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A NOTE ON MANAGING DEPOSIT FLOWS WITH CASH AND FUTURES MARKET DECISIONS

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A Note on Managing Deposit Flows with Cash and Futures Market Decisions*

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Abstract

As deposit markets become less regulated, financial intermediaries must focus more of their attention on the explicit pricing of deposit accounts. An implication of pricing deposits is that the intermediary faces a random source of funds when future deposit supplies are unknown. This note shows that financial future contracts can be used to hedge the risk of deposit withdrawals, allowing the financial firm to set lower deposit rates than it would without futures trading. A model of risk averse banking behavior is constructed to determine the relationship between hedging deposit withdrawals and setting deposit rates. Using the certificate of deposit futures contract to hedge demand and savings deposit withdrawals, an empirical application of the model reveals that the possible gains in profitability from setting deposit rates and hedging withdrawals are small but statistically significant.

A Note on Managing Deposit Flows with Cash and Futures Market Decisions

With the recent deregulation of deposit accounts and the increased competition in the banking industry, financial firms are focusing more attention on the pricing of their deposits.[1] Highly concentrated demand, savings, and time deposit markets permit this price-setting behavior, and traditionally, depository financial intermediaries agree to accept whatever quantity of deposits forthcoming at a predetermined deposit rate. This behavioral mode is prone to problems of bank liquidity, however. Setting deposit rates ex ante, the intermediary is uncertain about the quantity and mix of liabilities it will have on its balance sheet ex post. As a solution to this liquidity problem, bank liability management can be used to fill out the financial firm's balance sheet ex post. The essence of most ex post liability management strategies is the selection and use of perfectly competitive funds markets where the desired quantity of funds can always be purchased or sold. This implies that if a deposit rate-setting bank has access to a perfect funds market, variations in the cost of funds are a secondary problem to variations in deposit quantities; the bank's main concern is filling out its balance sheet (see Mason (1979)).

This note presents an alternative to the ex post liability management policies used to satisfy an intermediary's balance sheet constraint. A position in a financial futures market is used jointly with deposit rate-setting to hedge, ex ante, the quantity of funds forthcoming. That is, the futures hedge is an anticipatory hedge of a liability quantity risk faced by the financial intermediary. Hedging permits the separation of withdrawal risk considerations from profitability considerations in setting deposit rates. Ex ante liability management through financial futures hedging and deposit rate-setting becomes a substitute tool for controlling thrift liquidity relative to ex post liability management. This application of financial futures hedging is different than the literature on the anticipatory hedging of bank liability interest rates (see Franckle and Senchack (1982), Parker and Daigler (1981), and Speakes (1983)) because it explicitly considers the management of the deposit quantity risk faced by rate-setting intermediaries. Futhermore, cash and futures market decisions are determined simultaneously.

I. A Model of Deposit Flow Hedging

It is assumed the bank uses two tools to manage deposit flow uncertainty: trading CD futures contracts and setting deposit interest rates. To manage deposit withdrawals, the bank can buy CD futures contracts and raise deposit interest rates. The purchase of futures contracts represents an anticipatory hedge of deposit outflows (a funding hedge) because it acts as an alternative source of funds. If withdrawals are closely associated with a fall in market interest rates, the profits from a long (buy) futures position augment the reduced cash market sources of funds. Bank profits can be sustained in the face of deposit outflows. Conversely, expected deposit inflows and higher market interest rates create less need for a funding hedge; the long position should be reduced or possibly changed to a short (sell) position to increase bank profitability. In conjunction with the funding hedge, the bank can raise (lower) deposit interest rates to counter expected deposit withdrawals (inflows), assuming a positive interest elasticity of deposit supply.

Assume the bank has a one-period planning horizon. At the beginning of the period, the bank must decide on the CD futures position, X, and the deposit interest rate, R_D. At this time, the bank knows the current CD futures price, $(1-R_X)$, the rate on purchased funds, $R_B>R_D$, and the loan revenue at the end of the period, $R_L L$, but does not know the level of deposits, $\tilde{D}$, or the CD futures price, $(1-\tilde{R}_X)$, at the end of the period (Tildes indicate random variables realized in the future.) When deposits are realized and the futures position is offset, bank borrowing, B, takes place to fill out the balance sheet. The market for these funds is assumed to be perfectly competitive. Let $\tilde{D}$ be

