THE MEASUREMENT OF INTEREST RATE RISK BY FINANCIAL INTERMEDIARIES

by

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Summary

This note is concerned with the interest rate risk exposure of financial intermediaries in the case of imperfect competition. It is argued that an appropriate measure of risk should take into account not only the interest rate sensitivity of the current assets and liabilities of the intermediary but also the sensitivity of its charter value, that is of its value as a going concern.

At first glance at the title of the paper, one may wonder what more can be written on the management of interest rate risk. So many papers or books[1] have been written on the risk of an unexpected change in interest rates and on the new financial instruments (financial futures and options) which have been developed in the United States and in other countries. The specific purpose of this note is to propose a measure of interest rate risk which applies not only in the case of perfect competition (an implicit assumption in the current literature) but also in the case of imperfect competition.

It is argued that the literature on the solvency of banks and on the measurement of their market value gives interesting insights which are of importance for the management of interest rate risk. The basic idea is that the market value of a financial intermediary may include not only the current value of assets net of the liabilities but also its charter value or goodwill, that is its value as a going concern. When this is the case, one must be concerned with the effect of interest rate fluctuations not only on the current value of assets and liabilities (the focus of the current literature) but also on the value of the bank's charter.

The note is organized as follows. The determinants of the market value of a bank under imperfect competition are exposed in section one. In section two, we propose a measure of interest rate risk which will include as a special case the measure available in the current literature. An appropriate measure of risk should obviously be of interest to many parties ranging from managers and shareholders to depositors and deposit insurers.

Section One: The Determinants of the Market Value of a Financial Intermediary

An analysis of the effect of interest rate fluctuations on the market value of a financial intermediary starts naturally with the determinants of its market value. Useful insights are provided by GUTTENTAG and HERRING

(1983) who suggest that the market value (MV) of a bank includes the current value of assets (MV_A) net of the liabilities (MV_L) and the value of the goodwill or the bank's charter, that is:

$$MV = MV_A - MV_L + \text{Charter Value} . \qquad (1)$$

The charter value or goodwill is defined by GUTTENTAG-HERRING (p. 116) as follows: "Conceptually, the goodwill is the present value of net income the bank would be expected to earn on new business if it were to retain only its offices, employees and customers. The goodwill depends on the bank's authorized powers including power to do business within specified areas, the market structure in the area, the expertise of the bank's employees and the customer relationships it has developed." The simple example which follows illustrates how to evaluate numerically the current value of assets and liabilities and the charter value of a bank.

Take the case of a financial intermediary, bank 'S', which faces a flat yield curve of ten per cent. It holds only one asset, a three year to maturity fixed rate government bond (100), and issues a two year eight per cent deposit of 95 (interest paid annually). Equity is 5. The liabilities are constant over the next two years at the end of which bank 'S' is liquidated. The real costs incurred in monitoring assets and servicing deposits will be ignored for simplicity of exposition.

The particular structure of the example calls for a comment. There can be many reasons in the real world as to why we observe an interest rate differential between assets and liabilities. The longer maturity of assets may command a risk premium and, with deposits withdrawable on short notice, the posted deposit rate does not include the extra cost of refinancing in case of withdrawal. However, this does not explain the interest rate differential in our example. We assume that the average return (cost) of 10% and 8% are net of the price for risk[2] and we postulate that it is imperfect competition or regulation on the deposit market which creates the interest rate differential. Barriers to entry (such as a binding regulation on interest paid on demand deposits) prevent the creation of perfect substitutes which would erase the interest rate differential. The relevance of this hypothesis can be questioned in a period of deregulation but it would seem that regulation or 'organized competition' (the case in some European countries) creates imperfect competition in at least some deposits markets. Anyway, our model is quite general as perfect competition will appear as a special case.

