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An Analysis of the Determinants of Financial Derivative Use by Commercial Banks

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Research Honors Project

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Introduction

Derivatives, namely, futures, options and swaps, are off-balance sheet instruments that allow banks to transform the duration of their balance sheets in order to manage market risk without incurring additional capital requirements. Banks' use of derivatives has been growing rapidly in recent years due, in part, to regulatory changes concerning the amount of capital banks are required to hold as well as an increase in market risk exposure. The use of future and forward contracts grew from $95 billion in 1985 to nearly $2.5 trillion in 1993 -- a growth rate of almost 2500%. (Simmons 95) The increasing popularity of financial derivatives has brought about much concern regarding the potential risks and complexities involved in derivative trading. This paper will explore the determinants of the use of such instruments by commercial banks to ascertain whether they increase or decrease banks' exposure to risk.

Section One will provide background information defining financial derivatives and discussing their increasing popularity among commercial banks. A summary of recent regulatory developments surrounding capital requirements and derivative use will also be presented. Section Two will describe previous research that has been done on derivative use in the financial services industry. A theoretical model will be developed in Section Three, and an empirical model will be presented in Section Four. And the results and future implications of the study will be presented in Section Five and Six, respectively.

I. Background Information

Derivatives are financial contracts whose values are derived from the values of other underlying assets, such as foreign exchange, bonds, equities or commodities. For example a Treasury bond futures contract commits the parties to exchange a Treasury bond at a future date for a predetermined price. The value of the futures contract depends on the value of the underlying Treasury bond. If, for instance, the price of Treasury bonds increases then the value of the futures contract will increase because the buyer of the futures contract is now entitled to receive a more valuable asset.

Banks typically participate in derivatives markets because their traditional lending and borrowing activities expose them to financial market risk. Interest rate risk, or market risk, is, in general, the potential for changes in rates to reduce a bank's earnings or value. As financial intermediaries, banks encounter interest rate risk in several ways. The primary source of interest rate risk stems from timing differences in the repricing of bank assets, liabilities, and off-balance-sheet instruments. These repricing mismatches are fundamental to the business of banking and generally occur from either borrowing short term to fund long-term assets or borrowing long term to fund short-term assets. Financial derivatives provide banks with an effective way to manage interest rate risk without incurring additional capital charges. Derivatives can be used to hedge asset and liability positions by allowing banks to take a position in the derivatives market that is equal and opposite to a current or planned future position in the spot or cash market. Therefore, regardless of the movement in prices, losses in one market will be offset by gains in the other. Banks can also take a derivative position uncovered by potential earnings or losses.

In this case they are speculating on interest rate changes that the market doesn't anticipate.

It has been argued that federal deposit insurance held by banks provides an incentive to use derivatives in a speculative manner in order to increase the value of shareholder equity by expanding into activities that shift risk onto the deposit insurer. (Jason and Taylor 1994) Speculating with derivatives involves gambling on the future performance of the underlying assets in an attempt to reap trading profits. However, as has been the case in several instances, using derivatives in such a manner subjects banks to higher, rather than lower, risk exposure and can lead to significant financial losses. (Jason and Taylor 1994)

It is important from a policy perspective to determine how banks are using derivatives. If used properly as hedging instruments then derivatives can be quite useful as explained previously. Yet, speculating with derivatives would seem to be unacceptable from a safety and soundness standpoint. It is my hypothesis that banks engage in derivatives to hedge their exposure to interest rate risk rather than to increase it by speculating.

The acceleration of bank derivative use began in the late 1970s and 1980s, when banks' market risk exposure proved fatal for many institutions. During this period, interest rates were extremely volatile -- mortgage rates rose to over 15 percent while the prime rate surpassed 20 percent. Banks found themselves in a more vulnerable position. Further, because Regulation Q was being phased out banks' costs of borrowing rose significantly. Many banks experienced a dramatic drop in their market values, and as a

result 1000 insured banks with approximately $92 billion in deposits failed over the decade. (Hanwek 3)