$$\tilde{D} = D(R_D)+\tilde{\theta},\ \partial D/\partial R_D > 0,\ \partial D/\partial \theta > 0 \qquad (1)$$

where θ is the random change in deposits over the planning period, unknown ex ante but with a known subjective probability distribution. Bank profits at the end of the period are given by:[3]

$$\tilde{\Pi} = R_L L + [(1-\tilde{R}_X) - (1-R_X)]X - R_B B - R_D\tilde{D}$$

$$= R_L L + (R_X - \tilde{R}_X)X - R_B B - R_D\tilde{D}. \qquad (2)$$

Note that if futures prices fall and interest rates rise at the end of the period, selling futures contracts ($X < 0$) at the start of the period is profitable, while if prices rise and interest rates fall, buying futures contracts ($X > 0$) is profitable. For simplicity, initial margins and variation margin calls are ignored.

The bank's problem is to make two ex ante decisions, X and R_D, and one ex post decision, B, that will maximize the expected utility of profit subject to the balance sheet constraint at the end of the period. These decisions are based on the bank's subjective expectation about future events, described by the joint cumulative density $F(\tilde{R}_X,\tilde{\theta})$. It is assumed that this joint distribution does not change over the planning period. The decision problem can be written[4]

$$\underset{X,R_D \geq 0 \quad B \geq 0}{\text{Maximize}}\ E[\max U(\tilde{\Pi}) \mid F(\tilde{R}_X,\tilde{\theta})] \qquad (3)$$

$$\text{subject to: } L=(R_X-\tilde{R}_X)X+B+D$$

where E is the expectations operator, and U is a risk averse utility function such that $U'(\tilde{\Pi}) > 0$ and $U''(\tilde{\Pi}) < 0$ (a prime indicates derivation).

Assuming bank management is constant absolute risk averse and the joint distribution of random variables is normal, the objective function in expression (3) can be rewritten in a mean-variance expected utility framework, after substituting for B from the balance sheet constraint. The optimal solutions can easily be shown to be [5]

$$X^* = \frac{E(R_X - \tilde{R}_X)(1+R_B)}{\gamma Var[\tilde{R}_X]} + \frac{(R_B - R_D^*)Cov[\tilde{\theta},\tilde{R}_X]}{Var[\tilde{R}_X]} \quad (4)$$

$$R_D^* = R_B + \frac{\tilde{E}\tilde{D}(a\overset{*}{\varepsilon} - 1)}{\gamma Var[\tilde{\theta}]} + \frac{X^* \, Cov[\tilde{\theta},\tilde{R}_X]}{Var[\tilde{\theta}]} \quad (5)$$

where γ is the index of risk aversion, Var represents variance, Cov represents covariance, $a^* = (R_B - R_D^*)/R_D^*$, and $\varepsilon = (\partial D/\partial R_D)(R_D/D)$. The variable a^* is interpreted as the bank's percentage funding margin on a dollar of deposits; ε is a constant deposit rate elasticity of deposit supply. Both a^* and ε are non-negative.

In the right hand side of equation (4), the optimal futures position is written as the sum of two terms: an expectations term and a deposit risk term. Initially, let the expectations term be zero. In a banking industry offering unregulated deposit instruments, $Cov[\tilde{\theta},\tilde{R}_X] > 0$ if futures markets move in the same direction as cash market rates. That is, deposit outflow are associated with lower CD rates, deposits inflows with higher CD rates. Since $(R_B - R_D) > 0$, the optimal futures position represents a long hedge of the anticipated risk. If deposit outflows and lower interest rates occur, the profits from a long hedge substitute for the loss of deposits. A non-zero expectations term reinforces the incentive to take a long position if rates are expected to fall.

In the absence of futures trading, the solution to the firm-theoretic model would be given in equation (5) with the third term on the right hand side equal to zero. If $0 < \epsilon < 1/a^*$, then $(R_B - R_D^*) > 0$. In the the nonhedging solution, expected deposit outflows are managed by raising deposit rates, expected deposit inflows by lowering deposit rates. These qualitative effects are preserved when futures trading is introduced, but deposit interest rates with a funding hedge ($X^* > 0$) are lower than deposit rates without hedging. Low deposit rates may exacerbate the risk of bank deposit withdrawals; hedging the withdrawal risk in the futures market makes low deposit rates less risky. Alternatively, a large expected rise in interest rates could result in a short futures position ($X^* < 0$). Deposit interest rates would then be set higher with futures trading than without futures trading. A short futures position offers no protection from deposit withdrawals and is speculative; to compensate, the level of deposit rates must be raised. In this model, offering higher deposits rates to gain deposits occurs only in conjunction with futures speculation; futures market risk is substituted for deposit market risk in maximizing expected utility.