The market value of bank 'S' can be computed: it is the difference between the market value of assets (MV'_A) and the market value of the liabilities (MV'_L) evaluated at the current market rate of ten per cent. These are market values from the viewpoint of shareholders who discount the cash flows at their opportunity cost of funds of ten per cent.[3] Relation (2) gives the value of the asset and relations (3i) and (3ii) present two alternative ways to compute the value of liabilities:

$$MV'_A = \frac{10}{1.1} + \frac{10}{1.1^2} + \frac{10}{1.1^3} = 100 \quad (2)$$

$$MV'_L = \frac{.08 \times 95}{1.1} + \frac{1.08 \times 95}{1.1^2} = 91.7 \quad (3i)$$

$$= \left[\frac{.08 \times 95}{1.08} + \frac{1.08 \times 95}{1.08^2}\right] + \left[\frac{(.1 - .08)95}{1.1} + \frac{(.1 - .08)95}{1.1^2}\right] \quad (3ii)$$

$$= 95 - 3.3 = 91.7$$

and the market value of bank 'S' is equal to:

$$MV = MV'_A - MV'_L = 100 - 95 + 3.3 = 8.3 \; . \quad (4)$$

Two different expressions have been given for the market value of the liabilities of bank 'S'. The first one (3i) is conventional: it is the market value of the future cash outflows evaluated at the shareholders' opportunity cost of funds of 10%. The second expression (3ii) is more cumbersome but economically more meaningful. It states that the value of the liabilities of bank 'S' is the sum of two terms: the value of cash outflows evaluated at the current deposit rate of 8% (that is the value of deposits if the bank is closed today) and the present value of the future profit opportunities, i.e., the ability to pay below market rate on deposits. The second decomposition is more complex but it is useful to evaluate each terms of the GUTTENTAG-HERRING valuation formula: the market value of bank 'S' (8.3) is the sum of the value of the bank in case of immediate liquidation (current assets (100) minus current liabilities (95)) plus the value of its charter value or goodwill as a going concern (3.3). Also, the second decomposition will be quite useful to evaluate the risk of interest rate fluctuation.

The generalization of the market value formula is easy to make once a particular feature of the example--constant margin on deposits--is recognized. As the margin is likely to fluctuate over time, one must take into consideration the future interest rate differentials and volumes of deposits to evaluate the market value of the intermediary. In general, we would have:

$$MV = MV_A - MV_L + \sum_{t=1}^{\infty} \frac{(b - d_t)D_t}{(1 + b)^t} \tag{5}$$

with MV_A: The market value of current assets evaluated at the current asset rate;

MV_L: The market value of current deposits evaluated at the current deposit rate;

D_t: The volume of deposits in period t;

b: The government bond rate (flat yield curve being assumed).

We observe immediately that the last term of the market value (the charter value or goodwill) is equal to zero in the case of perfect competition (b = d).[4]

As is mentioned earlier, this decomposition of the market value of a financial intermediary has an important implication for the measurement of interest rate risk as one must analyze the effect of an unexpected change in interest rates not only on the market value of current assets and liabilities, but also the effect on the charter value, i.e., on the future profit opportunities:

$$\frac{\partial MV}{\partial b} = \frac{\partial MV_A}{\partial b} - \frac{\partial MV_L}{\partial b} + \frac{\partial \text{ Charter Value}}{\partial b} . \tag{6}$$

It is only in the case of perfect competition or in the case where the charter value is constant that the analyst can look only at the current value of assets and liabilities. The case of imperfect competition is surely more complex as one must anticipate the effects of a market rate change on the interest rate margin and on the volume of deposits. In section two, we propose a measure of interest rate risk which takes into account the interest rate sensitivity of the charter value.

Section Two: A Measure of Interest Rate Risk

A measure of interest rate risk is proposed for a stationary system where the volumes of deposits and interest rate margins are identical in each period. This is done only for expository convenience and a more realistic but complex formula is given in the appendix.

In the stationary case, the market value of the financial intermediary becomes:

$$MV = MV_A - MV_L + \sum_{t=1}^{\infty} \frac{(b - d)D}{(1 + b)^t}$$

$$= MV_A - MV_L + \frac{(b - d)D}{b} \ . \qquad (7)$$

Since we are interested in the response of the charter value to a change in market rates, we make the realistic assumption that the volume of deposits is a function of the deposit rate d and of the market rate b (i.e., $D = D(d, b)$) and that the deposit rate will respond to a change in market rate. The magnitude of the responses will of course vary from country to country and they should be estimated by the financial analyst.

