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Three essays on banking and corporate finance

Fang Zhao
Louisiana Tech University

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Fang Zhao, M.B.A.

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Supervisor of Dissertation Research

Head of Department

Finance
Department

Recommendation concurred in:

Advisory Committee

Approved:

Director of Graduate Studies

Dean of the College

Approved:

Dean of the Graduate School

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ABSTRACT

This dissertation is composed of three essays on banking and corporate finance. The first essay studies the relationship between interest-rate derivative usage and bank lending. Using recent data that cover a full business cycle, this paper documents a direct relationship between interest-rate derivative usage by U.S. banks and growth in their commercial and industrial (C&I) loan portfolios. This positive association holds for interest-rate options contracts, forward contracts, and futures contracts. This result is consistent with the implication of Diamond's model (1984) that predicts that a bank's use of derivatives permits better management of systematic risk exposure, thereby lowering the cost of delegated monitoring, and generates net benefits of intermediation services.

Using recent data that spans a full business cycle, the second essay examines how derivative usage affects the interest-rate sensitivity of bank holding companies from 1998 to 2003. The major finding of this study is that stock returns of a bank holding company using derivatives are less sensitive to interest-rate changes, controlling for balance-sheet composition and asset size. This economically significant finding suggests that interest-rate derivatives allow banks to lessen their systematic exposure to changes in interest rates and thereby increase their potential to better manage their interest-rate risk exposure. This result is consistent with Diamond's (1984) prediction in which a bank can use interest-rate derivatives to hedge against interest-rate risk.

Previous research investigates how corporate finance managers make their bond-maturity decisions. The third essay is exploratory, investigating the relationship between duration and bond characteristics. The relationship between firm features and the durations of 8,627 corporate debt issues placed by U.S. corporations in public markets between 1990 and 2002 is examined. The major finding of the study is that firm quality, as measured by credit rating, is directly related to bond duration. The findings also suggest that bond duration is inversely related to firm size, that regulated non-financial firms have longer bond duration, and that syndicated offerings have longer duration than non-syndicated offerings.

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Author Fang Zhao

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CHAPTER 1

INTRODUCTION

This dissertation is comprised of three essays on banking and corporate finance. The first two essays are closely related to the banks' use of derivatives. The choice of these two topics is motivated by Diamond's (1984) theory of financial intermediation. According to Diamond (1984), banks serve as delegated monitors with a comparative advantage to small depositors in monitoring and enforcing loan-contract provisions.

Diamond shows that portfolio diversification within financial intermediaries is the financial-engineering technology that allows banks to lower the cost of delegated monitoring and thereby to generate net benefits of intermediation services. In Diamond's model, banks find it optimal to eliminate all diversifiable risks because the resulting equilibrium enables banks to monitor loan contracts efficiently and avoid costly liquidation.

An implication of Diamond's model is that banks should not assume any nondiversifiable risks unless they have special advantages in managing them. One of the most important risks that banks face is interest-rate risk. Banks do not have special advantages in bearing interest-rate risk. Therefore, they use interest-rate derivatives to hedge against that risk. In theory, the existence of an active derivative market should increase the potential for banks to move toward their desired levels of interest risk.

In one of his speeches (2004), Alan Greenspan, the chairman of the Federal Reserve Board from August of 1987 to February of 2006, states that complex financial instruments such as derivatives have contributed to the development of an efficient, flexible, and resilient financial system. The potential of derivative instruments to reduce the interest-rate risk exposure of banks has been widely recognized; however, the tremendous increase in the use of derivatives by banks in the last two decades has triggered regulators' concerns as to whether banking firms have used derivatives primarily for hedging or for speculation. A major concern facing policymakers and bank regulators today is the possibility that the rising use of derivatives has increased the riskiness of individual banks and of the banking system as a whole.

The first essay in this study addresses the hedging vis-à-vis speculation question by examining the relationship between bank lending and derivative usage. There are two risk components in a bank's loan portfolio: systematic risk and unsystematic risk. Diamond demonstrates that interest-rate derivative contracts allow banks to reduce their exposure to systematic risk in their loan portfolios. This risk reduction allows banks to take further advantage of diversification. As a result, banks are able to make more loans without changing the total risk level of the loan portfolio. This position consequently increases the banks' abilities to provide more intermediation services. One major implication of Diamond's theory of financial intermediation is that derivative contracts facilitate loan growth.

The relationship between derivative usage and lending activity has been studied in recent years. Brewer, Minton, and Moser (2000) evaluate an equation relating the determinants of Commercial and Industrial (C&I) lending to the impact of derivatives on

C&I loan lending activity. They document a positive relationship between C&I loan growth and the use of derivatives over a sample period from 1985 to 1992. They find that derivative markets allow banks to increase lending activities at a greater rate than they would have otherwise. Brewer, Jackson, and Moser (2001) examine the major differences in the financial characteristics of banking organizations that use derivatives when compared to those that do not. They find that banks that use derivatives grow their business-loan portfolio faster than banks that do not use derivatives. Purnanandam (2004) also reports that the derivative users make more C&I loans than non-users.

There are two major research questions that arise in the literature with respect to derivative usage: Does derivative usage facilitate loan growth, and if not, is there a negative association between lending activity and derivative usage? Using recent data that cover a full business cycle, the first essay in this study revisits these two questions to ascertain if a significantly positive relationship still exists between bank lending activity and derivative usage.

The second essay investigates the relationship between banks' derivative usage and their interest-rate risk exposure. An implication of the Diamond (1984) model is that banks should not assume any risks that are not diversifiable unless the banks have special advantages in monitoring them. Thus, in Diamond's model, banks find it optimal to hedge all interest-rate risk either by using a derivative approach or by matching the maturity of assets and liabilities as closely as possible. The popularity of derivative usage is due to the fact that derivatives provide a relatively inexpensive means for banks to change their interest-risk exposure. As stated by Hirtle (1997), the existence of an active derivative market should increase the potential for banks to move toward their desired levels of interest risk. This potential benefit has been widely recognized, and the question that has arisen is whether or not banks have used derivatives primarily to reduce the risks arising from their other banking activities (for hedging) or to achieve higher levels of interest-rate risk exposure (for speculation).

The second essay tests Diamond's (1984) hypothesis that derivative instruments allow banks to better manage their interest-rate risk exposure. Specifically, an examination is made of the role of derivatives in determining the interest-rate sensitivity of bank holding companies' (BHC) net worth, while controlling for the influence of on-balance-sheet activities and other bank-specific characteristics.

Numerous theoretical and empirical studies have attempted to investigate the factors that firms consider when choosing the maturity of their debt issues. In the third essay, the duration of debt issues is examined. As an exploratory investigation, the third essay searches for potential linkages between the various theories and empirical findings from the previous literature on debt maturity and bond duration. Some questions about the determinants of debt maturity may also be answered by examining the firms' duration choices. Duration measures the number of years required to recover the true cost of a bond, considering the present value of all coupon and principal payments received in the future. Debt maturity focuses more on matching the cash flow generated from the chosen project to the life of the project. Research on comparing both approaches may discern whether firms focus on duration or maturity. Hypotheses that have been offered to explain corporate debt maturity are used to examine the firms' duration choices to see if factors that influence maturity choices also affect bond duration. A sample of 8,627 debt issues from the Thomson Financial SDC Platinum database is examined to identify the important factors in determining the length of duration of public, non-convertible debt. Macaulay's Duration is used as the dependent variable to test the theoretical hypotheses where bond duration is influenced by signaling and asymmetric information as well as agency problems.

The organizational plan for the dissertation is as follows: Chapter 2 examines the relationship between interest-rate derivative usage by U.S. banks and growth in their commercial and industrial loan portfolios. Chapter 3 investigates the role of derivatives in shaping bank holding companies' (BHC) interest-rate risk exposure in recent years. Chapter 4 tests theoretical hypotheses where bond duration is influenced by signaling and asymmetric information as well as agency problems. Finally, Chapter 5 presents the conclusions, implications, and recommendations for future research.

CHAPTER 2

BANK LENDING AND INTEREST-RATE DERIVATIVES

Introduction

The relationship between the use of derivatives and lending activity has been studied in recent years. Brewer, Minton, and Moser (2000) evaluate an equation relating the determinants of Commercial and Industrial (C&I) lending and the impact of derivatives on C&I loan lending activity. They document a positive relationship between C&I loan growth and the use of derivatives over a sample period from 1985 to 1992. They find that the derivative markets allow banks to increase lending activities at a greater rate than the banks would have otherwise. Brewer, Jackson, and Moser (2001) examine the major differences in the financial characteristics of banking organizations that use derivatives relative to those that do not. They find that banks that use derivatives grow their business-loan portfolio faster than banks that do not use derivatives. Purnanandam (2004) also reports that the derivative users make more C&I loans than non-users. There are two major research questions that arise in the literature: Does the use of derivatives facilitate loan growth? If not, is there a negative association between lending activity and derivative usage? Using recent data that cover a full business cycle, this essay revisits these questions to ascertain whether a direct relationship still exists.

This essay differs from the previous research in several aspects. First, it uses more recent data. Few of the previous research studies cover the period from 1996 through 2004. During this period, the use of interest-rate derivatives for individual banks is even more extensive than in earlier studies, rising from notional amounts of $27.88 trillion at the end of December 1996 to $62.78 trillion at the end of 2004.[1] Given the substantial change in the use of derivatives, the research inferences drawn in the previous studies based on less derivative usage may not hold under the current circumstances. Therefore, the use of more recent data in this essay will shed more light on the most recent impact of derivative usage on bank lending activity.

Second, the sample period in this essay covers a full business cycle, thereby providing a better indication of the relative variability of lending activities experienced by commercial banks over this period. Brewer, Minton, and Moser (2000) document a universal downward trend of C&I lending over a sample period of 1985 to 1992, a period during which the economy experienced a significant cyclical downturn. In contrast, my sample enables me to focus on a more comprehensive picture regarding the impact of derivative usage on lending activity through the different stages of the business cycle, such as economic boom and economic recession.

Finally, the definitions of several variables in the Call Reports are different prior to 1995. For example, futures and forwards are reported together in the Call Report data. It is more difficult for researchers to examine the effect of different derivative instruments on a bank's lending activities, since swaps and forwards may have different

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[1] The notional amount is the predetermined dollar principal on which the exchanged interest payments are based. The notional amounts of derivatives reported are not an accurate measure of derivative use because of reporting practices that tend to overstate the actual positions held by banks. Even though notional values do not reflect the market value of the contracts, they are the best proxy available for the usage and the extent of usage of interest-rate derivatives.

characteristics from futures and options. The sample period of the research in this essay (Chapter 2) is a time period over which there is a specific definition and consistent measurement of each interest-rate derivative instrument in the Call Reports. Therefore, the construction of these variables will be more accurate and much more detailed than the ones used in previous studies.

The sample in this essay represents FDIC-insured commercial banks with total assets greater than $300 million as of March 1996 that have a portfolio of C&I loans. Following Brewer, Minton, and Moser (2000), I evaluate an equation relating the determinants of C&I lending and the impact of derivatives on C&I lending activity. The major finding in this essay is that the interest-rate derivatives allow commercial banks to lessen their systematic exposure to changes in interest rates, which enables banks to increase their lending activities without increasing the total risk level faced by the banks. This consequently increases the banks' abilities to provide more intermediation services. Furthermore, a positive and significant association between lending and derivative activity indicates that the net effect of derivative use on C&I lending is complementary. That is, the complementary effect dominates any substitution effect.

Additionally, this positive association holds for interest-rate options contracts, forward contracts, and futures contracts, suggesting that banks using any form of these contracts, on average, experience significantly higher growth in their C&I loan portfolios. Furthermore, C&I loan growth is positively related to capital ratio and negatively related to C&I loan charge-offs. The findings in this essay are confirmed after a robustness check.

Examining the relationship between the C&I loan growth and derivative usage poses a potential endogeneity problem because the derivative-use decision and lending choices may be made simultaneously. To address this problem, an instrumental-variable approach is employed. Specifically, I estimate the probability that a bank will use derivatives in the first-stage specification, then I use the estimated probability of derivative usage as an instrument for derivative activity in the second-stage C&I loan growth equation. The probit specification for this instrumental variable is based on Kim and Koppenhaver (1992).

Chapter 2 is organized as follows: The following section describes the sample and data sources. A discussion of the empirical specifications for commercial and industrial lending is provided in the third section of this chapter. Next, the empirical results are presented in the fourth section. The fifth section of this chapter provides robustness test results, and the final section concludes the first essay of this dissertation.

Data and Sample Description

This section describes the sample selection criteria, the lending activity experience by FDIC-insured commercial banks from the fourth quarter of 1996 through the fourth quarter of 2004, as well as the interest-rate derivative products used by sample banks during the nine-year sample period.

Sample Description

The sample of banks includes FDIC-insured commercial banks with total assets greater than $300 million as of March 1996. Of these institutions, banks that have no commercial and industrial loans are excluded. The sample ranges from 942 banks in March of 1996 to 467 banks in December of 2004. Institutions that are liquidated during the sample period are included in the sample before liquidation and excluded from the sample for the periods after liquidation. Banks that merge during the sample period are included in the sample. By construction, the sample is therefore free from survivor bias. Balance sheet data and interest-rate derivative-usage information are obtained from the Reports of Condition and Income (Call Report) filed with the Federal Reserve System. State employment data are obtained from the U.S. Department of Labor, Bureau of Labor Statistics.

Lending Activity

Because the accessibility of credit depends importantly on banks' roles as financial intermediaries, loan growth is an important measure of intermediaries' activities. Following Brewer, Minton, and Moser (2000), I use C&I loan growth as a measure of lending activity because such a measure performs a critical function in channeling funds between the financial and the productive sectors of the economy. Table 1 presents year-end data for bank C&I loan lending activity for the sample banks from 1996 through 2004. The sample period covers a full business cycle and thereby provides a better indication of the relative variability of lending activities experienced by the commercial banks in different stages of a business cycle. Panels B through E report data for four categories of institutions classified by total asset size. Corresponding to the acceleration of C&I loans in the late 1990s, the average ratio of C&I loans to total assets increases steadily, from 12.44 percent at the year-end of 1997 to 13.15 percent at the year-end of 2000. Then, from year-end 2001 to year-end 2003, the average ratio of C&I loans to total assets exhibits a downward trend, which corresponds to the economic recession beginning in March of 2001. As panels B through E report, this pattern exists across different sizes of banks, with the largest decline occurring for banks having total assets greater than $10 billion. This decline stops at year-end 2004 when the overall economy experiences more rapid growth.

Interest-rate Derivative Products

The use of interest-rate derivatives by banks has grown dramatically in recent years, rising from notional amounts of $27.88 trillion at the end of 1996 to $62.78 trillion at the end of 2004. Four main categories of interest-rate derivative instruments are examined: swaps, options, forwards, and futures. Table 2 presents the notional principal amounts outstanding and the frequency of use of each type of interest-rate derivative by banks from year-end 1996 through year-end 2004. As in Table 1, data are reported for the entire sample of banks and for four subgroups of banks categorized by total asset size. Consistent with the dramatic increase in the use of derivatives in recent years, Table 2 shows extensive participation of banks in the interest-rate derivative markets over the nine-year sample period. Furthermore, the rapid growth in the use of various types of derivative instruments has not been confined to large commercial banks; medium-size and small-size banks have also experienced a tremendous increase in the participation of derivative markets.