II. Quantity Risks and the CD Futures Market

This section estimates the hedging effectiveness of the CD futures market by comparing the performance of the optimal strategy in equations (4) and (5) with a routine hedging strategy and a nonhedging strategy. This requires firm-specific data for L, $Cov[\tilde{\theta},\tilde{R}_X]$, $E\tilde{D}$, and $Var[\tilde{\theta}]$. It is unlikely that any existing financial intermediary faces a situation exactly satisfying the assumptions of the model, but equations (4) and (5) can be simulated using Report of Condition data compiled by the Federal Reserve. Commercial banks with domestic assets greater than $750 million report their assets and liabilities an a mid-weekly basis (170 banks total).[6] Since the model in section one assumes a single homogeneous source of deposits, the average bank's sum of demand and savings deposits is used to calculate $\tilde{\theta} = \tilde{D}-D$ and $Var[\tilde{\theta}]$. To capture the effects of changing deposit volitility, all variances and covariances are recalculated for each new hedging period. R_L is taken to be the weekly average prime rate on business loans; R_B is taken to be the rate on three-month CDs. Gross loans excluding federal funds sold are used to measure bank lending.

The simulation period begins in September 1981 and ends in June 1983. Wednesday settlement prices for the nearby CD futures contract were collected from the Wall Street Journal to calculate $E(R_X - \tilde{R}_X)$, $Var[\tilde{R}_X]$, and $Cov[\tilde{\theta},\tilde{R}_X]$. The time period contains 46 non-overlapping opportunities for hedging as a result. Ex post values were used for expected CD futures interest rates and expected deposits.

Two elements of equations (4) and (5) remain to be specified. The first is the value of the constant absolute risk averse index, γ. Rather than make an ad hoc assumption about any particular index value, the simulation is run with a variety of values ranging between $1x10^{-4}$ and $1x10^{-7}$. The simulation results reported below are for two index values, $1x10^{-4.8}$ and $1x10^{-5.4}$. Values larger than $1x10^{-4.8}$ did not significantly change the results, while values smaller than $1x10^{-5.4}$ generated negative deposit rates.[7]

The second variable to be specified is the elasticity of deposit supply, ϵ. Since the simulation explicitly prices the total of demand and savings deposits, a proxy for ϵ could be obtained from estimates of the interest elasticity of money demand. Barro and Santomero (1972) find the interest elasticity of household money demand to be -1/2, although their elasticity is with respect to the interest rate differential between savings and loan share dividends and commercial bank demand deposit rates. If the level of share dividend rates is used, they estimate an interest elasticity of -1. In light of this, simulation results are reported for four different elasticities of deposit supply, ranging from .1 to 1.0. The smallest elasticity measures come from estimates of the short-rate interest elasticity of money demand and the largest from estimates of the long-rate elasticity and the work of Barro and Santomero. Results are also reported with $\epsilon = 1.5$, for comparison purposes.

Table 1 presents the simulation results.[8] Column (2) represents the number of hedge positions placed by the bank. Column (3) is the proportion of total demand and savings deposits hedged in the CD futures market.[9] Column (4) is the ratio of the optimal hedge, determined in equations (11) and (12), to the routine hedge of deposit withdrawal risk, $\bar{X}$, A routine hedge is defined as a hedge equal to 100% of the absolute value of the deposit change. In the fifth column, $H(X^*,R_D^*)$ is the percentage change in the variability of unhedged profits when the optimal decisions X^* and R_D^* are used. Columns (6), (7), and (8) are defined similarly but with respect to combinations of the optimal, nonhedging, and routine hedging decisions. R_D^o and $\bar{R}_D$ are the deposit interest rates simulated for the nonhedging and routine hedging situations, respectively. In column (9), $P(X^*,R_D^*)$ represents the percentage change in bank profits when the optimal decisions X^* and R_D^* are used. $P(\bar{X},\bar{R}_D)$ in column (10) is defined similarly with respect to the routine hedging decisions. Finally, column (11) contains the mean difference $(R_D^o - R_D^*)$, for the respective simulations.