The effect of a change in the market rate b on the market value of the bank is given by relation (8):

$$\frac{\partial MV}{\partial b} = \frac{\partial MV_A}{\partial b} - \frac{\partial MV_L}{\partial d} \times \frac{\partial d}{\partial b} - \frac{\partial\left(\frac{(b - d)D}{b}\right)}{\partial b} \ , \qquad (8)$$

that is the effect of a market rate change on the market value of current assets, the effect of a consecutive deposit rate change on the market value of current deposits[5] (remember, evaluated at the current deposit rate) and finally the effect on the charter value or goodwill.

Relation (8) can be expressed usefully in a more operational form, relation (9),[6] where the term η_{xy} denotes the elasticity of variable x with respect to y, i.e., the ratio of a % change in the x variable to a % change in the y variable, $\frac{\Delta x}{x} / \frac{\Delta y}{y}$:

$$\eta_{MV,b} = \left(\eta_{MV_A,b} \times \frac{MV_A}{MV}\right) - \left(\eta_{MV_L,d} \times \eta_{d,b} \times \frac{MV_L}{MV}\right)$$

$$+ \frac{\frac{(b - d)D}{b}}{MV} \left(\eta_{D,d} \times \eta_{d,b} + \eta_{D,b} + \eta_{\frac{b-d}{b},b}\right) \qquad (9)$$

with $\eta_{MV_A,b} = \frac{\partial MV_A}{\partial b} \cdot \frac{b}{MV_A} = -Du_A \times \frac{b}{1+b}$, Du_A denoting the Macaulay duration of asset (Macaulay, 1938)[7]

and $\eta_{MV_L,d} = \frac{\partial MV_L}{\partial d} \cdot \frac{d}{MV_L} = -Du_L \times \frac{d}{1+d}$, Du_L denoting the Macaulay duration of deposits.

Relation (9) states that the elasticity of the market value of a financial intermediary with regard to a change in market rate, $\eta_{MV,b}$, is a weighted sum of elasticities. The weights are the value of current assets, liabilities and goodwill relative to the market value of the intermediary and the series of elasticities are the following: the elasticity of the asset with regard to the asset rate, the elasticity of deposits with regard to the deposit rate times the elasticity of the deposit rate with regard to the market rate and finally a series of elasticities representing the elasticity of the goodwill with regard to market rates, that is its effect on the volume of deposits (indirectly via the induced change in deposit rate and directly via the change in market rate) and its effect on the interest rate margin. Obviously, the smaller is the goodwill or its sensitivity to interest rate change, the smaller becomes its importance in the measurement of interest rate risk.

This formula is more complex than the usual gap between the durations of current assets and liabilities as it takes into account the interest rate sensitivity of the goodwill which depends, among other factors, on the current and future states of competition. A direct implication of this analysis for the hedge of the market value of a bank is that the duration gap between assets and liabilities should be related to the interest rate sensitivity of the goodwill. Specifically, the gap between the durations of assets and liabilities should be positive if the goodwill responds positively to a change in market rates, and, vice versa, the gap should be negative if the goodwill decreases with the interest rate level.

The relevance of the charter value for the measurement of interest rate risk is an empirical matter and recent work by FLANNERY-JAMES (1984) suggests some results. Using bank stock prices to infer the effective maturity of demand, savings and small time deposits, they suggest that the effective maturity appears to be longer than their very short contractual maturity. This implies that, when interest rates rise, the market value of these deposits falls by a greater amount than would be anticipated with such a short maturity. An interpretation of this result which is consistent with this note and with the author's work on the relevant maturity of demand and savings deposits[8] is that the maturity of these deposits is indeed very small but that there is a goodwill term attached to them. When interest rates rise, their liquidation value does not change (the case of demand and savings deposits) but the value of the goodwill rises, explaining the reported decline in their total market value. As FLANNERY and JAMES put it (p. 444): "The empirical evidence suggests that demand, savings and retail time deposit balances are 'sticky' or imperfectly responsive to change in market rates. When market interest rates rise (fall), the bank's effective cost of these liabilities changes by a smaller amount, raising (lowering) bank income, ceteris paribus." FLANNERY and JAMES conclude that this has allowed the banks to have a longer duration on assets than on liabilities. Of course, these results are based on past data and what is relevant today for hedging is the future response of the goodwill to interest rate changes.