As shown in Table 2, during the entire sample period, the most widely used interest-rate derivative instrument is the swap. At the end of 1996, 31.6 percent of banks report using interest-rate swaps. By the end of 2004, the percentage using swaps rise to 37.3 percent. Over the nine-year sample period, more than 95 percent of banks with total assets exceeding $10 billion report using interest-rate swaps.

Table 1 Lending Activity Based on Year-end Data Beginning with 1996 Through 2004 for FDIC-insured Commercial Banks with Total Assets Greater than $300 Million

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Panel A: All Banks									
Average Total Assets (TA)	3580.35	3993.56	4326.36	4503.84	4813.08	4823.37	4839.84	4908.20	5138.27
Average C&I Loans /Total Assets	0.1274	0.1244	0.1248	0.1281	0.1315	0.1224	0.1142	0.1102	0.1115
Number of Observation	942	818	728	677	602	561	522	497	467
Panel B: Total Assets < $500 million									
Average Total Assets	382.58	509.77	627.23	697.69	809.28	869.97	964.07	1004.05	1071.78
Average C&I Loans /Total Assets	0.1120	0.1081	0.1077	0.1106	0.1107	0.1075	0.1008	0.0965	0.0967
Number of Observations	366	334	299	271	247	228	213	207	197
Panel C: $500 million ≤ Total Assets < $1 billion									
Average Total Assets	685.24	871.85	1083.70	1231.14	1436.22	1608.72	1817.49	2062.01	2322.21
Average C&I Loans /Total Assets	0.1139	0.1107	0.1105	0.1129	0.1235	0.1130	0.1095	0.1093	0.1122
Number of Observations	232	208	185	176	155	146	135	134	129
Panel D: $1 billion ≤ Total Assets < $10 billion									
Average Total Assets	3059.11	4290.94	5163.10	5956.50	7310.57	9056.01	1020.88	11613.84	12936.69
Average C&I Loans /Total Assets	0.1425	0.1463	0.1459	0.1491	0.1529	0.1411	0.1304	0.1273	0.1309
Number of Observations	281	226	198	186	159	151	140	122	108
Panel E: Total Assets ≥ $10 billion									
Average Total Assets	3197.43	5671.76	6765.21	7378.67	8633.30	9802.80	1127.43	123901.87	142795.34
Average C&I Loans /Total Assets	0.1982	0.1916	0.2022	0.2079	0.2036	0.1766	0.1504	0.1361	0.1332
Number of Observations	63	50	46	44	41	36	34	34	33

Table 2 The Use of Derivatives Based on Year-end Data Beginning with 1996 Through 2004 for FDIC-insured Commercial Banks with Total Assets Greater than $300 Million

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Panel A: All Banks									
Users of Swaps (%)	31.57	35.08	34.47	34.27	32.72	31.86	33.14	39.03	37.26
Average Ratio to Total Assets [a]	0.3084	0.3341	0.4316	0.4542	0.5307	0.4822	0.4982	0.5636	0.5812
Users of Options (%)	16.45	19.19	19.64	19.79	19.60	16.22	15.52	14.08	13.49
Average Ratio to Total Assets [b]	0.1066	0.1058	0.1426	0.1471	0.1412	0.1312	0.1520	0.2197	0.2232
Users of Forwards (%)	9.02	12.22	11.13	11.82	11.63	13.19	16.48	19.32	22.06
Average Ratio to Total Assets [c]	0.1926	0.1342	0.2017	0.1584	0.1598	0.1502	0.1552	0.0931	0.0717
Users of Futures (%)	5.28	5.13	5.36	5.47	4.65	5.53	5.75	6.24	6.85
Average Ratio to Total Assets [d]	0.4291	0.3288	0.4283	0.2965	0.3225	0.4598	0.3854	0.4022	0.2151
Users of swaps, options, forwards, and futures (%)	3.18	3.42	3.02	3.40	2.99	3.92	4.02	4.02	4.28
Number of Observations	942	818	728	677	602	561	522	497	467
Panel B: Total Assets < $500 million									
Users of Swaps (%)	7.38	7.78	8.02	10.32	8.91	7.02	10.80	13.53	15.23
Average Ratio to Total Assets [a]	0.1238	0.0945	0.0778	0.1020	0.0540	0.0618	0.0740	0.0726	0.0620
Users of Options (%)	2.73	3.89	4.35	4.80	4.45	5.26	2.35	2.46	1.52
Average Ratio to Total Assets [b]	0.0952	0.0967	0.0885	0.0972	0.0972	0.0932	0.0313	0.0248	0.0165
Users of Forwards (%)	0.43	1.50	1.34	1.85	2.43	3.51	10.37	10.14	11.17
Average Ratio to Total Assets [c]	0.0270	0.010	0.0288	0.0175	0.0147	0.0412	0.0565	0.0124	0.0096
Users of Futures (%)	0.55	0.30	0.00	0.00	0.00	0.44	0.47	0.97	1.02
Average Ratio to Total Assets [d]	0.3739	0.0505	0.00	0.00	0.00	0.0333	0.0352	0.0383	0.0384
Users of swaps, options, forwards, and futures (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of Observations	366	334	299	271	247	228	213	207	197
Panel C: $500 million ≤ Total Assets < $1 billion									
Users of Swaps (%)	19.39	18.27	19.45	21.02	18.71	17.81	22.96	29.10	31.00
Average Ratio to Total Assets [a]	0.1327	0.1007	0.0521	0.0610	0.0729	0.0661	0.0469	0.0495	0.0621
Users of Options (%)	7.33	9.62	11.35	10.23	11.61	5.48	3.86	3.73	3.88
Average Ratio to Total Assets [b]	0.0731	0.0624	0.0807	0.0972	0.0513	0.0304	0.0687	0.1480	0.1480
Users of Forwards (%)	1.42	6.73	5.95	3.98	5.81	8.22	13.33	16.42	22.48
Average Ratio to Total Assets [c]	0.0160	0.0190	0.0391	0.0296	0.0296	0.0558	0.0581	0.0306	0.0240
Users of Futures (%)	0.00	0.48	0.67	1.14	1.29	2.05	1.48	1.49	2.33
Average Ratio to Total Assets [d]	0.00	0.0201	0.0057	0.0302	0.0301	0.0308	0.0508	0.0707	0.0247
Users of swaps, options, forwards, and futures (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.75	1.55
Number of Observations	232	208	185	176	155	146	135	134	129

[a] The average ratio of total assets equals the ratio of the notional principal amount of outstanding swaps to total assets for banks reporting the use of swaps.
[b] The average ratio of total assets equals the ratio of the notional principal amount of outstanding options to total assets for banks reporting the use of options.
[c] The average ratio of total assets equals the ratio of the notional principal amount of outstanding forwards to total assets for banks reporting the use of forwards.
[d] The average ratio of total assets equals the ratio of the notional principal amount of outstanding futures to total assets for banks reporting the use of futures.

Table 2 (Continued) The Use of Derivatives Based on Year-end Data Beginning with 1996 Through 2004 for FDIC-insured Commercial Banks with Total Assets Greater than $300 Million

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Panel D: $1 billion ≤ Total Assets < $10 billion									
Users of Swaps (%)	56.58	53.09	57.57	65.59	65.41	57.62	60.00	62.29	65.74
Average Ratio to Total Assets [a]	0.1226	0.1245	0.1151	0.1037	0.0821	0.0991	0.0969	0.0990	0.1158
Users of Options (%)	25.62	34.51	33.84	33.87	35.22	25.83	26.43	24.59	22.22
Average Ratio to Total Assets [b]	0.0620	0.0460	0.0503	0.0602	0.0594	0.0685	0.0460	0.0641	0.1062
Users of Forwards (%)	13.52	19.47	17.68	19.89	18.24	19.21	20.00	24.59	27.78
Average Ratio to Total Assets [c]	0.0290	0.0194	0.0468	0.0178	0.0199	0.0712	0.0753	0.0341	0.0536
Users of Futures (%)	5.69	6.19	7.03	6.99	5.66	5.96	6.43	7.38	7.41
Average Ratio to Total Assets [d]	0.3500	0.2220	0.1831	0.1352	0.0673	0.1044	0.1086	0.0909	0.0217
Users of swaps, options, forwards, and futures (%)	2.14	2.65	1.52	3.23	2.52	3.97	2.86	2.46	2.78
Number of Observations	281	226	198	186	159	151	140	122	108
Panel E: Total Assets ≥ $10 billion									
Users of Swaps (%)	96.82	100	100	100	100	100	100	100	100
Average Ratio to Total Assets [a]	0.9196	1.1207	1.6920	1.7834	1.9616	2.3357	2.0354	2.6250	2.570
Users of Options (%)	88.89	92.00	91.30	90.91	87.80	88.89	91.18	91.18	93.94
Average Ratio to Total Assets [b]	0.1762	0.2285	0.3375	0.3433	0.3294	0.2610	0.3196	0.3889	0.3460
Users of Forwards (%)	66.67	74.00	67.39	70.45	63.41	69.44	76.47	67.65	66.67
Average Ratio to Total Assets [c]	0.3614	0.3313	0.4568	0.3780	0.3945	0.3221	0.3617	0.3033	0.2215
Users of Futures (%)	50.79	52.00	52.17	50.00	43.90	50.00	52.94	52.94	57.58
Average Ratio to Total Assets [d]	0.4721	0.4088	0.5964	0.4161	0.4630	0.4209	0.4883	0.5403	0.4493
Users of swaps, options, forwards, and futures (%)	38.10	44.00	41.30	38.64	34.15	44.44	47.06	47.06	45.5
Number of Observations	63	50	46	44	41	36	34	34	33

[a] The average ratio of total assets equals the ratio of the notional principal amount of outstanding swaps to total assets for banks reporting the use of swaps.
[b] The average ratio of total assets equals the ratio of the notional principal amount of outstanding options to total assets for banks reporting the use of options.
[c] The average ratio of total assets equals the ratio of the notional principal amount of outstanding forwards to total assets for banks reporting the use of forwards.
[d] The average ratio of total assets equals the ratio of the notional principal amount of outstanding futures to total assets for banks reporting the use of futures.

Another notable increase occurred in the forward-rate agreement (FRA) usage. FRA is a contract that determines the rate of interest, or currency exchange rate, to be paid or received on an obligation beginning at some future date. At the end of 1996, 9.02 percent of the sample banks report using FRAs. By the end of 2004, the percentage using FRAs more than doubled. While the percentage of banks participating in the swaps and forwards increased over the sample period, the proportion of banks using interest-rate options fell. This decline is most notable between year-end 2000 and year-end 2004. With the exception of banks with total assets greater than $10 billion, less than 7.5 percent of banks report having open positions in interest-rate futures.

Finally, less than 3 percent of the sample banks report having open positions in interest-rate swaps, interest-rate options, interest-rate forwards, and interest-rate futures. In contrast, nearly half of the banks with total assets greater than $10 billion report having positions in all four types of interest-rate derivative instruments. This result strongly suggests that large banking organizations are much more likely than small banking organization to use derivatives. As shown in Panel E of Table 2, approximately 25 of the largest banks heavily participated in the interest-rate derivative market, a result similar to the finding of Carter and Sinkey (1998).

Specifications of Variables

Based on the literature regarding the determinants of bank lending, this section describes the specification for intermediation, the independent variables used in the empirical model, and the measure of derivative activities.

The Specification for Intermediation

The foundation of the empirical analysis in this article is the specification for bank lending by Sharpe and Acharya (1992). They regress a measure of lending activity on a set of possible supply and demand factors $(X_{j,t-1})$. Brewer, Minton, and Moser (2000), who studied an earlier sample of commercial banks for the period June 30, 1985, through the end of 1992, extended the specification by adding a measure of participation in interest-rate derivative markets $(DERIV_{j,t})$ into the equation. Following Sharpe and Acharya (1992), I use the quarterly change in C&I loans relative to last period's total assets $(CILGA_{j,t})$ as the dependent variable. In order to examine the relationship between the growth in bank C&I loans and the banks' participation in interest-rate derivative markets, I also include various measures of participation in interest-rate derivative markets $(DERIV_{j,t})$ in the following regression specification:

$$CILGA_{j,t} = f(X_{j,t-1},\ DERIV_{j,t}) \tag{1}$$

Independent Variables (Traditional Supply and Demand Factors)

The explanatory variables represent both supply and demand factors $(X_{j,t-1})$. Based on the literature on the determinants of bank lending, I determine how these supply and demand factors enter into the regression specification. First, Bernanke and Lown (1991) and Sharpe and Acharya (1992), among others,[2] relate overall loan growth to capital requirements. In addition, Sharpe (1995) finds that there is a positive association between bank capital and loan growth. In a more recent work, Beatty and Gron (2001)

[2]Examples of this literature also include Hall (1993), Berger and Udell (1994), Haubrich and Wachtel (1993), Hancock and Wilcox (1994), Brinkman and Horvitz (1995), and Peek and Rosengren (1995).

document that, consistent with Sharpe's finding, banks with higher capital growth relative to assets experience greater increases in their loan portfolios, and banks with weak capital positions are less able to increase their loan portfolios due to capital constraints. When a bank's capital falls short of the required amount, the bank could attempt to raise the capital-to-asset ratio by reducing its assets (the denominator of the ratio) rather than raising capital (the numerator of the ratio). One way of doing this is to shift the asset portfolio away from lending, such as cutting back its investment in C&I loans. Banks may choose this strategy over equity issuance simply because issuing equity is costly.[3] Therefore, undercapitalized banks are less able to increase their loan portfolios while satisfying the regulatory capital requirements. In contrast, banks with stronger capital positions have more room to expand their loan portfolios and still be able to satisfy the regulatory requirement for the capital-to-asset ratio. If capital-constrained banks adjust their lending to meet some predetermined target capital-to-asset ratios, one would expect a positive relationship between a bank's capital-to-asset ratio and C&I loan growth. In order to control for the effect of capital requirements on C&I lending activity, a measure of the bank's capital-to-asset ratio (CARATIO) is included in the empirical specification for C&I loan growth. CARATIO is measured as the ratio of a bank's total equity capital to total assets at time t-1.

Another factor found to affect loan growth is the quality of a bank's loan portfolio. Following Sharpe and Acharya (1992), I use C&I loan charge-offs (CILCOFA) as a

[3]For example, Stein (1998), among others, shows that asymmetric information between investors and a bank causes adverse selection problems that make issuing new equity costly.

proxy for loan quality.[4] The variable CILCOFA is constructed as the ratio of C&I loan charge-offs in the last period (t-1) to total assets in the last period (t-1). Charge-offs usually rise during a recession and decline only after an economic recovery. Therefore, a low charge-offs ratio can also be a signal of a favorable economic environment in a bank's geographic region of operations. In addition, the ratio of C&I loan charge-offs to total assets could capture the impact of regulatory pressures on loan growth because regulators often apply pressure to banks to increase their rates of charge-offs. For example, capital-constrained banks may be required to increase their rates of charge-offs so that they can clear the regulatory hurdle for capital ratios by eliminating some of their assets.[5] Therefore, the ratio of C&I loan charge-offs to total assets could reflect the impact of regulatory pressures on banks' capital management. Each of these reasons suggests that those banks with high charge-offs should, other things being equal, be viewed as less well capitalized than banks with low charge-offs, and are therefore less able to increase their loan portfolios due to capital constraints. For these reasons, one would expect CILCOFA to have a negative association with C&I loan growth.