Because of the rapidly rising number of bank failures during the 1980s, the Federal Regulatory Agencies became concerned about the amount of capital held by commercial banks. At the time capital requirements for a bank were based solely on its total assets. No consideration was given to the risk embedded in the assets. The Committee assigned to investigate the problem formulated the Federal Deposit Insurance Corporation Improvement Act (FDICIA), passed in 1991. In an effort to develop formal capital charges that conformed more closely to banks' true risk exposure regulators implemented risk-based capital requirements through FDICIA in accordance with the Basel Accord of 1988. The new risk-based capital requirements took into account the amount of credit risk of the assets held by a particular bank in determining the level of capital required for that bank. The requirements called for assets to be divided into four categories according to their riskiness. Cash and its equivalents, including short term Treasury securities, were assigned a zero weight, municipal general obligation bonds and mortgage-backed securities a 20 percent weight. Moderate risk assets and assets in a bank's loan portfolio, including residential mortgages, carried a 50 percent weight and commercial loans, loans made to developing countries (LDC loans) and corporate bonds held a 100 percent weight. A required minimum ratio of total capital to risk-weighted assets was established at 7.25 percent. (Hanwek 49)

The risk-based capital requirements discussed above are based solely on credit risk; however, in developing FDICIA, regulators realized the need to establish guidelines

for protecting banks against interest-rate risk as well. From the regulatory perspective in a risk-based capital environment, interest-rate risk should be incorporated into existing capital requirements as well as credit risk. Thus, as outlined in FDICIA, regulators set out to incorporate interest rate risk into capital charges based on the interest rate sensitivity of the assets and liabilities of the bank. Specifically, assets, liabilities and off-balance sheet instruments are divided into seven maturity groups: 0 to 3 months; 3 months to 1 year; 1 year to 3 years; 3 to 5 years; 5 to 10 years; 10 to 20 years; and more than 20 years. Each group is then assigned a duration based on a benchmark instrument representative of the assets and the liabilities in that group. Duration is the measure of the approximate change in the value of an asset or liability for a change of 100 basis points in interest rates. Once the durations are computed, they are multiplied by the balances in each of the respective groups, and the net balance sheet duration is calculated. (Fabozzi 71) The results provide an estimate of the amount by which the surplus or equity position, (the difference between a bank's assets and liabilities) is expected to change as a result of a given change in interest rates. According to the proposal, if the surplus changes by more than one percent of assets, the bank must hold additional capital in an amount equal to the excess. (Fabozzi 71)

Although the recommendation was part of the 1991 proposal, the incorporation of interest rate risk into capital requirements was not immediately implemented by the regulatory agencies. It was subjected to further study as regulators struggled to devise a method to measure the effects of interest rate changes as well as a method to model the effects of such changes on the market value of a bank's portfolio or net worth. (Hanweck

150) Finally, in 1996, an amendment to the Basel Capital Accord proposed that commercial banks with significant trading activities set aside capital to cover the market risk exposure in their trading accounts. The US bank regulatory agencies have adopted this amendment and began enforcing it in1998. Beginning on January 1, 1998, any bank or bank holding company whose trading activity equals more than 10 percent of its total assets or whose trading activity is equal to more than $1 billion must hold regulatory capital against their market risk exposure. These capital charges are based on value at risk estimates1 generated by banks' own internal, risk measurement models using the standardizing regulatory parameters of a 10-day (k = 10) holding period and 99 percent (alpha = 1) coverage. Thus, as described previously, a bank's market risk capital charge is based on its estimate of the potential loss that would not be exceeded with 99 percent certainty over the subsequent 2-week period. (Lopez 4)

Although the capital charges against market risk exposure were not implemented until January of 1998, the credit risk-based capital requirements outlined in FDICIA have changed the way banks manage market risk. Traditional interest rate risk management techniques involved simply changing the maturity structure of the bank's assets and liabilities to minimize exposure to changes in interest rates. However, the new regulations left many banks with a short supply of capital thus, making it more difficult for banks to increase asset holdings to change balance sheet duration while maintaining

1 In general, value at risk (VaR) models are models of the time-varying distributions of portfolio returns, and VaR estimates are forecasts of the maximum portfolio value that could be lost over a given holding period with a specified confidence level; i.e., a specified lower quantile of the forecasted distribution of portfolio returns. (Lopez 1)

an adequate level of capital. Banks needed a way to manage interest rate risk without additioanl capital on their balance sheet. Financial derivatives seemed to be the solution.