We have argued in this note that the measure of interest rate risk for a financial intermediary is not independent of the level of competition. When there is imperfect competition, one must take into account not only the interest rate sensitivity of current assets and liabilities but also the effect of interest rate changes on the future profit opportunities, that is the effect on the charter value or goodwill. The information set required to evaluate the interest rate risk exposure will include the durations of current assets and liabilities and an estimate of the interest rate sensitivity of the (current and future) interest margins and volumes of deposits. The argument developed in this note is in fact not novel but is implicit in Paul Samuelson's early work on interest rate risk for banks (1945, p. 24): "It should not be necessary to argue before economists that the banking system is a going concern and is to be treated as such."

Appendix

As the volume of deposits and the deposit rate are unlikely to remain constant over time, one must consider the more general valuation formula:

$$MV = MV_A - MV_L + \sum_{t=1}^{\infty} \frac{(b - d_t)D_t}{(1 + b)^t} \tag{A1}$$

and the elasticity of the market value of the intermediary with regard to the market rate becomes:

$$\eta_{MV,b} = \left(\eta_{MV_A,b} \times \frac{MV_A}{MV}\right) - \left(\eta_{MV_L,d} \times \eta_{d,b} \times \frac{MV_L}{MV}\right)$$
$$+ \frac{1}{MV} \left(\sum_{t=1}^{\infty} \frac{(b - d_t)D_t}{(1 + b)^t} \left(\eta_{D_t,d_t} \times \eta_{d_t,b} + \eta_{D_t,b} + \eta_{\frac{b-d_t}{b},b}\right)\right) \tag{A.2}$$

where t denotes the time period. As is mentioned in footnote (4), we have assumed imperfect competition on the deposit market only. With imperfect competition on the asset market, one would extend the analysis along similar lines to measure the elasticity of goodwill on assets.

Footnotes

[1]For instance BIERWAG-KAUFMANN (1983), BIERWAG-KAUFMANN-TOEVS (1983b), FITZGERALD (1983), GAY-KOLB (1983) or ROSENBLUM (1982).

[2]Alternatively, we could say that the rates of 10% and 8% are 'certainty equivalent' return and cost.

[3]There are three assets in our example: government bonds, deposits and equity. We assume that the shareholders have the opportunity to invest in bonds or equity so that the appropriate discount rate to value the 'certainty equivalent' cash flows is the government bond rate of 10%.

[4]We must mention two simplifications in the valuation formula: 1) We have assumed that the (certainty equivalent) return on asset is the government bond rate. With imperfect competition on the asset market, we would have a similar goodwill term on assets (DERMINE, 1984b). 2) We have ignored the risk of bankruptcy and the value of the put option granted by the deposit insurance (MERTON, 1977).

[5]We take only into account the changes in market value of current assets and liabilities because the changes in current volumes (f.i. an outflow of demand deposits) would be exactly matched (financed) by a change in the volume of assets.

[6]The proof is available on demand.

[7]Relation (9) is valid only for a flat yield curve and identical change in interest rates. More complex measures of duration have been derived for various yield curves and stochastic processes (BIERWAG-KAUFMANN-TOEVS, 1983a and 1983b).

[8]The maturity of a demand or a savings deposit is the minimum amount of time before the volume or the interest rate is changed. For many of these deposits, the maturity is extremely short (DERMINE, 1984a).

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Philippe LASSERRE and Max BOISOT. February 1980. 109, VI p.

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Paris : Association pour l'Etude de la Langue et la Civilisation Japonaise, 1980. pp. 118-130.

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