The relationship between bank health and regional economic conditions is another factor to consider. The idea that regional economic performance affects bank health is intuitive and broadly consistent with the aggregate banking data.[6] Avery and Gordy

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[4]Another measure of loan quality is the provision for loan losses. The reason that charge-offs is used instead of provision for loan losses is because the loan charge-offs variable also captures the impact of regulatory influence.

[5]Kim and Kross (1998) and Ahmed, Takeda, and Thomas (1999), among others, find evidence that regulatory capital and earnings outcomes influence managers' discretion in charge-offs, loan loss provisions, and miscellaneous gains.

[6]For example, Daly, Krainer, and Lopez (2003) show that there is a significant trackable link between regional economic performance and bank health. Also, Berger, Bonime, Covitz, and Hancock

(1998) find that one-half of the change in bank loan performance from 1984 to 1995 can be explained with a group of state-level economic variables. Also, Bernanke and Lown (1991) and Williams-Stanton (1996) point out that regional economic conditions should influence bank C&I loan growth. The intuition is that banks in states with weak economic conditions are likely to have fewer profitable opportunities than banks in states with stronger economies. The state employment growth rate ($EMPG_{j,t-1}$) is included in the model as a proxy for local economic conditions that are not captured by the other explanatory variables.[7] If state employment growth is a proxy for economic conditions, one would expect EMPG to be positively related to C&I loan growth, other things being equal.

Measure of Derivative Activities

In order to capture the effects of derivative usage on bank-loan growth, I include various measures of participation in interest-rate derivative markets ($DERIV_{j,t}$) in the C&I loan growth specification (the construction of this variable is presented in equation 2). The coefficient estimate on DERIV reflects the impact of derivative usage conditional on adequately incorporating the intermediating process in the remaining terms of the specification. Modern theories of the intermediary role of banks describe how derivative contracting and lending can be complementary activities. Diamond (1984) develops a theory of financial intermediation. In his model, banks optimally offer debt contracts to "depositors" and accept debt contracts from "entrepreneurs." Depositors delegate monitoring activities to banks that have the ability to economize the costs of monitoring

(2000) document that aggregate state-level and regional-level variables are important contributors to the persistence in firm-level performance (i.e., return on assets) observed in the U.S. banking industry.

[7]See Calomiris and Mason (2000), Avery and Gordy (1998), and Berger et al. (2000).

loan contracts made with entrepreneurs. However, banks face an incentive problem that originates from the cost of delegated monitoring on behalf of their depositors. Diamond shows that diversification within a bank lowers the cost of delegated monitoring. An implication of his model is that banks should not assume any nondiversifiable risks unless they have special advantages in managing them. Thus in his model, banks find it optimal to hedge all interest-rate risk by interest-rate derivatives.[8] However, even after diversifying, banks may still face systematic risks that cannot be diversified away.

Diamond demonstrates that derivative contracts can serve as a third form of contracting, which enables banks to reduce their exposure to systematic risk in their loan portfolios. This use of derivative contracts to hedge systematic risks enables banks to obtain further reductions in delegation costs, and, in turn, allows banks to intermediate more effectively. Empirically, Brewer, Jackson, and Moser (1996) find that there is a negative correlation between risk and derivative usage for savings and loan institutions. In fact, they find that S&Ls that use derivatives experience relatively greater growth in their fixed-rate mortgage portfolios. Brewer, Minton, and Moser (2000) examine the relationship between lending and derivative usage for an earlier sample of FDIC-insured commercial banks. Their results indicate that banks using interest-rate derivatives, on average, experience significantly higher growth in their C&I loan portfolios. These results are consistent with the notion that derivative usage would help banks better cope with interest-rate risk and thereby enable them to hold more loans to earn more income from their lending activity. If interest-rate derivative activity complements the lending

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[8]See Purnanandam (2004).

activity as predicted by Diamond's (1984) model, one would expect a positive coefficient estimate on the DERIV variable.

In this essay, a downward trend in C&I lending during the economic recession beginning in March of 2001 is observed. Brewer, Minton, and Moser (2000) also document a similar pattern regarding C&I lending over a sample period from 1985 to 1992, a period during which the economy experienced a significant cyclical downturn. They argue that the downward trend in lending activity and the concurrent increase in the use of interest-rate derivatives suggest that derivative usage might be a substitute for lending activity. They suggest that a negative relationship between derivative usage and lending activity could arise in two cases. The first case is when banks use derivatives for speculative purposes. Gain from speculating on interest-rate changes would enhance revenues from bank trading desks. The second instance is when banks charge a fee as over-the-counter dealers for placing derivative positions. Pursuit of either of these activities as a replacement for the traditional lending activities of banks would imply that derivative activity would be a substitute for lending activity. If these activities were substitutes, one would expect a negative coefficient on the DERIV variable.

From the above discussion, a specification for Equation (2) can be written as follows:

$$\begin{aligned} CILGA_{j,t} &= \alpha_0 + \sum_{t=2}^{T} \alpha_t D_t + \beta_1 CARATIO_{j,t-1} + \beta_2 CILCOFA_{j,t-1} \\ &+ \beta_3 EMPG_{j,t-1} + \beta_4 DERIV_{j,t} + \varepsilon_{j,t} \end{aligned} \quad (2)$$

In Equation (2), $CILGA_{j,t}$ is measured as the quarterly change in C&I loans relative to last period's total assets. D_t is a time-indicator variable equal to one for period t, or zero otherwise. The variable $CARATIO_{j,t-1}$ is the ratio of a bank's total equity capital to total assets in the previous period (t-1). $CILCOFA_{j,t-1}$ is the ratio of C&I loan charge-offs in the previous period (t-1) to total assets in the previous period (t-1). $EMPG_{j,t-1}$ is the state employment growth rate relative to last period (t-1), where EMP equals total employment in the state in which the bank's headquarters are located. The variable $DERIV_{j,t}$ is a measure of participation in interest-rate derivative markets.

Table 3 reports summary statistics for the variables used in the estimation of Equation (2). The mean of quarter-to-quarter changes in C&I loans scaled by values of beginning-of-quarter total assets is 0.4 percent over the full sample period. During this period, the average capital-to-asset ratio is 9.45 percent, the average C&I loan charge-offs over assets is 0.05 percent, and the average state employment growth rate is 0.45 percent. Consistent with the data presented in Table 2, 20.78 percent of the sample banks reported using interest-rate swaps during the sample period, 11.26 percent of the sample banks reported using interest-rate options, and 8.61 percent reported using FRAs. Only 3.28 percent of the sample banks reported using interest-rate futures. Finally, over-the-counter dealers and subsidiaries of foreign banks comprise only 1.2 percent and 4.5 percent, respectively, of the sample bank observations.

Instrumental Variable

Examining the relationship between the C&I loan growth and derivative usage poses a potential endogeneity problem because the derivative-use decision and lending choices may be made simultaneously. As the data show, the decisions could be made jointly since a bank's C&I lending activity might affect its decision to use derivatives. To address this problem, an instrumental-variable approach is used.

Table 3 Summary Statistics for the Full Sample [a]

Variable	Mnemonic	Mean	Standard Deviation	Observations
Dependent variable and supply and demand factors				
Dependent variable				
C&I Loan Growth over total assets	CILGA	0.004	0.0525	293568
Supply and demand factors				
Capital to asset ratio	CARATIO	0.0945	0.0460	248278
C&I loan charge-offs over assets	CILCOFA	0.0005	0.0012	232234
Employment growth	EMPG	0.0043	0.0727	248277
Log total assets	LNTOTASST	13.75	1.2323	293536
Additional supply and demand factors used in robustness tests				
Lagged dependent variable	Defined Above			
Unused credit lines to total assets	UNLC	0.0092	0.0233	224571
Classification Variable				
Swaps (0-Yes, 1-No)	DSWAP	0.2078	0.4057	294475
Futures (0-Yes, 1-No)	DFUTURES	0.0328	0.1782	294475
Forwards (0-Yes, 1-No)	DFORWARD	0.0861	0.2805	294475
Options (0-Yes, 1-No)	DOPTION	0.1126	0.3161	294475
Derivatives Dealer (0-No, 1-Yes)	DEALER	0.0120	0.1082	294475
Foreign Bank (0-No, 1-Yes)	FBANK	0.0453	0.2081	294475

[a] Means and standard deviations for all variables are used in the empirical analyses. The statistics are computed over the period from March 1996 through December 2004.

The probit specification for the instrumental variable is based on Kim and Koppenhaver (1992).[9] This probit specification includes the log of bank assets, the capital-to-asset ratio, net interest margin, and the first lag of the dependent variable. Commercial bank size as measured by the logarithm of its total assets is included to control for the differences in derivative use that might be caused by differences in the types of businesses and customers at large and small banks.[10] The capital-to-asset ratio is included in the probit specification because a bank's capital adequacy is a necessary condition for its participation in the derivative market. A bank's net interest margin enters into the equation because banks can use derivatives to lock-in the spread between interest income and interest expense. Since derivative use at time t is usually dependent on derivative use at time t-1, the first lag of the dependent variable is included to take into account the dependence over time. To determine the probability of a bank's derivative usage, the above probit specification for each sample date t is estimated, and then the estimated probability from the first-stage estimation is used as an instrument for derivative activity in the second-stage estimation.[11] The results of this first-stage regression are presented in Appendix A. Overall, the probit results show that, as predicted, bank size, capital-to-asset ratio, and the lagged dependent variable play a significant role in determining the probability of derivative usage by U.S. commercial banks.

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[9]Brewer, Minton, and Moser (2000) use a similar probit specification in their study.

[10]Previous literature finds that size is an important indicator in a bank's derivative activities; e.g., Sinkey and Carter (1997), Kim and Koppenhaver (1992), and Gunther and Siems (1996).

[11]A Hausman test indicates that the instrumental variable is a valid instrument.

Since banks' use of derivatives increases during the sample period, a pooled cross-sectional time-series regression is employed to incorporate this dynamic effect.[12] Specifically, I run a cross-sectional Ordinary Least Squares regression with C&I loan growth as the dependent variable and then report the time-series means of the parameter estimates and their corresponding t-statistics. The t-values are computed using Newey-West heteroskedasticity-and-autocorrelation-consistent errors. I use the predicted derivative use, obtained from the probit specification, to instrument the actual derivative-use variable as an independent variable.

Empirical Results

Using the quarterly change in C&I loans relative to last period's total assets as the dependent variable, I utilize Equation (2) to examine the determinants of C&I lending and the impact of derivatives on C&I lending activity. Table 4 reports the results of pooled cross-sectional time-series regressions using quarterly data from March 1996 through December 2004.

Regression (1) of Table 4 is the reduced form of the supply equation that examines the impact of fundamental factors on C&I lending activity. This regression serves as a base for examining the relationship between derivative activity and C&I lending. In regression (1), C&I loan growth is significantly and positively related to the beginning-of-period CARATIO. This result is consistent with the hypothesis that capital-constrained banks adjust their loan portfolios in subsequent periods to meet some predetermined target capital-to-asset ratios. Similar to Brewer, Minton, and Moser (2000), I also find a significant, negative association between CILCOFA and C&I loan

[12]Appendix B provides the coefficient on the time-period indication variables.

Table 4 Univariate Multiple Regression Coefficient Estimates for the Determinants of Quarterly Changes in C&I Loans Relative to Last Period's Total Assets [a, b]

Independent variables	Regression (1)	Regression (2)	Regression (3)	Regression (4)
CARATIO	0.1037	0.1041	0.1042	0.0791
	(3.48) ***	(3.47) ***	(3.47) ***	(2.16) **
CILCOFA	-0.8336	-0.8569	-0.8603	-0.8124
	(-3.65) ***	(-3.77) ***	(-3.79) ***	(-3.55) ***
EMPG	0.0046	0.0045	0.0045	0.0103
	(0.37)	(0.36)	(0.36)	(0.96)
DERIV		0.0023		0.0022
		(2.83) ***		(2.05) **
SWAPS			0.0012	
			(1.30)	
OPTIONS			0.0028	
			(2.90) ***	
FUTURES			0.0119	
			(2.04) **	
FORWARDS			0.0021	
			(1.90) **	
OF			-0.0201	
			(-1.68) *	
OS			-0.0011	
			(-0.62)	
OW			-0.0002	
			(-0.09)	
FS			0.0087	
			(-1.32)	
FW			-0.0020	
			(-0.26)	
SW			-0.0023	
			(-0.86)	
OFS			0.0188	
			(1.41)	
OFW			0.0087	
			(0.43)	
FSW			0.0082	
			(0.74)	
SWO			0.0011	
			(0.30)	
OFSW			-0.0163	
			(-0.73)	
DEALER				-0.0081
				(-3.54) ***
FOREIGN				-0.0059
				(-3.11) ***
LAGGED CILGA				0.0054
				(1.41)
UNLC				0.0466
				(4.07) ***
OBSERVATIONS	232096	232096	232096	223881
ADJ R-SQUARE	0.00566	0.00416	0.00424	0.00573

[a] All regression equations contain time-period indicator variables. T-statistics (reported in parentheses) are calculated using Newey-West heteroscedasticity-and-autocorrelation-consistent errors. Statistical significance is displayed by the use of one (10%), two (5%), or three (1%) stars. The sample contains 36 quarters of observations from 1996 Q1 through 2004 Q4. The dependent variable for all regressions is the quarterly change in C&I loans relative to last period's total assets.

[b] CARATIO is measured as the ratio of total equity capital to total assets at time t-1. CILCOFA is measured as the ratio of C&I loan charge-offs in period t-1 to total assets in period t-1. EMPG is the state employment growth rate, where EMP equals the total employment in the state in which the bank's headquarters are located. DERIV, SWAPS, OPTIONS, FORWARDS, and FUTURES are instrumental variables obtained from a probit specification for participation in the indicated derivative markets. OF, OS, OW, FS, FW, SW, OFS, OFW, FSW, SWO, and OFSW are eleven possible interactions between each type of derivative instruments. Among these interaction terms, O stands for option, F stands for futures, S stands for swaps, and W stands for forwards. DEALER is a binary variable, which equals to one if the institution is listed as an IDSA member, or zero otherwise. FOREIGN is a binary variable, which equals to one if the institution is a foreign-owned institution, or zero otherwise. LAGGED CILGA is the first lag of the dependent variable. UNLC is unused lines of credit to total assets.

growth. This negative relationship is consistent with the notion that the charge-offs variable captures the impact of regulatory pressures, a strong economic environment, or both. The previous period's state employment growth variable EMPG fails to enter the equation significantly. This result is inconsistent with Brewer, Minton, and Moser (2000), who study a sample of banks that predates the advent of interstate banking. During the course of the 1990s, deregulation in the banking industry led to consolidation and to banks' geographic expansion. As a result, U.S. banks have also become more geographically diversified. In fact, the regression results might suggest that state economies play a lesser role in affecting banks' health and performance following the full expansion of interstate banking.