II. Literature Review

Several studies examined the use of derivatives by banks. Deshmukh, Greenbaum, and Kanatas (1983) argue that an increase in interest rate uncertainty encourages depository institutions to decrease their lending activities, which entail interest rate risk, and to increase their fee for service activities, which do not. Therefore, they argue, if interest rate risk can be controlled by derivatives then perhaps banks that use derivatives experience less interest rate uncertainty and can increase their lending activities which result in greater returns relative to the return on fixed fee for service activities. Thus their overall profitability would be higher compared to those banks that do not use derivatives to control for interest rate uncertainty. (Brewer 482)

Brewer, Jackson, Moser and Saunders found that there is a negative correlation between risk and derivative usage for savings and loan institutions. In fact, it was found that S&Ls that used derivatives experienced relatively greater growth in their fixed-rate mortgage portfolios. (Brewer 481) These results indicate that financial institutions use derivatives for hedging purposes, which would explain the reduction in the volatility risk with an increase in derivative use. Jason and Taylor (1994), and Stern and Linan (1994) found that trading derivatives for profit is risky and may expose firms to large losses. (Brewer 482)

In an earlier study, Katerina Simmons used quarterly Call Report data to examine the pattern of derivative use by banks between 1988 and 1993. She found that banks with weaker asset quality tend to use derivatives more intensely than banks with better asset quality. Simmons found no relationship between duration gap measures and derivative use. Thus, her study provided no indication as to whether banks use derivatives to increase or reduce interest rate risk. (Simmons 104)

While some studies indicate that derivatives may be useful to banks because they give firms a chance to hedge their exposure to interest rate risk, others have found that derivatives can impose a significant amount of risk on an institution, resulting in large financial losses. It is the goal of this study to determine if banks use derivatives to lessen their exposure to interest rate risk or to gamble speculatively in derivative markets.

III. Theory

This paper argues that banks use derivatives to minimize risk exposure, assuming that banks maximize profits subject to a risk constraint. In theory, a bank's exposure to interest rate risk should have an effect on the size of its derivative holdings if the financial instruments are used for hedging purposes. Furthermore, it is argued that derivative use will vary according to bank size, balance sheet composition, total risk exposure, profitability and appetite for assuming risk. I will discuss each of these characteristics below.

A. Risk Exposure

1. Interest Rate Risk Exposure

In theory, banks can benefit from derivative markets because derivatives, like insurance, can be used to hedge against risk. Carefully chosen derivative deals can reduce interest rate risk inherent in banking activities because the preexisting interest rate risk can sometimes be offset by a counterbalancing derivative risk. Therefore if derivatives are used to hedge against interest rate risk, then the volume of derivatives held by a bank should be negatively related to current interest rate risk experienced by the bank.

2. Credit Risk Exposure

The ratios of loan loss reserves to loans and non-current loans to loans are indications of the quality of assets held by a bank. Each bank must maintain an allowance for loan and lease losses that is adequate to absorb estimated credit losses associated with its loan and lease portfolio. A bank with relatively risky assets would be required to hold a relatively larger loan loss reserve balance.

Loans are considered non-current if they are 90 days or more past due or if they are in non-accrual status. Thus a bank with a relatively greater proportion of non-current loans would be considered relatively riskier. It can be argued that investors would view a bank with a relatively high loan loss reserve or a bank with a relatively high balance of non-current loans as one of high risk. Thus the bank might have a difficult time raising additional capital as needed to manage interest rate risk in the traditional manner. Furthermore, a riskier loan portfolio may be an indication of management's predilection for risk that might be carried over into derivative dealings. If management has greater tendencies towards risk then they might be more likely to assume the risk involved in speculating with derivatives. Banks in either situation would theoretically be more likely

to use derivatives. However, it would be difficult to discriminate among those that are using derivatives prudently to manage interest rate risk and those that are speculating. On the other hand, it has been argued that banks that hold a relatively risky portfolio of assets would avoid using derivatives in order to avoid regulatory scrutiny. (Simmons 100) Therefore, the direction of the relationship between derivative use and bank credit risk is ambiguous.

