bank of Chicago, January/February 8, 16-29.
11. Koch, Timothy W, Bank Management, 1988, Chicago, IL, The Dryden Press.
12. Patnaik, Ila, and Ajay Shah, 2002, "Interest Rate Risk in the Indian Banking System," ICRIER Working Paper No. 92 (ICRIER), New Delhi
13. Rose, Peter S, Commercial Bank Management, 3rd Ed., 1996, Chicago, IL, Irwin.
14. Saunders, A Financial Institution Management: A Modern Perspective, Mc Graw-Hill Co.2000.