Regressions (2) and (3) include different measures of derivative activity. Regression (2) augments the predicted probability of derivative usage in any type of interest-rate derivative contract (DERIV). Regression (3) decomposes the DERIV variable into four types of interest-rate derivative instruments: SWAPS, OPTIONS, FORWARDS, and FUTURES. Each type of derivative activity is estimated using the probit specification discussed earlier in this section. The estimates generated in the probit specification are then used in conjunction with the supply and demand factors in the second-stage regression to predict C&I loan growth.

Columns (2) and (3) of Table 4 report the estimation results for the derivative-augmented regressions. First, the coefficient estimates on CARATIO, CILCOFA, and EMPG are qualitatively similar to those in the base model. Second, the CARATIO and CILCOFA coefficient estimates remain statistically significant.

Regression (2) of Table 4 shows that banks using any type of interest-rate derivative, on average, experience significantly higher growth in their C&I loan portfolios.[13] This positive relationship between derivatives use and C&I loan growth is consistent with Diamond's (1984) model of financial intermediation. In that model, Diamond argues that interest-rate derivatives allow commercial banks to lessen their systematic exposure to changes in interest rates. In addition, interest-rate derivatives create extra risk tolerance, enabling banks to provide more C&I loans without increasing the total risk level faced by the banks. Furthermore, a positive and significant coefficient estimate on the DERIV variable indicates that the net effect of derivative use on C&I lending activity is complementary. That is, the complementary effect dominates any substitution effect.

The regression reported in column (3) of Table 4 examines the relative role played by each type of derivative instrument in explaining C&I loan growth. Since banks that invest in the human capital and internal control systems necessary to be active in the market for derivatives are more likely to use more than one type of derivative,[14] I also control for the effect of eleven possible interactions between each type of derivative activity in the regression.[15] The results show that the coefficient estimates on all four kinds of derivative variables are positive. The coefficient estimates on OPTIONS, FORWARDS, and FUTURES are statistically significant. These results suggest that the

[13]When the actual derivative use rather than the predicted derivative use is included in the C&I loan growth specification, the coefficient estimate (not reported) on DERIV is positive and marginally significant at the 10% level. The actual derivatives-use indicator variable is a binary variable equal one if a bank engages in any interest-rate derivative activity, or zero otherwise.

[14]See Carter and Sinkey (1998).

[15]See Table 4 for a detailed breakdown of interaction terms.

use of these three types (Options, Forwards, and Futures) of derivatives is significantly associated with higher C&I loan growth. Further, except for the interaction between options and futures, none of the coefficient estimates on the interaction terms between each type of derivative activity is significant.[16] Overall, my results suggest that aggregate use of derivative instruments, in particular interest-rate options, interest-rate futures, and interest-rate forwards, is associated with higher growth rates in C&I loans.

Robustness Check

To check the validity of the regression results, I augment the regression (2) specification by adding variables measuring other characteristics of financial institutions that may explain lending activity during the sample period. The augmented regression reported in column (4) of Table 4 addresses the concern of omitting important variables that might alter the observed positive relationship between lending activity and participation in interest-rate derivatives.

First, the lagged dependent variable (LAGGED CILGA) is included in the regression to account for the possibility that the derivative-participation variable is a proxy for growth potential. I also include a control for a foreign-firm effect by introducing a binary variable equal to one if a bank is a subsidiary of a foreign financial institution (FOREIGN), or zero otherwise. Previous literature suggests that the operation of foreign-owned banks helps to fund U.S. operations of foreign industrial firms.[17] Therefore, foreign-owned banks may be expected to provide both loans and interest-rate

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[16]Without the interaction terms, the coefficient estimates (not reported) on all four kinds of derivative instruments have a positive sign, and the estimates on options and forwards are statistically significant.

[17]For example, see Bhattacharaya (1993).

derivatives to their customers, inducing a positive coefficient. On the other hand, foreign-owned banks also have some disadvantages due to problems in managing from a distance and coping with multiple economic/regulatory environment.[18] These disadvantages may cause foreign-owned banks to experience slower growth in their loan portfolios, other things being equal.

In consideration of the possibility of a spurious relationship between C&I loan growth and dealer activity performed by large banks that are heavily involved in derivative contracting, a binary variable is included in the regression to control for membership in the International Swaps and Derivatives Association (ISDA). The binary variable DEALER equals one if a bank is identified as a dealer by the ISDA membership list,[19] or zero otherwise.

Finally, the ratio of the dollar value of any unused lines of credit (UNLC) to total assets is included as a measure of risk tolerance. The risk is two-dimensional. First, liquidity problems may emerge as banks commit to fill larger credit lines. Second, banks' off-balance-sheet exposures to credit risk may increase as they extend lines of credit to manage the interest-rate risk. Controls introduced for these possibilities provide a way of separating loan growth from risk-taking motivations.

Regression (4) incorporates the above proxies for other activities that may cloud the positive association between derivative activity and loan growth. As shown in column (4) of Table 4, the results of the study remain robust. Specifically, the coefficient on predicted derivative activity (DERIV) remains positive and statistically significant. In addition, the coefficient on the foreign-bank variable (FOREIGN) is negative and highly

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[18]For example, see Berger, Dai, Ongena, and Smith (2003) and Buch (2003).

[19]ISDA membership list is available at http://www.isda.org.

significant, suggesting that foreign-owned banks experience slower growth in C&I loan lending activities. As Brewer, Minton, and Moser (2000) suggest, dealer activities performed by the banks could give rise to a negative relationship between derivative usage and lending because banks enhance their revenue by acting as over-the-counter (OTC) dealers and charge a fee for placing derivative positions. Consistent with their prediction, the coefficient on the dealer variable is negative and significant. Finally, the coefficient estimate on the lagged dependent variable is not significantly different from zero. The ratio of unused lines of credit to total assets, UNLC, is positive and significant, suggesting that the higher the risk tolerance as measured by UNLC, the greater the C&I loan growth.

Conclusions

Commercial banks employ different methods, including the use of interest-rate derivatives to manage interest-rate risks. The use of these derivative instruments by banks has increased tremendously in the past decade, rising from notional amounts of $27.88 trillion at the end of December of 1996 to $62.78 trillion at the end of 2004. The relationship between derivative usage and lending activity has been studied in related literature in recent years. This essay addresses the question of whether derivative usage complements or substitutes for the lending activity, investigates the relationship between bank participation in derivative contracting and bank lending for the period of March 31, 1996, through December 31, 2004.

Overall, this essay (Chapter 2) documents a direct relationship between derivative usage by U.S. banks and growth in their commercial and industrial loan portfolios. More specifically, I find that aggregate use of derivative instruments, in particular interest-rate options, interest-rate futures, and interest-rate forwards, is associated with higher growth rates in C&I loans. These findings are consistent with the results of an earlier study by Brewer, Minton, and Moser (2000), who examine the relationship between lending and derivative usage for a sample of FDIC-insured commercial banks between 1985 and 1992. This documented positive association is consistent with Diamond's (1984) hypothesis that derivative contracting and lending are complementary activities. Diamond's model predicts that banks can reduce the cost of delegated monitoring by holding a diversified portfolio. Engaging in derivative activities helps banks reduce the cost of monitoring contracts issued to their loan customers, thereby enabling banks to increase their lending activities without increasing the total risk level faced by the banks.

In addition, these results suggest that C&I loan growth has a significant positive relationship with the capital ratio. These results are consistent with the previous banking research in that banks with stronger capital are more able to increase their loan portfolios. I also document a negative relationship between C&I loan charge-offs and C&I loan growth. This negative association is in line with the notion that the charge-offs variable captures the impact of regulatory pressures or a strong economic environment, or both. Further, the main results are confirmed after a robustness check.

Finally, the sample shows that less than 3 percent of the sample banks report having open positions in all four kinds of interest-rate derivative instruments. In contrast, nearly half of the banks with total assets greater than $10 billion report having positions in all four kinds of interest-rate derivative instruments. This result strongly suggests that large banking organizations are much more likely than small banking organizations to fully utilize derivatives.

CHAPTER 3

USE OF INTEREST-RATE DERIVATIVES AND BANK HOLDING COMPANY INTEREST-RATE RISK

Introduction

One of the most important forms of risk that banks face as financial intermediaries is interest-rate risk. Interest-rate risk arises from mismatches in the rate sensitivity of the bank's inflows and outflows. A special function of a financial institution is asset transformation, which involves buying primary securities or assets (such as mortgages, loans, and securities) and issuing secondary securities or liabilities (such as certificates of deposit and federal funds borrowing) to fund asset purchases. Inflows from assets often have maturity and liquidity characteristics different from outflows from liabilities. Financial institutions potentially expose themselves to interest-rate risk in mismatching the maturities of assets and liabilities.

The interest-rate risk is the risk that a bank's income and/or market value will be adversely affected by changes in interest rates. In addition to potential refinancing or reinvestment problems that occur when interest rates change, a bank faces market-value risk as well. For example, mismatching maturities by holding longer-term assets than liabilities means that when interest rates rise, the market value of the bank's assets falls by a greater amount than its liabilities. This mismatching of maturities exposes the bank to the risk of economic loss and, potentially, the risk of insolvency.

Managing Interest-rate Risk

Commercial banks manage interest-rate risk using two major techniques. One is to match the maturity of their assets and liabilities as closely as possible (on-balance-sheet technique); the other technique is to use interest-rate derivatives (off-balance-sheet technique).

Traditionally, banks use maturity gaps to predict how their net interest margin, or accounting earnings, would be affected by changes in market interest rates. If the changes in revenue from assets perfectly match the changes in expense from liabilities, then a rise or fall in interest rates will have an equal and offsetting effect on both sides of the balance sheet. In principle, perfect matching leaves a bank's earnings or market value unaffected by changes in interest rates. Flannery and James (1984) provide evidence on the importance of the maturity gap by examining the relationship between the interest-rate sensitivity of common stock returns and the maturity gap between interest-rate-sensitive assets and liabilities. In the financial institution industry, a commonly used measure of on-balance-sheet maturity composition is an institution's one-year maturity gap. This measure reflects the short-term maturity mismatch of the institution's assets and liabilities (Schrand, 1997).

Since the 1980s, derivative instruments have become an increasingly important product used by banking institutions to manage their interest-rate risk exposure. The rise in derivative usage arises from the fact that derivatives provide a relatively inexpensive means for banks to change their interest-rate risk exposure. In theory, the existence of an active derivative market should increase the potential for banking firms to attain their desired level of interest-rate risk exposure. Diamond (1984) develops a theory of financial intermediation in which banks have monitoring advantages as compared to small depositors. He shows that diversification within a bank lowers the cost of delegated monitoring and generates net benefits of intermediation services. An implication of Diamond's model is that banks should not assume any nondiversifiable risk unless they have special advantages in monitoring them. Thus in Diamond's model, banks find it optimal to hedge interest-rate risk by using interest-rate derivatives.

Previous Studies

Even though the potential for using derivative instruments in hedging interest-rate risk is widely recognized, the tremendous increase in the use of derivatives by banks has triggered regulators' concerns as to whether banking firms have used derivatives primarily for hedging or for speculation. Much research focuses on the role played by derivatives, but there is no clear answer regarding which of these two alternatives, hedging or speculation, is more likely.

A major concern facing policymakers and bank regulators today is the possibility that the rising use of derivatives has increased the riskiness of individual banks and of the banking system as a whole. A number of studies have examined the relationship between interest-rate risk exposure and banks' derivative usage. The evidence from previous studies is mixed. Sinkey and Carter (1994), Tufano and Headley (1994), and Gunther and Siems (1996) find a significant, negative relationship between the balance sheet "gap" measures of interest-rate risk exposure--the difference between assets and liabilities that mature or re-price within a specified time-period--and the extent of derivative usage by banks. These research articles have documented evidence that is consistent with the idea that increased use of derivatives by banks tends to result in higher levels of interest-rate risk exposure. Hirtle (1997) studies a sample of 139 bank holding companies and finds that holdings of derivatives are associated with significantly greater interest-rate exposure for the sample period of 1991 to 1994. These findings are consistent with the idea that the derivative instruments act as substitutes for on-balance-sheet sources of interest-rate risk exposure rather than as a hedge.

In contrast to these studies, Brewer, Jackson, and Moser (1996) find a negative correlation between risk and derivative usage by savings and loan institutions. Ahmed, Beatty, and Takeda (1997) find that for the majority of derivative users, derivative usage reduces interest-rate exposure. Schrand (1997) finds that derivative activities are negatively associated with stock-price interest-rate sensitivity for a sample of publicly traded savings and loan associations (S&Ls). The results also indicate that S&Ls, on average, use derivatives to hedge interest-rate risk rather than to speculate. Brewer, Minton, and Moser (2000) evaluate an equation relating the determinants of Commercial and Industrial (C&I) lending and the impact of derivatives on C&I loan lending activity. They find that engaging in derivative activities helps banks reduce the delegation costs of monitoring contracts issued by their loan customers, thereby enabling banks to increase their lending activities without increasing the total risk level faced by the banks. Brewer, Jackson, and Moser (2001) examine the major differences in the financial characteristics of banking organizations that use derivatives relative to those that do not. They find that banks that use derivatives grow their business loan portfolio faster than banks that do not use derivatives. The first essay of this dissertation (Chapter 2) investigates the relationship between bank participation in derivative contracting and bank lending for the period March 31, 1996, through December 31, 2004. I find that the aggregate use of derivative instruments, in particular interest-rate options, interest-rate futures, and interest-rate forwards, is associated with higher growth rates in C&I loans. This documented positive association is consistent with Diamond's (1984) hypothesis that derivative contracting and lending are complementary activities. Minton, Stulz, and Williamson (2005) examine the use of credit derivatives by U.S. bank holding companies from 1999 to 2003. They find that credit derivatives make it easier for banks to maximize their value with less capital, thereby reducing the cost of loans for bank customers. Their results are also consistent with the prediction of hedging theories. These studies suggest that banks use derivatives for hedging purposes rather than substituting for traditional on-balance-sheet activity.

Following the lead of previous research, I test Diamond's (1984) hypothesis that derivative instruments allow banks to better manage their interest-rate risk exposure. Specifically, I examine the role of derivatives in determining the interest-rate sensitivity of bank holding companies' (BHC) net worth, while controlling for the influence of on-balance-sheet activities and other bank-specific characteristics.

Contribution to the Literature

This essay (Chapter 3) differs from the previous literature in several aspects. First, it uses more recent data. Few of the previous studies covered the period from 1996 through 2003. During this period, interest-rate derivative usage for individual banks was much more extensive than found in earlier studies. For example, the notional amount of derivative holdings by banks rose from $27.88 trillion at the end of December 1996 to $62.78 trillion at the end of 2004. Given the substantial increase in the use of derivatives, the inferences that can be drawn may be clearer than in previous research. Therefore, the use of more recent data in this chapter sheds more light on the effect of derivative usage on banks' interest-rate risk exposure. Further, beginning with the third quarter of 1997, the Federal Reserve's Report of Condition and Income provides greater detail of banks' assets and liabilities, reporting those that are due to mature or re-price within one year.[20] Therefore, construction of a maturity-gap variable will be more accurate and much more detailed than those used in previous studies.