B. Balance Sheet Characteristics

1. Capitalization

Banks are required to hold a percentage of capital based on the risk embedded in their asset holdings. Profit maximizing banks have an incentive to increase their assets given the size of their capital balance. Such banks would tend to purchase assets until their capital to asset ratio reaches its minimum as required by regulators. Once in that position, the banks are better off using derivatives to manage interest rate risk because they do not require additional capital. Therefore, a negative relationship should exist between derivative use and the banks' risk weighted capital to asset ratio.

2. Size of Asset Portfolio

In theory large banks are more likely to be involved in derivative use for several reasons. First, derivatives are very complex instruments and require careful management and analysis. Smaller banks may not have the resources to devote to understanding the complexities of these instruments. Furthermore, transaction fees involved in trading derivatives decrease with increased volume of purchases. Thus larger banks that can afford to make larger transactions pay relatively smaller transactions fees. Finally, larger

banks are more likely to have greater exposure to market risk particularly because of the differences in their borrowing sources. Large banks tend to use instruments, such as jumbo CDs, whose price and yields vary with the market on a day-to-day basis. Therefore, the relationship between derivative use and asset size is expected to be positive.

C. Other Characteristics -- Bank Profitability

Recalling the work of Deshmukh, Greenbaum, and Kanatas (1983), banks who can manage interest rate risk using derivatives will be less constrained in their lending activities and will thus be able to invest in higher risk/higher yielding assets. Derivatives free banks from the restrictions imposed by traditional internal hedging by allowing the bank to separate its choice of assets or sources of funding from considerations of market risk. Therefore, derivative use is expected to have a positive relationship with bank profitability.

IV. Empirical Model

This section analyzes the determinants of derivative use among commercial banks with more than $500 million in assets. The independent variables which are described below include: net interest margin, return on assets, capital to total assets unweighted for risk, non-current loans to loans, loan loss allowance to loans, total assets, and a trend variable based on quarterly real GDP. The dependent variable is the ratio of derivatives to total assets. The regression equation is presented in Figure 1. Two regressions will be

run. The first lags net interest margin one quarter, and the second is identical to the first except that the lag is removed.

Figure 1

Volume of Derivatives	= C + α	Exposure to Interest Rate Risk	+ α	Non-Current Loans	+ α	Loan-Loss Allowance	+ α	Profit	+ α	Bank Size	+ α	Capital to Assets	+ α GDP

Exposure to interest rate risk is measured as net interest margin, the difference of interest income and interest expense relative to assets. This index measures the sensitivity of the return on assets to changes in market yields. Wright and Houpt (1995) used net interest margin to trace the threat of interest rate risk to commercial banks over a nineteen year period. They found that from 1976 to 1995, net interest margins of the banking industry have shown a fairly stable upward trend while savings and loan institutions exhibited highly volatile margins. (Wright 115) If derivatives are, in fact, used to hedge interest rate risk then banks that use derivatives will be less exposed to interest rate risk and have a lower net interest margin. However, in the first model, which lags net interest margin, the coefficient on net interest margin is expected to be positive. This would indicate that banks that faced a high net interest margin in the previous quarter would increase their derivative holdings in the current quarter to hedge this exposure to risk. The coefficient on net interest margin in the second model would be expected to be negative because if derivatives are used to hedge interest rate risk then the more intensely a bank uses derivatives, the less exposed they should be to interest rate risk.

The variables used to measure credit risk are the ratios of non-current loans relative to loans and loan loss reserves to loans. If a bank has more credit risk, it would have less access to additional capital and may therefore be more likely to use derivatives. Thus the coefficient on non-current loans to loans is predicted to be positive and the coefficient on loan loss reserves to total loans is also predicted to be positive. On the other hand, the use of derivatives may be perceived by regulators as risky, and banks with weak asset quality might be subject to more scrutiny or restrictions by regulators when they attempt to use derivatives, thus discouraging the use of derivatives by such banks. (Simmons 101) This might indicate a negative sign on both coefficients. Therefore the sign on this variable is ambiguous.

The return on assets ratio is used to measures the profitability of a bank. A bank with higher profits would be more likely to have used derivatives because derivatives can be used to hedge loss in income associated with interest rate risk exposure allowing banks to take on more profitable investments.