After a close examination of Table 1, several comments can be made. First, the optimal strategy in equations (11) and (12), (X^*, R_B^*), implies a small futures trading position relative both to total deposits and to the routine hedging position. Note that the futures positions are long hedges, indicating $Cov[\tilde{\theta},\tilde{R}_X]$ is positive on average. Second, at low elasticities of supply, implementing the (X^*,R_D^*) strategy is likely to increase the variability of bank profits (column (5)). However, the increase in the variability of profits is due to the increased variability of deposit rates in the presence of futures rather than a lack of hedging effectiveness in the CD futures market. This is verified in column (6) where the percent change in the variability of unhedged profits is calculated assuming deposit rates are set at the higher, nonhedging level.

Third, hedging deposit withdrawals and jointly setting deposit rate is likely to increase bank profits, especially at lower elasticities of deposit supply. The percentage increase in profits is estimated at less than 100 basis points and is always significant (column (9)). The fourth and final comment pertains to the routine hedging results. Columns (7), (8), and (10) show that the performance of a routine hedging strategy is highly variable, depending on the value of the risk aversion index. Routine hedging may increase or decrease the variability of unhedged profits, although the level of profits is never significantly affected.

In sum, the possible hedging effectiveness of the optimal strategy (X^*, R_D^*) and the CD futures market is somewhat difficult to interpret. On the one hand, the simultaneous decisions to hedge deposit withdrawals and set deposit interest rates tend to increase the variability of unhedged profits. Even after adjusting for the increased variability of profits resulting from the deposit rate decision, the percent reduction in the variability of profits when hedging deposit withdrawals is substantially smaller than the results reported by Ederington (1979) and Franckle (1980) for hedging pure interest rate risk. The results in Table 1 imply the link between deposit flows and CD futures rates is not very strong, at least for the average bank reporting weekly asset and liability positions to the Federal Reserve. On the other hand, if the purpose of the hedge is to maintain the intermediary's level of profits in the face of deposit withdrawals, the optimal strategy (X^*, R_D^*)

Table 1

Average Two-Week Futures Trading and Interest Rate Results,
September 1981 - June 1983

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ε	N	X^*/D	$X^*/\bar{X}$	$H(X^*,\overset{*}{R}_D)$	$H(X^*,\overset{o}{R}_D)$	$H(\bar{X},\bar{R}_D)$	$H(\bar{X},\overset{o}{R}_D)$	$P(X^*,\overset{*}{R}_D)$	$P(\bar{X},\bar{R}_D)$	$D(\overset{o}{R}_D,\overset{*}{R}_D)$
			A. Constant Absolute Risk Aversion Index = $1 \times 10^{-4.8}$							
.1	45	.92%	47.98%	2.77%	-2.08%	11.16%	11.30%	.78%	-.15%*	.06%
		(.14)[a]	(5.31)	(.43)	(.32)	(2.46)	(2.59)	(.11)	(.25)	(.01)
.3	45	.88	46.48	2.25	-2.08	13.06	13.15	.68	-.13*	.05
		(.13)	(5.28)	(.34)	(.32)	(2.78)	(2.96)	(.10)	(.24)	(.01)
.5	45	.84	45.18	2.04	-2.08	15.12	15.21	.63	-.12*	.05
		(.13)	(5.28)	(.32)	(.32)	(3.13)	(3.34)	(.09)	(.23)	(.01)
1.0	43	.80	44.23	1.47	-2.18	21.74	21.53	.53	-.06*	.04
		(.12)	(5.30)	(.30)	(.32)	(4.35)	(4.67)	(.08)	(.23)	(.01)
1.5	43	.74	42.07	1.30	-2.18	27.82	27.74	.48	-.08*	.03
		(.11)	(5.32)	(.26)	(.32)	(5.58)	(5.93)	(.07)	(.21)	(.01)
			B. Constant Absolute Risk Aversion Index = $1 \times 10^{-5.4}$							
.1	43	2.48%	83.87%	1.08%	-1.61%	-3.57*	-1.48%	.92%	-1.05*%	.15%
		(.37)	(4.44)	(.25)	(.25)	(1.94)	(.26)	(.12)	(.92)	(.02)
.3	43	1.95	74.79	.06	-1.81	-1.54*	-1.13	.51	-.14*	.06
		(.30)	(5.02)	(.20)	(.27)	(.78)	(.36)	(.10)	(.24)	(.01)
.5	43	1.72	69.75	-.25*	-1.85	-1.15*	-.70	.44	-.15*	.05
		(.28)	(5.23)	(.20)	(.28)	(.80)	(.48)	(.09)	(.24)	(.01)
1.0	42	1.45	62.67	-.48	-1.88	-.04*	-.80*	.36	-.21*	.03
		(.24)	(5.62)	(.22)	(.28)	(.95)	(.91)	(.08)	(.24)	(.01)
1.5	40	1.33	58.65	-.57	-1.87	2.58*	3.23	.51	-.16*	.03
		(.22)	(5.83)	(.21)	(.25)	(1.39)	(1.55)	(.22)	(.24)	(.01)