Second, the sample period in this essay (Chapter 3) covers a full business cycle, thereby providing evidence for interest-rate changes experienced during both economic expansions and economic contractions. Schrand (1997) studies a sample of publicly traded savings and loan associations (S&Ls) and documents a universal downward trend of interest rates over a sample period of 1984 to 1988. Hirtle (1997), on the other hand, examines a sample of bank holding companies for the sample period of 1991 to 1994, a period during which the economy experienced increased interest rates. In contrast, the sample in this essay provides a more comprehensive picture regarding the impact of derivative usage on the interest-rate sensitivity of bank holding companies through the different stages of the business cycle; in particular, the different interest-rate environments associated with economic expansion and contraction.

Finally, previous studies shed light on the statistical relationship between derivative usage and banks' interest-rate risk exposure; none, however, presents evidence

[20] The increase in derivative usage also increases the importance of establishing how these instruments are being utilized.

on the economic significance of derivative instruments in shaping banks' interest-rate exposure. The major finding in this essay is that stock returns of bank holding companies using derivatives are less sensitive to interest-rate changes after controlling for balance-sheet composition and asset size. This result is both statistically and economically significant. In fact, the sample results in this essay suggest that an average-size bank holding company would have to increase its capital by $209.37 million to shift the interest-rate beta down by 35 basis points, if it did not use interest-rate derivatives to hedge its interest-rate risk.

This essay (Chapter 3) is organized as follows: The next section describes the sample and data sources (Data Sources and Construction of the Maturity-gap Variable). A discussion of the econometric methods used then follows (Econometric Methods). Next, the empirical results are presented (Empirical Results) followed by robustness test results (Robustness Checks). The final section of this Chapter provides the conclusions and policy implications relevant to this essay.

Data Sources and Construction of the Maturity-gap Variable

This section describes the data sources used in this essay (Chapter 3) and the construction of the one-year maturity-gap variable. In the financial institution industry, a commonly used measure of on-balance-sheet maturity composition is an institution's one-year maturity gap, a measure that reflects the short-term maturity mismatch of the institution's assets and liabilities. Even though the one-year gap imperfectly represents interest-rate risk exposure, it is the best proxy for the duration of a bank holding company's portfolio, given the available data.[21]

Data Sources

The stock return data and interest-rate data as well as the balance sheet data and derivative data from 1998 through 2003 are obtained from the following sources:

(1) Market return data (Friday of each week) are obtained from the Center for Research in Security Prices (CRSP) value-weighted indices covering the period from January 1998 through December 2003. Bank return data are obtained from CRSP.

(2) Interest-rate data (yield on the constant-maturity one-year Treasury security) are obtained from the FRED II database at the Federal Reserve Bank of St. Louis.

(3) The balance sheet data and derivative data are obtained from the Reports of Condition and Income filed with the Federal Reserve System (Call Reports).

Construction of the One-year Maturity-gap Variable

I follow the approach of Purnanandam (2004) and construct a 12-month gap measure (SHORT). Figure 1 shows the detailed construction of the one-year maturity-gap variable. This measure captures the net imbalances in effective maturity (i.e., adjusted for re-pricing terms) of the assets and liabilities of a bank over a one-year period. Beginning with the third quarter of 1997, Call Reports filed with the Federal Reserve System provide a detailed account of banks' assets and liabilities that are due to mature or re-

[21]Duration is a superior measure of interest-rate risk exposure. First, duration is a measure of the average life of a security because it recognizes that not all of the cash flow from a typical security occurs at its maturity. Second, duration also expresses the elasticity of a security's price relative to changes in the interest rate and measures a security's responsiveness to changes in market interest rates.

price within a year. The measure used in this essay (Chapter 3) is comparable to the SHORT used by Flannery and James (1984) and is defined as the absolute value of assets maturing or re-pricing within a year minus liabilities that mature or re-price within a year scaled by the total assets of the bank. A one-year maturity gap is constructed as shown below:

Loans and Leases Due to Mature or Re-price Within a Year		Term Deposits Due to Mature or Re-price Within a Year
+		+
Securities Due to Mature or Re-price Within a Year		Fed Funds Borrowed
+	−	+
Fed Funds Sold		Other Liabilities for Borrowed Funds
+		+
Customer's Liabilities to the Bank for Outstanding Acceptance		Bank's Liabilities on Customer's Outstanding Acceptance

Figure 1 Construction of the One-year Maturity Gap

This number, the one-year maturity gap, is scaled by the total assets of the bank in order to compute the one-year maturity-gap-to-asset ratio (ASHORT), since an appropriate scale variable is required to put the dollar measure of maturity mismatch in the same unit of measurement as the measure of interest-rate sensitivity.

Econometric Methods

The foundation of the empirical analysis is the two-factor market model of Flannery and James (1984) who measure the interest-rate sensitivity for a sample of actively traded commercial banks and savings and loan associations during the period 1976 to 1981. In the two-factor market model regression, Flannery and James relate bank j's common stock returns to the returns on the market and an interest-rate term designed to capture changes in interest rates. The coefficient on the interest-rate term (the interest-rate "beta") can be interpreted as measuring interest-rate exposure. Based on the methodology developed by Flannery and James (1984), Hirtle (1997) extended the specification by regressing interest-rate betas on a variable that reflects the scope of BHCs' participation in the interest-rate derivative market in a second-stage regression. The interest-rate risk measures derived from the first-stage regression can be viewed as the "output" of banks' attempts to manage their interest-rate risk exposure, using the "inputs" of balance-sheet positions and interest-rate derivatives.

A two-stage procedure is employed in this essay. Following Flannery and James (1984), I first estimate the market-model regression to capture the measures of interest-rate sensitivity (the interest-rate "beta"). Then these interest-rate betas are regressed on a series of variables that reflect the composition of the BHCs' balance sheet and the scope of their participation in the interest-rate derivative market.

Two-factor Model

The approach used is based on the methodology introduced by Flannery and James (1984). Specifically, the following equation is used to measure interest-rate sensitivity for each bank j:

$$\tilde{R}_{jt} = \beta_{0j} + \beta_{mj}\tilde{R}_{mt} + \beta_{Ij}\tilde{R}_{It} + \tilde{\varepsilon}_{jt} \tag{3}$$

Where

$\tilde{R}_{jt}$ = the return of bank j's stock in week t.

$\tilde{R}_{mt}$ = the return on the CRSP value-weighted portfolio of common stock in week t.

$\tilde{R}_{It}$ = the weekly holding period return on a constant-maturity one-year Treasury security.

Since the holding period returns on bonds are negatively correlated with the change in the level of interest rates, a positive value for β_{Ij} implies that bank j's market value declines when interest rates rise. Therefore, β_{Ij}, the coefficient on the interest-rate term, measures the sensitivity of the return on bank holding company (BHC) j's stock to changes in interest rates while controlling for changes in the return on the market. In that sense, β_{Ij} can be used to measure BHC j's interest-rate risk exposure. A positive interest-rate beta implies that the value of the BHC's equity tends to decrease when interest rates rise, while a negative beta implies the opposite. As specified in Equation (3) above, however, the interest-rate beta is only a partial measure of interest-rate risk exposure. Changes in the interest-rate environment may also affect the return on the market and, consequently, BHC equity values (Flannery and James, 1984).

In order to obtain a total measure of each BHC's interest-rate risk exposure, the market return variable, R_{mt}, is decomposed into two portions by regressing it on a constant and R_{It}. The residuals from this regression capture the portion of R_{mt} that is uncorrelated with the interest-rate term R_{it}. By substituting these residuals for R_{mt} in the market-model equation, the coefficient on R_{it} in the market model will reflect both the direct influence of changes in interest rates on BHC equity values and the indirect influences working through changes in the market rate of return (Flannery and James, 1984). Giliberto (1985) argues that such orthogonalization introduces a bias into the coefficient estimate and standard error for the interest-rate risk variable. Using OLS, the only unbiased estimator is for β_{mj}. Without *a priori* knowledge of the bias direction, one cannot establish how the test of β_{Ij} is affected. Therefore, the regular t-test is inappropriate for drawing inferences about interest-rate sensitivity. However, as Hirtle (1997) shows, the bias is that the resulting coefficient is an estimate of the total derivative of the return on the bank's stock with respect to the interest-rate variable rather than the partial derivative. The total derivative is the coefficient of interest, so the "bias" introduced by the orthogonalization is both intentional and desired.

In this study, first-stage regressions are estimated annually between 1998 and 2003 for each bank whose stock traded publicly for at least 30 weeks in a given calendar year. This process results in a separate interest-rate sensitivity beta for each bank for each year that the bank is in the sample.

Second-stage Regression

In the second-stage equation, the interest-rate betas derived from the first-stage regression are regressed on a series of variables that reflect the composition of the BHCs' balance sheet and the scope of their participation in the interest-rate derivative market. The second-stage estimation equation is as follows:

$$\beta_{ijt} = \alpha_0 + \sum_{t=2}^{T} \alpha_t D_t + \alpha_1 (\frac{Short}{TA})_{jt} + \alpha_2 (\frac{Deriv}{TA})_{jt} + \alpha_3 (\ln tasst) + \varpi_{jt} \quad (4)$$

β_{ijt} is the interest-rate beta of bank j's equity. D_t is a time-indicator variable. *Short* (maturity-gap measurement) is the j^{th} bank's average net short position; it is defined as the value of assets maturing or re-pricing within a year minus liabilities maturing or re-pricing within a year. *TA* is the j^{th} bank's total assets. *Deriv* is the j^{th} bank's notional amount of interest-rate derivative instruments. ϖ_{jt} is an error term. The intercept

α_0 captures the effects of interest-rate changes on assets and liabilities that mature or re-price in more than one year as well as the effects of other specification errors.[22]

To test the hypothesis that off-balance-sheet derivative activities are negatively associated with the interest-rate sensitivity of stock prices after controlling for on-balance-sheet exposure, a measure of interest-rate derivative instruments (*Deriv*) is incorporated into regression (4). Balance-sheet and derivative data are collected from the June Call Report for each bank for each year in the sample. $(\frac{Deriv}{TA})_{jt}$ is the j^{th} bank's notional principal amount of interest-rate derivative contracts scaled by its total assets.

Further, the logarithm of BHC asset size is included to control for differences in interest-rate risk exposure that might be caused by differences in the types of businesses and customers at large and small banks. In addition, Demsetz and Strahan (1995, 1997) point out that banks of different size may have different risk preferences. For example, large banks may choose to pursue risk-increasing activities (such as commercial and industrial lending) because they are equipped with greater diversification advantages as compared to smaller banks. Secondly, large bank holding companies may have greater access to markets and products (e.g., over-the-counter dealer activity, foreign deposits, and geographically diversified subsidiaries). These operating advantages can significantly change their interest-rate risk profiles as compared to their smaller counterparts. Finally, previous research finds that size is an important determinant of a bank's derivative

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[22]The examination of the conditional number and variance of inflation factors does not indicate a problem with multicollinearity.

activities.[23] Thus, it is important to control for asset size in the regression to avoid the possibility of a spurious relationship between derivative activity and other size-related factors.

Empirical Results

The empirical results of this essay (Chapter 3) are presented in this section. Table 5 summarizes the descriptive statistics. Table 6 presents the market-model regression results, and Table 7 reports the second-stage regression results. The economic implications of these results are also discussed in this section.

Descriptive Statistics

Table 5 summarizes the sample from 1998 through 2003. During the sample period, the average maturity-gap-to-asset ratio is a negative 23 percent; the average notional value of interest-rate derivatives over assets is 50 percent. The mean return for the bank holding companies in the sample is 3.70 percent, and the mean return for the value-weighted CRSP is 1.8 percent. During the sample period, 23.08 percent of the sample banks reported using interest-rate swaps, 12.04 percent reported using interest-rate options, and 10.68 percent reported using interest-rate forwards. Only 3.19 percent of the sample banks reported using interest-rate futures. Finally, approximately 1 percent of the banks in the sample are members of ISDA.

Market-model Regression and Interest-rate Sensitivity

The market-model regressions are estimated annually between 1998 and 2003 for each BHC whose stock traded publicly for at least 30 weeks in a given year. Table 6

[23]For example, Sinkey and Carter (1997), Kim and Koppenhaver (1992), and Gunther and Siems (1996) find that size is an important determinant of a bank's derivative activities.

Table 5 Summary Statistics for the Full Sample [a, b]

Variable	Mnemonic	Mean	Standard Deviation
Stock Return and Interest-rate Indices			
BHC's Stock Return	BHCRET	0.0037	0.0448
Market Return	VWRET	0.0018	0.0269
Interest-rate Term	TREAS01	0.0025	0.1002
Balance Sheet Data			
Maturity Gap Scaled by BHC's Total Assets	ASHORT	-0.2326	3.1738
Derivative Scaled by BHC's Total Assets	ADERIV	0.4985	3.1168
Log Total Assets	LNTASST	20.0067	2.1729
Classification Variable			
Swaps (0-Yes, 1-No)	DSWAP	0.2308	0.4686
Futures (0-Yes, 1-No)	DFUTURES	0.0319	0.1843
Forwards (0-Yes, 1-No)	DFORWARD	0.1068	0.3390
Options (0-Yes, 1-No)	DOPTION	0.1204	0.3628
Derivatives Dealer (0-No, 1-Yes)	DEALER	0.0120	0.1082

[a] Means and standard deviations for all variables used in the empirical analyses. The statistics are computed over the period from 1998 through 2003.

[b] BHCRET is a bank holding company's weekly stock returns, and VWRET is the value-weighted CRSP weekly returns. TREAS01 is the weekly holding-period return on a constant-maturity one-year Treasury security. SHORT (maturity-gap measurement) is assets that mature or re-price within a year minus liabilities that mature or re-price within a year. DEALER is a binary variable, which is equal to one if the BHC is an ISDA member, or zero otherwise.

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Table 6 Aggregate Market-model Annual Regressions, 1998 Through 2003

$$\tilde{R}_{jt} = \beta_{0j} + \beta_{mj}\tilde{R}_{mt} + \beta_{Ij}\tilde{R}_{It} + \tilde{\varepsilon}_{jt}$$

	1998	1999	2000	2001	2002	2003
Intercept (β_{0j})	-0.0029	-0.0033	0.0033	0.0068	0.0052	0.0019
	(-7.24) ***	(-7.81) ***	(6.06) ***	(14.23) ***	(12.87) ***	(5.81) ***
Market Return (β_{mj})	0.8670	0.4676	0.3215	0.5242	0.7089	0.7204
	(57.05) ***	(27.28)	(20.82) ***	(31.05) ***	(40.26) ***	(44.57) ***
Interest-rate Term (β_{Ij})	0.2363	0.317	0.270	0.481	-0.0908	0.475
	(2.97) ***	(1.85)*	(1.26)	(4.07) ***	(-6.41) ***	(4.80) ***
R-squared	0.2331	0.1669	0.1400	0.1357	0.1736	0.1980
Number of Bank Holding Companies	215	204	201	193	178	171

$\tilde{R}_{jt}$ = the weekly return of bank j's stock in week t.