The capital to assets unweighted for risk ratio is also included in the model. It can be argued that a bank that is not well capitalized may be more likely to use derivatives because derivatives can transform the duration of the balance sheet without incurring additional capital charges. Thus the sign on this variable would be negative. However, since I used a ratio unweighted for risk, it will increase with riskiness. Therefore the sign on this variable is expected to be positive.

Bank size is measured by the amount of total assets. The coefficient on this variable is expected to be positive because a larger bank is more likely to use derivatives than a smaller bank, as discussed in the theoretical section.

A measure of quarterly real GDP was included in the model as a trend variable to control for cyclical economic changes that might affect all banks' incomes.

This model estimates the determinants of derivative use by commercial banks based on pooled time series, cross sectional quarterly data for 38 banks for the period 1995:IV to 1997:III. A total of 304 cases were observed. The data were taken from the Federal Deposit Insurance Corporation's (FDIC) Institutional Directory System, which provides financial information on banks based on quarterly Call Reports. The sample selected for this study included banks with assets over $500 million. The sample banks are diversified geographically and by size with large dealer banks excluded from the study because their derivative trading accounts are not representative of the typical commercial bank.

V. Results

Model I

In the first regression the independent variable, net-interest margin, was lagged one quarter in order to test if derivatives were being used to reduce interest rate risk exposure present in the previous quarter. Overall this model performed fairly well with all but two variables being significant. (See Table I) However, the coefficient on the net interest margin variable has a negative sign indicating that banks that use derivatives tend to have lower interest rate risk in previous quarters. This result may be due to the fact

that the data in this study are based on quarterly measurements of derivative holdings. Since derivative positions are adjusted more frequently then quarterly, quarterly data might not truly reflect the effect of the previous quarters' net interest margin on derivative use.

Three of the five remaining independent variables were significant in this first model. Bank asset size was positive and significant at the .001 level indicating that larger banks tend to use derivatives to a greater extent than smaller banks. Banks that hold more capital relative to assets also tend to be more frequent users of derivatives according to this model. The capital to asset variable was positive and significant at the .001 level also. Because banks are required to hold a percentage of capital based on the riskiness of their assets, this result may indicate that banks with greater tendencies towards risk are more likely to use derivatives. However, since the variable used in this study was the ratio of capital to total assets unweighted for risk, it is difficult to distinguish among those banks that are well capitalized and those whose large capital holdings are a result of a risky asset portfolio. But, well-capitalized low risk banks would have a greater proportion of their asset portfolio weighted at zero risk, therefore the ratio of capital to total assets as measured in this study would be lower for such banks. On the other hand, banks with riskier assets would have a lower proportion of their assets at zero risk, therefore their capital to total asset ratios will be higher. And since the results show a positive coefficient on the captial to asset variable which indicates banks with a higher capital to assets ratios tend to be more intensive users of derivatives, the risky asset view of derivative use seems to hold true. Future studies might consider the ratio of capital to

risk weighted assets which would indicate if a bank was well capitalized or if a bank's capital was necessary because of its risky assets.

The coefficient on the variable, non-current loans relative to total loans, was positive and significant at the .10 level. This result indicates that banks with a relatively greater proportion of credit risk would be more likely to use derivatives to a greater extent. There are two possible arguments supporting this result. First, it could be assumed that banks with riskier tendencies in lending activities may be more likely to take on risk in other areas as well, including derivative dealings. This result could perhaps suggest that banks use derivatives to speculate because of the management's appetite for risky activities. On the other hand, banks with relatively greater credit risk may find it more difficult to raise capital in the marketplace, thus making it more difficult to adjust their balance sheets in the traditional way of managing interest rate risk. Derivatives would seem to be the likely solution for banks in this type of situation because they do not require additional capital and can be used to hedge interest rate risk exposure.

The variables, return on assets and loan loss reserves to loans, were not significant in this model.