[a]Standard error of the mean.

*Not different from zero at the 5% significance level.

appears to perform well. The question of what the appropriate measure of hedging effectiveness should be when cash and futures decisions are made jointly merits further research.

III Implications

The results presented here have two important implications. To begin with, the need for financial futures hedging by financial intermediaries is often questioned because any hedge of the interest rate risk associated with an existing cash market position can be duplicated by the purchase and sale of cash market instruments with different maturities. However, even if the interest rate sensitivities of a financial firm's assets and liabilities are perfectly matched, the presence of deposit flow uncertainty justifies a role for financial futures hedging as it is viewed here. In the extreme, a Phoenix savings and loan association could benefit from hedging deposit withdrawals if it is faced with liquidity risk problems. This use of hedging by a Phoenix is in contrast to Guttentag's (1983) argument that a Phoenix may want to hedge its interest rate risk to stabilize the income of the FSLIC.

The results presented here also have implications for public policy. With respect to the regulation of financial futures trading by intermediaries, the analysis here indicates that while the futures hedge lowers the variability of unhedged profits when considered in isolation, the interaction of the futures decision and other joint decisions can increase the variability of unhedged profits. Should banks be required to make futures trading decisions without regard to other cash market decisions and vice versa? If so, the gains from preventing joint cash and futures market decisions must be greater than the suboptimal allocation of financial resources resulting from sequential decision-making.

VI. Footnotes

[1]Throughout this paper the terms "bank", "financial firm," and "financial intermediary" are used synonymously.

[2]The framework used here is related to the model developed by Sealey (1980).

[3]This model ignores the quantity risks associated with bank loans such as default and prepayment risk. The model here also treats the two cash market sources of funds, B and D, as discount instruments. If interest is not paid on bank liabilities when the level of deposits is revealed, the model would have to be recast in a two-period framework, complicating the analysis.

[4]The balance sheet constraint is expression (3) explicitly treats futures trading profits (losses) as a source (use) of funds. In reality, a bank's futures position is treated as an off-balance sheet item with trading profits and losses appearing in the income statement. Dropping $(R_X-\tilde{R}_X)X$ from the balance sheet constraint would make no difference in the qualitative results presented below.

[5]A sufficient condition for a maximum in expression (4) is that the utility function demonstrate risk aversion.

[6]This data was obtained from the Federal Reserve Bulletin, volumes 67-69.

[7]The static simulation was conducted using the SAS/ETS procedure SIMNLIN with 100 maximum iterations for the algorithm.

[8]A few of the bank specific items used in the simulation are as follows (means over the simulation period with standard error in parentheses).

L (in millions)	D (in millions)	$Cov[\tilde{\theta},\tilde{R}_X]$
2,828	$1,605	57,097
(15)	(32)	(10,240)

[9]For the purposes of the simulation, the optimal futures hedge expressed in equation (11) was restricted to be no larger in absolute value than the routine hedge, although it could be smaller. This restriction was imposed so that the bank's futures trading position would conform to the current regulatory guidelines for bank use of financial futures. These guidelines were issued simultaneously by all those bank regulatory agencies in November 1979 (revised in March 1980) and require that financial futures positions be a bona fide hedge of overall exposure, leaving the specifics of the hedging program up to the individual bank. For national banks, consult Banking Circular No. 79 issued by the Comptroller of the Currency; for insured nonmember banks, consult Banking Letter No. 17-80 issued by the FDIC.

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