$\tilde{R}_{mt}$ = the weekly return on the CRSP value-weighted portfolio of common stock in week t.

$\tilde{R}_{It}$ = the holding period return on a constant-maturity one-year Treasury security.

Statistical significance is displayed by the use of one (10%), two (5%), or three (1%) stars.

Table 7 Univariate Multiple Regression Coefficient Estimates [a, b]

Independent variables	Regression (1)	Regression (2)	Regression (3)
ADERIV		-0.0072	
		(-2.72) ***	
LNTASST		-0.0039	-0.0039
		(-0.55)	(-0.61)
ASHORTD1			-0.1010
			(-1.53)
ASHORTD2	0.0095	0.0101***	-0.0003
	(3.59) ***	(3.66)	(-0.13)
ASHORTD3	0.0049	0.0055	-0.0048
	(0.56)	(0.62)	(-0.62)
ASHORTD4	0.0027	0.0028	-0.0075
	(0.75)	(0.76)	(-1.02)
ASHORTD5	0.0076	0.0077	-0.0026
	(3.01)	(3.04) ***	(-0.45)
ASHORTD6	0.0062	0.0062	-0.0041
	(1.82) *	(1.87) *	(-0.50)
ADERIVD1			-0.0063
			(-0.39)
ADERIVD2			-0.0094
			(-1.04)
ADERIVD3			-0.0142
			(-1.57)
ADERIVD4			-0.0029
			(-0.35)
ADERIVD5			-0.0031
			(-0.39)
ADERIVD6			0.0014
			0.01
ASHORT	-0.0101	-0.0104	
	(-4.29) ***	(-4.45) ***	
OBSERVATIONS	1186	1186	1186
ADJ R-SQUARE	0.0687	0.0706	0.0866

[a] All regression equations contain time-period indicator variables. T-statistics (reported in parentheses) are calculated using Newey-West heteroscedasticity-and-autocorrelation-consistent errors. Statistical significance is displayed by the use of one (10%), two (5%), or three (1%) stars. The sample contains six years of observations from 1998 through 2003. The dependent variable for all regressions is the estimates of interest-rate betas from the first-stage regression.

[b] ADERIV is measured as the ratio of notional amount of interest-rate derivatives to total assets. ASHORT is measured as the ratio of maturity-gap variable to total assets. LNTOTASST is the logarithm of a bank's total assets. ASHORTD1, ASHORTD2, ASHORTD3, ASHORTD4, ASHORTD5, and ASHORTD6 are six interactions between maturity-gap measurement and time-period indication variables. ADERIVD1, ADERIVD2, ADERIVD3, ADERIVD4, ADERIVD5, and ADERIVD6 are six interaction terms between derivative activity measurement and time-period indication variable.

presents the yearly analysis of the market-model regressions. The regression process produces a separate interest-rate sensitivity beta for each bank holding company for each year that the BHC is in the sample. The average of those individual betas is positive (0.4013), suggesting that an increase in interest rates leads to a decrease in BHC equity values. These regressions are representative of the results across the BHCs contained in the sample for a given year. Consistent with the findings of Hirtle (1997), there is considerable variation across years in both the coefficients on the market return and on the interest-rate term. In five of the six sample years, the interest-rate beta from these cross-sectional regressions is positive and differs significantly from zero.

Estimation Results of Regression Model

Since banks' use of derivatives increases during the sample period, a pooled cross-sectional time-series regression is employed to incorporate this dynamic effect. Specifically, I run a cross-sectional OLS regression with interest-rate betas as the dependent variable and then report the time-series means of the parameter estimates and their corresponding t-statistics. The t-values are computed using Newey-West heteroskedasticity-and-autocorrelation-consistent errors. Using estimates of interest-rate betas from the first-stage regressions as dependent variables, I utilize Equation (4) to examine the impact of derivatives on bank holding companies' stock return interest-rate sensitivity. Table 7 reports the results of pooled cross-sectional time-series regression results for the sample period 1998 through 2003.

Regression (1) of Table 7 serves as a base for examining the relationship between a financial institution's stock returns' interest-rate sensitivity and the maturity composition of on-balance-sheet assets and liabilities. Under the maturity-mismatch hypothesis, the expected sign of the coefficient estimate on $(\frac{Short}{TA})$ is negative. The test results, consistent with Flannery and James (1984), find a significantly negative relationship between the measure of bank stock interest-rate sensitivity and the bank's net short-asset position.

In Regression (2) of Table 7, the interest-rate betas are regressed not only on the on-balance-sheet activities but also on the off-balance-sheet activities approximated by the notional principal amount of interest-rate derivatives scaled by BHCs' total assets (ADERIV). The coefficient on ADERIV reflects the impact of derivative usage conditional on adequately incorporating the remaining terms of the specification. In Diamond's (1984) model, banks are delegated monitors having a comparative advantage in monitoring and enforcing loan contracts made with borrowers. Diamond shows that derivative instruments allow banks to lessen their systematic exposure to changes in interest rates. Thus, in his model, banks find it optimal to hedge all interest-rate risk using interest-rate derivatives. If derivative instruments allow banks to reduce their interest-rate risk exposure as predicted by Diamond's (1984) model, one would expect negative coefficient estimates on the ADERIV variable.

As discussed in an earlier section, the logarithm of BHC asset size is included to control for differences in interest-rate risk exposure that might be caused by differences in the types of businesses and customers at large and small banks. To control for the effect of changes in the interest-rate environment across time on on-balance-sheet activity, I also introduce five possible interactions between the maturity-gap measurement and the time-indicator variables. Column (2) of Table 7 reports the estimation results for the derivative-augmented regressions. First, the coefficient estimates on the maturity-gap variable is qualitatively similar to that in the base model. Second, the ASHORT coefficient estimate remains statistically significant.

Regression (2) of Table 7 shows that the coefficient estimate on ADERIV is negative and statistically significant, suggesting that banks using interest-rate derivatives, on average, experience significantly lower interest-rate betas. In fact, when the data are evaluated at the sample means, using the results from regression (2) of Table 7, it is estimated that each 100 basis points increase in derivative usage results in a 35 basis points reduction in banks' stock return interest-rate sensitivity.[24]

Normally, financial economists use the total variance of a bank's historical stock returns (or its standard deviation) as a measure of overall volatility associated with the asset risk of a firm. If interest-rate derivative instruments enable banks to lessen their systematic exposure to changes in interest-rate risk, holding everything else equal, one would expect the variance of stock return for a bank that uses derivatives to be less than the variance of stock return for the same bank had it not used derivatives. Similarly, one would expect that the capital level required for derivative users to be less than nonusers. Brewer, Jackson, and Moser (2001) examine the major differences in the financial characteristics of banking organizations that use derivatives relative to those that do not. They indeed find that banking organizations that use derivatives to manage interest-rate risk hold lower levels of (expensive) capital than do other institutions. This finding implies that derivative usage allows banks to substitute inexpensive risk management for expensive capital.

[24] As shown in regression (2) of Table 3, the coefficient estimate on ADERIV is -0.0072. The average ADERIV is 0.4985. Therefore, when the data are evaluated at the sample mean, every 100 basis points increase in derivative usage results in a 35 basis points reduction in a bank's stock return interest-rate sensitivity.

To evaluate the economic significance of the results, I calculate the standard deviations of banking holding companies' stock returns in each sample year. The standard deviations are then recalculated, assuming that these banking firms do not engage in interest-rate derivative activities. As shown in Table 8, the standard deviations of stock returns are consistently smaller for users than for nonusers. This result is in line with the predictions of hedging theories in that derivative instruments allow banks to lessen their systematic exposure to changes in interest rates.

Next, the annual average market value of the stocks for bank holding companies is calculated, and this market value is used as the base to calculate the extra capital that a banking firm in the sample needed each year to hedge against the interest-rate risk. (See Table 8 for detailed calculations.) The results indicate that a bank holding company, on average, would have to use $209.37 million of capital each year to shift the interest-rate beta down by 35 basis points had it not used interest-rate derivatives to hedge against interest-rate risk. This finding is inconsistent with Hirtle (1997).[25] Its economic significance provides further evidence that increased use of derivatives is associated with lower interest-rate sensitivity after controlling for on-balance-sheet exposure.

This negative relationship between derivative activity and bank stock return interest-rate sensitivity is consistent with Diamond's (1984) model of financial intermediation. In that model, Diamond argues that interest-rate derivatives allow banks to lessen their systematic exposure to changes in interest rates. Similar to the findings of

[25]Hirtle uses the two-factor market model and finds that for the typical bank holding company, increases in the use of interest-rate derivatives corresponded to greater interest-rate risk exposure during a sub-sample period (1991-1994).

Table 8 Risk Sensitivity of BHC Stock Return, 1998 Through 2003

Standard Deviation of BHC Stock Return						
	1998	1999	2000	2001	2002	2003
With Derivative Usage	0.002306	0.00272	0.002348	0.00263	0.002756	0.002653
Without Derivative Usage	0.003169	0.00334	0.002837	0.00289	0.003137	0.003396

	1998	1999	2000	2001	2002	2003
Mean of Market Value of Stock	762,264,000	812,641,000	958,502,000	988,005,000	1,137,381,000	1,167,870,000

For example, extra capital needed by sample BHCs to hedge interest-rate risk in year 1998 = (0.003169/0.002306)*762,264,000-762,264,000 = $285.27 million. Similarly, the extra capital needed by sample BHCs to hedge interest-rate risk in all sample years is calculated. The average extra capital for all sample years (1998 through 2003) is $209.37 million.

Brewer, Jackson, and Moser (1996), the results of this study suggest that bank holding companies use derivatives to hedge interest-rate risk rather than to speculate.

Robustness Checks

Overall, the results in the previous section suggest that bank stock return interest-rate sensitivity is negatively related to banks' participation in the derivative market. As a further check on the validity of the results, I introduce five interaction terms between the measure of derivative activity and time-indicator variables in regression (3) of Table 7. Adding these variables addresses the concern that the impact of the derivative activity on bank holding companies' stock return interest-rate sensitivity is driven by any particular time period or interest environment.[26] As shown in column (3) of Table 7, none of the coefficient estimates on interaction terms is statistically significant, suggesting that the variability of interest rates during the sample period does not cloud the significant association between derivative activity and stock return interest-rate sensitivity.[27]

Regressions (1), (2), and (3) in Table 7 are based on a two-stage procedure. In this procedure, I first estimate the market model regression to capture the measures of interest-rate sensitivity (the interest-rate "beta"). Then these interest-rate betas are regressed on a series of variables that reflect the composition of the BHCs' balance sheets and the scope of their participation in the interest-rate derivative market. Balance sheet and derivative data are collected from the June Call Report for each bank for each year in the sample. As an alternative specification, I evaluate the following equation:

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[26]Monetary policy may shift over the business cycle, which may lead to a shift in the relationship between bank holding companies' stock returns and derivative activity.

[27]Equation (2) is also estimated separately for each sample year; the results confirm the pooled cross-sectional estimation.

$$R_{jt} = \alpha_0 + \sum_{t=2}^{T} \alpha_t D_t + \alpha_1 (\frac{Short}{TA})_{jt} + \alpha_2 \text{DerivDummy}_{jt} + \alpha_3 \text{DerivInterest}_{jt} + \alpha_4 \text{ShortInterest}_{jt} + \beta_{mj} \tilde{R}_{mt} + \beta_{Ij} \tilde{R}_{It} + \varpi_{jt} \quad (5)$$

Equation (5) incorporates the BHC's stock return data, BHC's quarterly balance sheet data, and BHC's quarterly interest-rate derivative data from 1998 through 2003. The results of the pooled cross-sectional time-series regression are also robust to the inclusion of the derivative-use indicator variable, which is a binary variable equaling one if a bank engages in any interest-rate derivative activity, or zero otherwise. Specifically, the interest-rate betas captured from the first-stage regression are regressed on a derivative-use dummy variable (DERIVDUMMY), the maturity-gap variable, the interactions between the maturity-gap variable and the interest-rate term (SHORTINTEREST), and the interactions between the derivative-use dummy and the interest-rate term (DERIVINTEREST).

As shown in Table 9, the coefficient estimates on DERIVINTEREST are negative and statistically significant. By contrast, the coefficient estimates on the interest-rate term are positive and statistically significant. A striking feature of this second robustness check is that coefficient estimates on DERIVINTEREST and the interest-rate term balance out, suggesting that derivative users' stock returns are insensitive to changes in interest rates, holding everything else equal.[28] Once again, this result suggests that interest-rate derivatives allow banks to lessen their systematic exposure to changes in interest rates, thereby increasing the potential for banks to better manage their interest-rate risk exposure.

[28] A joint hypothesis test indicates that the coefficient estimates on DERIVINTEREST and the interest-rate term net to zero.

Table 9 Univariate Multiple Regression Coefficient Estimates [a, b]

Independent Variables	Regression (4)
ASHORT	0.00002
	(0.82)
DERIVDUMMY	0.0019
	(0.97)
DERIVINTEREST	-0.1385
	(-2.39) **
SHORTIINTEREST	0.0049
	(0.92)
MARKETRETURN	0.8909
	(16.11) ***
INTEREST TERM	0.1370
	(3.27) ***
OBSERVATIONS	2461
ADJ R-SQUARE	0.2116

[a] The multiple regression equation contains time-indicator variables. T-statistics (reported in parentheses) are calculated using Newey-West heteroscedasticity-and-autocorrelation-consistent errors. Statistical significance is displayed by the use of one (10%), two (5%), or three (1%) stars. The sample contains six years of observations from 1998 through 2003. The dependent variable is the weekly return of bank j's stock in week t.

[b] ASHORT is measured as the ratio of maturity-gap variable to total assets. MARKETRETURN is the weekly return on CRSP value-weighted portfolio of common stocks in week t. INTEREST TERM is the weekly holding period return on a constant-maturity one-year Treasury security. DERIVDUMMY is a binary variable equal to one if a bank engages in any interest-rate derivative activity, or zero otherwise. DERIVINTEREST is the interaction between the derivative-use dummy variable and the interest-rate term. SHORTINTEREST is the interaction between the maturity-gap variable and the interest-rate term.

Conclusions and Policy Implications

Commercial banks employ different methods, including the use of interest-rate derivatives to manage interest-rate risk. The use of these derivative instruments by banks has increased tremendously in the past decade, rising from notional amounts of $27.88 trillion at the end of December 1996 to $62.78 trillion at the end of December 2004. The popularity of derivative usage is due to the fact that derivatives provide a relatively inexpensive means for banks to change their interest-risk exposure. In theory, the existence of an active derivative market should increase the potential for banks to move toward their desired levels of interest risk. Alan Greenspan states that complex financial instruments such as derivatives have contributed to the development of an efficient, flexible, and resilient financial system. The potential of derivative instruments has been widely recognized, and the question that has arisen in consequence is whether banks have used derivatives primarily to reduce the risks arising from their other banking activities (for hedging) or to achieve higher levels of interest-rate risk exposure (for speculation). If they use derivatives for hedging, is there a significant association between derivative activities and stock return interest-rate sensitivity? Using recent data that cover a full business cycle, this chapter revisits these questions to ascertain if a statistically significant relationship still exists between derivative activities and stock return interest-rate sensitivity.