Table I
Dependent Variable: Derivatives Relative to Assets
Sample Size: 304
Adjusted R Square: .311157

CHARACTERISTIC	VARIABLE	COEFFICIENT	EXPECTED SIGN
Interest Rate Risk Exposure	Net Interest Margin (lagged one quarter)	-.040521** (-2.768)	+
Capitalization	Capital to Assets	.083477*** (5.178)	+
Credit Risk	Loss Allowance to Loans	-.025532 (-.927)	?
	Non-Current Loans to Loans	.014437* (1.703)	?
Profitability	ROA	.007218 (.197)	+
Bank Size	Assets	3.2e-08*** (9.460)	+

*indicates significance at the .10 level
**indicates significance at the .01 level
***indicates significance at the .001 level

Model II

The second model, removing the lag on net interest margin and including all of the previously explained variables, slightly improved the results. (See Table II) The adjusted R-square value for model II increased to .32777 from .311157 in model I. The signs on the variables remained the same and their individual significance improved slightly. Return on assets and loan loss reserves remained insignificant.

The improvement in this model could be due to the fact that banks can adjust derivatives on a very frequent basis and the results of these adjustments may be better represented by the net interest margin in the current quarter rather than the previous quarter.

Table II
Dependent Variable: Derivatives Relative to Assets
Sample Size: 304
Adjusted R Square: .32777

CHARACTERISTIC	VARIABLE	COEFFICIENT	EXPECTED SIGN
Interest Rate Risk Exposure	Net Interest Margin	-.040178*** (-2.901)	-
Capitalization	Capital to Assets	.093442*** (6.191)	+
Credit Risk	Loss Allowance to Loans	-.033209 (-1.249)	?
	Non-Current Loans to Loans	.014429* (1.724)	?
Profitability	ROA	.013259 (.387)	+
Bank Size	Assets	3.44e-08*** (6.191)	+

*indicates significance at the .10 level
**indicates significance at the .01 level
***indicates significance at the .001 level

VI. Conclusion

The major results of this project support the notion that financial derivatives are used to hedge interest rate risk. The results indicate that the lower a bank's exposure to interest rate risk, as measured by net interest margin, the more likely the bank is to use derivatives. The study also found that larger banks tend to use derivatives to a greater extent than smaller banks and that banks with a greater proportion of credit risk are more likely to use derivatives. It was also found that banks that utilize derivatives typically have a higher capital to asset ratio. This result might indicate that banks with relatively

more credit risk are more likely to use derivatives. This study found no relationship between bank profitability and derivative use.

In order to understand how these results relate to those of previous studies they will be compared with those covered in the literature review section. The findings of the present study agree with that of Brewer, Jackson, Moser and Saunders who found a negative correlation between interest rate risk and derivative usage for savings and loan institutions. On the other hand, these results are at odds with a previous study by Deshmukh, Greenbaum and Kanatas (1983) which found that banks that use derivatives are more profitable than banks that do not. The results of the present study also contradict the results of Jason and Taylor (1994) which indicated derivative trading is risky and may expose firms to large losses. The results of this study can also be compared to a study done by Simmons (1995). She found no significant relationship between interest rate risk exposure and derivative use, yet her results concerning capital to assets agreed with those of the present study.

Although the results of this study support the major hypothesis that derivatives are used to reduce banks' exposure to interest rate risk, the field of study remains fruitful for further research. First of all, it would be interesting to trace the data farther back in history when the use of derivatives first began to accelerate. A greater number of observations would give a better indication of profit and risk variability over time which may show some changes in the way derivatives have been used over time. It would also be interesting to evaluate the changes in banks use of derivatives as a result of the new interest-rate risk based capital standards that were enacted in January of this year.

Furthermore, the question of causation between derivative use and risk exposure might be addressed in future research. While this study explored the determinants of derivative use by banks, it would be interesting to test whether or not overall bank risk depends on the use of derivatives. Finally, the data used in this study did not separate the various types of derivatives, further studies might utilize data on specific types of derivatives to analyze the determinants of swap use, an inherently riskier derivative, versus the less risky use of futures and options.

Financial markets have responded to increasing interest rate risk with new products that allow banks to transform the duration of their balance sheets without incurring additional capital charges. While some argue that derivatives are too risky to be used by commercial banks, the results of this study support the argument that derivatives can be used to effectively lower market risk exposure for banks. As pointed out earlier the question of how banks use derivatives remains an interesting topic for further research. Furthermore, it is of no doubt that the soundness of the banking system is an issue of primary concern to society. Thus continued careful monitoring of banks' derivative activities by regulators is essential to ensure that the increasingly popular instruments are utilized in ways that contribute to the objective of a safe and sound banking system.

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