The major finding of this essay (Chapter 3) is that stock returns of a bank holding company using derivatives are less sensitive to interest-rate changes, controlling for balance-sheet composition and asset size. This finding is consistent with the results of an earlier study by Schrand (1997), who studies a sample of publicly traded savings and loan associations (S&Ls) over a sample period from 1984 to 1988. In addition, the results in this essay are statistically and economically significant. In fact, the sample results suggest that a bank holding company, on average, would have to use $209.37 million of capital each year to shift the interest-rate beta down by 35 basis points if it did not use interest-rate derivatives to hedge against interest-rate risk. This result is consistent with Diamond's (1984) prediction in which a bank can use interest-rate derivatives to hedge against interest-rate risk. Furthermore, the results presented in this essay (Chapter 3) also suggest that the restrictive policies for banks' derivative activities have consequences in innovation promotion and more effective bank risk management. The possibility that the use of interest-rate derivative instruments is associated with lower bank holding companies' stock return interest-rate sensitivity implies that restrictions on bank participation in financial derivatives could prevent banks from managing interest-rate risk more effectively.

CHAPTER 4

DURATION OF CORPORATE DEBT ISSUES

Introduction

Numerous theoretical and empirical studies have attempted to investigate the factors that firms consider when choosing the maturity of their debt issues. In this chapter, the duration of debt issues is examined. Some questions about the determinants of debt maturity may also be answered by examining firms' duration choices. Duration measures the number of years required to recover the true cost of a bond, considering the present value of all coupon and principal payments received in the future. Debt maturity focuses more on matching the cash flow generated from the chosen project to the life of the project. Research comparing both approaches may discern whether firms focus on duration or maturity. Hypotheses that have been offered to explain corporate debt maturity are used to examine the firms' duration choices to see if factors that influence maturity choices also affect bond duration.

Using a sample of debt issues from the Thomson Financial SDC Platinum database, I document the determinants of the durations of 8,627 public, non-convertible corporate debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. I examine how signaling and asymmetric information as well as agency problems are related to bond duration.

The primary finding is that firm quality, as measured by credit rating, is directly related to bond duration. I also find evidence suggesting that bond duration is inversely related to firm size. In addition, I find that regulated non-financial firms have longer bond durations and that syndicated offerings have longer durations than non-syndicated offerings.

This essay (Chapter 4) is organized as follows: The next section provides a comprehensive examination of the theories surrounding debt maturity and bond duration, including a set of testable hypotheses. A description of the data obtained for analysis is provided, and the models and results are then presented. The conclusions of this essay are presented in the final section of Chapter 4.

Theories and Hypotheses

Theories and hypotheses that have been offered to explain corporate debt maturity are used to examine the firms' duration choices to determine if factors that influence maturity choices also affect bond duration. Specifically, I investigate how signaling and asymmetric information as well as agency problems are related to bond duration.

Signaling and Asymmetric Information

Flannery (1986) examines the maturity structure of a firm's risky debt using a model of uncertainty where debt serves as a signal of credit quality. The model indicates that, given low costs for debt issuance, high-quality firms will issue short-term debt when they expect to benefit from bondholder scrutiny during the refinancing process, while low-quality firms issue long-term debt to avoid re-evaluation. On the other hand, abnormally high refinancing costs will lead to a pooling equilibrium where both high-quality and low-quality firms issue long-term debt.

The risk of not being able to refund debt because of deterioration in financial or economic conditions can motivate firms to lengthen the maturity of their debt. Sharpe (1991) and Titman (1992) suggest that unfavorable news about a borrower may arrive on the refinancing date, causing investors not to extend credit or to raise default premia on new debt issues. Diamond (1991) refers to this refinancing risk as a liquidity risk in that the borrower is forced into an inefficient liquidation because refinancing is unavailable. Diamond (1991) builds on Flannery's (1986) paper by suggesting that high-quality firms indeed desire short-term debt but face the risk that refinancing may be unavailable, forcing liquidation and loss of control. Thus, the optimal maturity structure is decided by a trade-off between its preference for short-term debt based on an expected improvement in credit rating and greater liquidity risk. While liquidity risks give some firms an incentive to borrow long-term, they may not be able to do so because the rate of return required to compensate investors for bearing long-term credit risks can induce firms to take risky low-quality projects. According to Diamond (1991), there are two categories of short-term borrowers: high-rated borrowers using short-term debt to take advantage of the arrival of information and low-rated borrowers who are screened out of the long-term debt market because lenders want to keep them on a "short leash." Thus, long-term bonds are issued by those firms having intermediate ratings.

Diamond (1993) develops an asymmetric-information model where debt seniority is related to debt maturity. Assuming that credit ratings provide noisy signals for the quality of a firm's projects, lenders have two possible options: (1) liquidating bad projects and denying the firm a chance to extract control rents, or (2) simply accepting a promised payment at the end of the life of the project in return for forgiving the amount of currently due obligations. As a result, high-quality borrowers utilize short-term debt since it can be refinanced as positive information is revealed. Alternatively, low-quality borrowers have long-term debt in the hope that lenders will not want to liquidate. However, in an effort to avoid identifying themselves as low-quality borrowers, they will emulate the high-quality borrowers by issuing debt at both ends of the maturity spectrum.

I construct two empirical tests to measure the relationship between firm quality and bond duration. First, I test Flannery's (1986) separating equilibrium hypothesis by comparing investment-grade issues with speculative-grade issues. In this case, the signaling hypothesis suggests that investment-grade issues should have shorter durations than speculative-grade issues. Alternatively, Diamond's (1993) asymmetric information model suggests no difference between bond-rating groups. Second, I test Diamond's (1991) hypothesis by comparing high- and low-rated issues to intermediate-rated issues. Asymmetric information theory suggests that both high-rated and low-rated issues should have shorter durations than intermediate-rated issues since low-quality firms are screened out of the long-term debt market. Even though credit-rating information is publicly available, it is used to test the asymmetric information hypothesis since firms with a low credit rating are more susceptible to information asymmetry problems than are firms with a high credit rating. As a result, firms with a low credit rating are more likely to issue short-term debt due to the larger information costs associated with long-term debt.

Agency Problems

Myers (1977) analyzes possible externalities generated by debt on shareholders' (and management's) optimal investment strategies. According to Myers (1977), in some cases, the benefits from undertaking profitable investment projects are split between stockholders and bondholders. If debt matures after the expiration of the firm's investment option, profits from investment will accrue, at least partially, to the bondholders rather than accrue fully to the shareholders. As a result, a shareholder and manager coalition will be reluctant to pursue future investment. Myers calls this the underinvestment problem. Myers (1977) predicts that debt maturity after the expiration of the growth option causes an underinvestment problem. High-growth opportunity firms are more likely to face an underinvestment problem compared with low-growth opportunity firms. The implication of the Myers (1977) paper is that firms with a history of underinvestment and a large number of growth opportunities should attempt to control underinvestment by including less debt in their capital structure, placing restrictive covenants on debt issues, or shortening the maturity of debt issues. Empirically, Barclay and Smith (1995), Guedes and Opler (1996), Stohs and Mauer (1996), and Highfield (2005) all find that firms with more growth options have shorter-term debt, supporting the idea that short-term debt is employed to reduce agency problems. Applying this line of logic to bond duration, one would expect high-growth firms to have shorter bond duration.

Because small firms typically have more growth opportunities, along with greater business risk, they are more susceptible to agency problems than their larger counterparts. Thus, small firms in riskier businesses attempt to lower agency costs by issuing short-term debt. Although several authors (e.g., Mitchell, 1991; Barclay and Smith, 1995; Stohs and Mauer, 1996; and Ooi, 1999) find a positive relationship between debt maturity and firm size, Carey, Prowse, Rhea, and Udell (1993) and Scherr and Hulburt (2001) find that firm size is inversely related to debt maturity. Alternatively, Guedes and Opler (1996) find that large firms issue at both ends of the maturity spectrum, while small firms tend to issue long-term debt. Based on this line of reasoning, one would expect larger firms to have longer bond duration.

While some firms struggle with agency problems and benefit from the self-imposed discipline of short-term debt, other firms such as utilities and financial institutions are monitored by government and industry regulators. Using an agency-problem framework, Smith (1986) and Barclay and Smith (1995) suggest that regulations reduce managerial discretion and effectively control underinvestment, risk shifting, and asset-substitution problems. Citing fewer growth opportunities, Smith (1986), Smith and Watts (1992), Barclay and Smith (1995), Guedes and Opler (1996), Kirshnaswami, Spindit, and Subramaniam (1999), and Highfield (2005) find that regulated firms issue long-term debt. Applying this line of logic to bond duration, one would expect to find that regulated firms have longer bond duration.

Finally, Rajan (1992) suggests that short-maturity loans provide opportunities for lenders to extract rents from borrowers at the time of loan renewal or to subject the borrower to a hold-up problem. In the case of syndication, any rents would have to be shared with other members of the syndicate; therefore, since the lead bank incurs additional costs from the monitoring activities necessary to convince other banks to join the syndicate, rent extraction becomes less profitable. Long-term loans lower the overall cost of monitoring by allowing these costs to be amortized over time, making the loan more profitable for the lead bank in the syndicate. Additionally, short-maturity loans also come with more frequent renewals that increase the amount of monitoring necessary to convince other banks to join the syndicate. Dennis and Mullineaux (2000) find that loan syndication is directly related to loan maturity; therefore, extending this concept to the bond market, on average, one would expect syndicated bond issues to have longer durations than their non-syndicated counterparts.

In this essay, I construct four empirical tests for the relationship between agency problems and bond duration. First, I test Myers' (1977) theory that high-growth firms have shorter bond duration in an effort to control agency problems. Second, similar to Barclay and Smith (1995) and Stohs and Mauer (1996), I test for a direct relationship between firm size and bond duration since small firms have more growth opportunities and should use short-term debt to control agency problems. Third, consistent with Smith (1986) and Barclay and Smith (1995), I test the proposition that regulated firms have longer bond duration. Finally, since syndicated loans are effectively a hybrid of public and private debt, comparable to Dennis and Mullineaux (2000) and Highfield (2005), I test the hypothesis that syndicated bond offerings have longer duration than non-syndicated offerings.

Data Source

The sample for this essay (Chapter 4) includes 8,627 public, non-convertible corporate debt instruments issued between January 1, 1990 and December 31, 2002. Issue information comes from the Thomson Financial SDC Platinum U.S. Corporate New Issues database (SDC). Bank debt and commercial paper are not included in the SDC database. The SDC database is limited to public debt offerings with a maturity of at least one year (defined as 360 days). In addition, I eliminated observations where the issuing firm did not have an S&P rating at the time of issuance.

Table 10 presents sample summary statistics. The bonds in the sample range in duration from 0.97 years to over 99.99 years, and the mean duration is 6.10 years. The bonds in the sample range in maturity from 1 year to a little over 101 years, and the mean maturity is about 9.75 years. Approximately 31 percent of the sample has an S&P A rating or above, 2 percent has an S&P B rating or below, and 67 percent falls into the S&P middle-rate range. Approximately 94 percent of the sample has an S&P rating in the investment-grade range, and 6 percent falls into the S&P high-yield range. About 40 percent of the bond issues are syndicated. Of those, the average coupon rate is just over 6.78 percent, and the average firm in the sample has a total market capitalization of $9 billion.

Table 11 shows the distribution of debt issues in the sample by year of issue. Corresponding to the low interest-rate environment of the late 1990s, the heaviest volume of new issues in the sample was in 1997 and 1998. As shown in panel A of Table 11, the mean duration over the sample period is 6.10 years, ranging from an average duration of 4.05 years in 2000 to 7.50 years in 1993. Panel B of Table 11 shows the mean maturity for the sample, which is 9.75 years. Overall, the mean maturity for the sample ranges from an average maturity of 5.71 years in 2000 to 12.22 years in 1991. As a general rule, (1) bonds paying interest prior to maturity will have durations less than their maturity, and (2) the larger the coupon, the shorter the duration. Table 11 indicates that the mean duration is less than the mean maturity for the sample.

Table 12 presents the distribution of debt issues by duration across bond ratings. As one would expect for new bond issues, the sample contains relatively few high-yield rated bonds as compared to the number of investment-grade bonds. In fact, the sample

Table 10 Sample Descriptive Statistics

The sample contains 8,627 debt instruments issued placed in U.S. markets between January 1, 1990 and December 31, 2002. The descriptive statistics of the sample are presented below.

VARIABLE	N	MEAN	STD DEV	MINIMUM	MAXIMUM
Coupon	8627	6.779	1.506	0.000	17.000
Duration	8627	6.097	3.734	0.973	99.990
Maturity	8627	9.751	9.937	1.000	101.464
Log (Maturity)	8627	1.857	0.974	0.000	4.619
Market-to-book	8627	1.073	3.167	0.995	264.285
Regulate	8627	0.685	0.464	0.000	1.000
Log (Total Cap)	8627	22.919	1.771	14.224	28.360
DEratio	8627	9.187	177.180	0.000	99.000
SYNDICATE	8627	0.401	0.490	0.000	1.000
Multiple	8627	0.289	0.453	0.000	1.000
Financial	8627	0.504	0.500	0.000	1.000
HIGHTECH	4937	0.163	0.369	0.000	1.000
S&P Rating AAA	8627	0.045	0.207	0.000	1.000
S&P Rating AA	8627	0.162	0.368	0.000	1.000
S&P Rating A	8627	0.450	0.497	0.000	1.000
S&P Rating BBB	8627	0.285	0.451	0.000	1.000
S&P Rating BB	8627	0.034	0.182	0.000	1.000
S&P Rating B	8627	0.020	0.140	0.000	1.000
S&P Rating CCC	8627	0.001	0.044	0.000	1.000
S&P Highrate	8627	0.657	0.474	0.000	1.000
S&P Midrate	8627	0.320	0.466	0.000	1.000
S&P Lowrate	8627	0.022	0.147	0.000	1.000

Table 11 Time Distribution of Debt Issues

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The total number of issues per year and the mean duration of the issues placed each year are presented below.

Panel A: Time Distribution of Debt Issues Duration

Year of Issuance	Total Number of Issues	Mean Duration in Years
1990	145	6.27
1991	248	6.71
1992	414	6.86
1993	536	7.50
1994	404	5.97
1995	625	6.38
1996	980	5.65
1997	1291	6.33
1998	1395	7.16
1999	872	5.58
2000	654	4.05
2001	973	5.18
2002	90	5.67
Total	8627	6.10

Panel B: Time Distribution of Debt Issues Maturity

Year of Issuance	Total Number of Issues	Mean Maturity in Years
1990	145	11.91
1991	248	12.22
1992	414	10.80
1993	536	11.66
1994	404	8.88
1995	625	10.28
1996	980	9.06
1997	1291	10.81
1998	1395	12.15
1999	872	8.30
2000	654	5.71
2001	973	9.33
2002	90	8.14
Total	8627	9.75

Table 12 Distribution of Debt Issues by Duration Across S&P Bond Ratings

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. This table shows the distribution of the debt issues by S&P bond rating and term to duration. The mean and standard deviation of bond duration for each rating class are also presented.

	S&P Bond Rating							
Duration	AAA	AA	A	BBB	BB	B	CCC	Total
$X < 2$	101	619	612	173	3	0	0	1508
$2 \le X < 5$	47	233	1068	626	78	22	0	2074
$5 \le X < 7$	26	110	483	438	125	100	10	1292
$7 \le X < 10$	54	294	1209	876	72	49	7	2561
$10 \le X < 20$	160	138	507	352	18	3	0	1178
$20 \le X < 30$	0	1	2	1	1	0	0	5
$30 \le X$	1	4	3	1	0	0	0	9
Total	389	1399	3884	2467	297	174	17	8627
Mean Duration	7.79	4.58	6.09	6.67	6.13	6.39	6.67	6.10
Std. Dev.	5.24	4.08	5.24	3.59	2.30	1.42	1.19	3.73

does not contain any observations with CC, C, or D ratings. In this sample, 56 percent of the issues has a duration under 7 years; 15 percent of the sample has a duration between 7 and 10 years; and 29 percent has a duration of 10 years or greater. Of bonds with an S&P rating of A or higher, 47 percent has a duration of 5 years or less, and only 1 percent has a duration of 20 years or greater. Thus, over 52 percent of the sample having a high S&P rating has a duration between 5 and 20 years. Conversely, of bond issues with an S&P rating of BBB or lower, 15 percent has a duration of 5 years or less, and 13 percent has a duration of 20 years or greater. Thus, about 72 percent of the sample with an S&P rating of BBB or lower has a duration of 5 to 20 years. As a check, I regress the duration on S&P investment-grade credit ratings and S&P speculative-grade credit ratings. At the same time, I limit the durations to 20 years or less, since 99 percent of the observations has a duration of less than 20 years. As shown in Table 13, the issues with investment-grade ratings tend to have longer durations than their high-yield counterparts.

Table 14 presents the distribution of debt issues by maturity across S&P bond ratings. There are 43 percent of the issues having a maturity under 7 years; 11 percent of the sample has a maturity between 7 and 10 years; and 46 percent has a maturity of 10 years or greater. Table 14 shows that, in general, as bond ratings decline, the mean term to maturity declines.

Of the 5,672 bonds with an S&P rating of A or higher, 1,906 (34 percent) have maturities of less than 5 years, and 768 (14 percent) have maturities of 20 years or greater. Thus, approximately 53 percent of the sample with a high S&P rating falls in the maturity range of 5 to 20 years. Conversely, of the 2,955 bond issues with an S&P rating of BBB or lower, only 452 (15 percent) have maturities of less than 5 years, and 387 (13 percent)

Table 13 Distribution of Debt Issues by Duration Across S&P Bond Ratings (Regression Results)

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The dependent variable for all regressions is bond duration. S&P AAA is a binary variable equal to one for bonds issued by firms with Standard and Poor's AAA credit rating at the time of issuance, zero otherwise. S&P AA is a binary variable equal to one for bonds issued by firms with Standard and Poor's AA credit rating at the time of issuance, zero otherwise. S&P A is a binary variable equal to one for bonds issued by firms with Standard and Poor's A credit rating at the time of issuance, zero otherwise. S&P BBB is a binary variable equal to one for bonds issued by firms with Standard and Poor's BBB credit rating at the time of issuance, zero otherwise. S&P BB is a binary variable equal to one for bonds issued by firms with Standard and Poor's BB credit rating at the time of issuance, zero otherwise. S&P B is a binary variable equal to one for bonds issued by firms with Standard and Poor's B credit rating at the time of issuance, zero otherwise. S&P CCC is a binary variable equal to one for bonds issued by firms with Standard and Poor's CCC credit rating at the time of issuance, zero otherwise. The t-statistics for each coefficient reported in parentheses are calculated using heteroscedasticity-consistent standard errors (HCSEs), and statistical significance is displayed by the use of one (10%), two (5 %), and three (1%) stars.

	Investment-grade Regression	Speculative-grade Regression
INTERCEPT	6.20***	6.05
	(8.10)	(5.61)
S&P AAA	1.52***	
	(6.58)	
S&P AA	1.71***	
	(9.51)	
S&P A	-0.14	
	(-0.85)	
S&P BBB	0.42**	
	(2.49)	
S&P BB		0.02
		(0.10)
S&P B		0.35
		(1.30)
S&P CCC		0.63
		(0.74)
R-SQUARE	0.0502	0.0301
ADJ R-SQUARE	0.0497	0.0219
OBSERVATIONS	8627	8627

Table 14 Distribution of Debt Issues by Maturity Across S&P Bond Ratings

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. This table shows the distribution of the debt issues by S&P bond rating and term to maturity. The mean and standard deviation of term to maturity for each rating class are also presented.

	S&P Bond Rating							
Term to Maturity	AAA	AA	A	BBB	BB	B	CCC	Total
$X < 2$	83	563	437	60	2	0	0	1145
$2 \leq X < 5$	38	175	610	355	31	4	0	1213
$5 \leq X < 7$	35	127	727	422	55	19	2	1387
$7 \leq X < 10$	18	77	371	339	84	57	7	953
$10 \leq X < 20$	61	329	1253	924	106	93	8	2774
$20 \leq X < 30$	49	41	185	122	14	1	0	412
$30 \leq X$	105	87	301	245	5	0	0	743
Total	389	1399	3884	2467	297	174	17	8627
Mean Term to Maturity	15.19	7.23	9.54	10.83	8.78	8.87	8.65	9.75
Std. Dev.	13.84	10.07	9.38	10.30	4.97	2.40	1.88	9.94

have maturities of 20 years or greater. Thus, approximately 72 percent of the sample with an S&P rating of BBB or lower falls in the maturity range of 5 to 20 years. The distribution of debt issues by maturity across bond ratings shown in Table 14 confirms the results shown in Table 12.

Methods and Results

I calculate the duration as follows:

$$Macaulay\ Duration = \frac{\frac{1C}{1+y} + \frac{2C}{(1+y)^2} + \cdots + \frac{nC}{(1+y)^n} + \frac{nM}{(1+y)^n}}{P} \qquad (6)$$

Where

P = price of the bond

C = semiannual coupon interest (in dollars)

y = one-half the yield to maturity or required yield

n = number of semiannual periods (number of years × 2)

M = maturity value (in dollars)

Using the duration of the bond issue as the dependent variable, the following specifications of bond issue duration are estimated:

$$\begin{aligned} DURATION = {} & \beta_0 + \beta_1 S\&P\ INVEST_i + \beta_2 MV/BV_i + \beta_3 REGULATE_i \\ & + \beta_4 LN(TOTALCAP)_i + \beta_5 SYNDICATE_i + CONTROL\ VARIABLES + \varepsilon_i \end{aligned} \qquad (7)$$

$$\begin{aligned} DURATION = {} & \beta_0 + \beta_1 S\&P\ HIGHRATE_i + \beta_2 S\&P\ LOWRATE_i + \beta_3 MV/BV_i + \beta_4 REGULATE_i \\ & + \beta_5 LN(TOTALCAP)_i + \beta_6 SYNDICATE_i + CONTROL\ VARIABLES + \varepsilon_i \end{aligned} \qquad (8)$$

The control variables include a binary variable for multiple issues by the same firm and the total-debt-to-equity ratio (Debt/Equity).[29] The t-values are computed using White's (1980) heteroscedasticity-consistent standard errors (HCSEs).

Signaling and Asymmetric Information

Equation (8) allows me to test Flannery's (1986) separating equilibrium hypothesis. I compare investment-grade issues to speculative-grade issues by including a binary variable. *S&P INVEST* denotes bonds issued by firms with S&P investment-grade credit ratings at the time of issuance. Table 15 presents the regression model coefficient estimates. Column (1) reports the full regression estimates, column (2) reports the estimation excluding financial firms, and column (3) reports the estimation for financial firms only.[30]

The signaling hypothesis is confirmed if investment-grade issues have shorter durations than speculative-grade issues, but Diamond's (1993) asymmetric information model suggests no difference between the bond rating groups. Unlike Stohs and Mauer (1996), I do not find evidence supporting Flannery's (1986) signaling hypothesis. In addition, the empirical results in this chapter do not support Diamond's (1993) asymmetric information model that there is no difference between investment-grade issues and speculative-grade issues. Instead, the results of this study suggest that investment-grade firms issue debt with a longer duration than their high-yield counterparts, on average.

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[29]The F-test shown in Table 15 fails to reject the hypothesis that the coefficient estimates on MV/BV, Debt/Equity, and LNTOTALCAP are jointly zero.

[30]An examination of the conditional number and variance of inflation factors does not indicate a problem with multicollinearity.

Table 15 Regression Models

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The dependent variable for all regressions is bond duration. S&P INVEST is a binary variable equal to one for bonds issued by firms with Standard and Poor's investment-grade credit rating at the time of issuance, or zero otherwise. SYNDICATE is a binary variable for bond issues that are syndicated. LNTOTALCAP is the natural logarithm of the total capitalization of the issuing firm. (MV/BV) is the issuing firm's market-to-book ratio. The control variables (not presented) include (Debt/Equity), the total-debt-to-equity ratio, and MULTIPLE, a binary variable for multiple issues by the same firm. The t-statistics for each coefficient reported in parentheses are calculated using heteroscedasticity-consistent standard errors (HCSEs), and statistical significance is displayed by the use of one (10%), two (5 %), and three (1%) stars.

	All Issues	Non-financial Issues	Financial Issues
INTERCEPT	12.78***	10.81***	8.18***
	(24.00)	(12.56)	(9.60)
S&P INVEST	0.65***	1.14***	-0.45
	(3.79)	(6.72)	(-1.01)
MV/BV	-0.07	0.08	-0.08
	(-0.64)	(0.03)	(-0.58)
REGULATE	-0.93***	0.28***	
	(-10.64)	(2.81)	
LNTOTOTALCAP	-0.32***	-0.22***	-0.14***
	(-13.54)	(-5.66)	(-4.30)
DERATIO	0.02**	0.01*	0.05
	(2.23)	(1.95)	(1.04)
SYNDICATE	1.57***	1.00***	1.74***
	(19.73)	(10.11)	(13.40)
MULTIPLE	0.14*	-0.43***	0.42***
	(1.68)	(-4.02)	(3.22)
R-SQUARE	0.1039	0.0447	0.0506
ADJ R-SQUARE	0.1031	0.0431	0.0491
H_0: (MV/BV) = (Debt/Equity) = LNTOTALCAP = 0	62.20***	11.72***	6.45***
OBSERVATIONS	8627	4274	4353

Equation (9) allows me to specifically examine Diamond's (1991) hypothesis that there is a nonmonotonic structure in credit ratings. I compare high-rated and low-rated issues to intermediate-rated issues by including two binary variables. *S&P HIGHRATE* is a binary variable for bonds issued by firms rated as AAA, AA, or A by S&P at the time of issuance. *S&P LOWRATE* is a binary variable for bonds issued by firms rated as B, CCC, or D by S&P at the time of issuance. These results are shown in Table 16.

I find that high-rated firms tend to issue debt with longer durations than middle-rated companies. The coefficient for low-rated firms is not statistically significant except for the issues restricted to non-financial firms. This direct relationship between credit ratings and duration is inconsistent with Diamond's (1991) hypothesis that there is a nonmonotonic structure in credit ratings, and it is also inconsistent with Diamond's (1993) asymmetric information model that low-quality issuers attempt to emulate high-quality issuers.

Agency Problems

Four empirical tests are constructed in this essay (Chapter 4) to evaluate the relationship between agency problems and bond duration. First, a growth measure, the issuing firm's market-to-book ratio (MV/BV), is used to test Myers' (1977) theory that firms with high growth opportunities have shorter bond duration in an effort to control agency problems. Inconsistent with Barclay and Smith (1995), Guedes and Opler (1996), Stohs and Mauer (1996), and Highfield (2005), I find that all coefficient estimates for MV/BV are statistically insignificant.

Since small firms have more growth opportunities and should issue short-term debt to control agency problems, in the second empirical test regarding agency problems,

Table 16 Regression Models

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The dependent variable for all regressions is bond duration. S&P HIGHRATE is a binary variable for bonds issued by firms rated as AAA, AA, or A by S&P at the time of issuance. S&P LOWRATE is a binary variable for bonds issued by firms rated as B, CCC, D by S&P at the time of issuance. SYNDICATE is a binary variable for bond issues that are syndicated. LNTOTALCAP is the natural logarithm of the total capitalization of the issuing firm. (MV/BV) is the issuing firm's market-to-book ratio. The control variables (not presented) include (Debt/Equity), the total-debt-to-equity ratio, and MULTIPLE, a binary variable for multiple issues by the same firm. The t-statistics for each coefficient reported in parentheses are calculated using heteroscedasticity-consistent standard errors (HCSEs), and statistical significance is displayed by the use of one (10%), two (5 %), and three (1%) stars.

	All Issues	Non-Financial Issues	Financial Issues
INTERCEPT	13.66***	11.93***	7.44***
	24.11)	(13.22)	(8.59)
S&P HIGHRATE	0.27***	0.59***	-0.19
	(2.99)	(5.83)	(-1.10)
S&P LOWRATE	-0.36	-0.53*	0.16
	(-1.30)	(-1.94)	(0.20)
MV/BV	-0.08	-0.01	-0.02
	(-0.66)	(-0.01)	(-0.58)
REGULATE	-0.94***	0.25**	
	(-10.73)	(2.55)	
LNTOTOTALCAP	-0.34***	-0.24***	-0.12***
	(-13.26)	(-5.92)	(-3.20)
DERATIO	0.01**	0.02*	0.05
	(2.20)	(1.87)	(1.05)
SYNDICATE	1.61***	1.07***	1.73***
	(19.68)	(10.59)	(3.11)
MULTIPLE	0.15 *	-0.42***	0.41***
	(1.78)	(-3.90)	(3.11)
R-SQUARE	0.1036	0.0441	0.0507
ADJ R-SQUARE	0.1027	0.0423	0.0489
H_0: (MV/BV) = (Debt/Equity) = LNTOTALCAP = 0	59.78***	12.64***	3.74***
OBSERVATIONS	8627	4274	4353

I test for a direct relationship between firm size and duration using the natural logarithm of the total capitalization of the issuing firm (LNTOTALCAP). Consistent with Carey et al. (1993) and Scherr and Hulburt (2001), I find that bond duration is inversely related to firm size, a finding inconsistent with Myers' (1977) hypothesis that small firms use short-term debt to control agency problems.

The hypothesis that regulated firms have long-term debt is also tested by using a binary variable for regulated firms (REGULATE). Inconsistent with Smith (1986) and Barclay and Smith (1995), the findings in the third test regarding agency problems indicate that regulated firms have shorter duration, with one exception: non-financial institutions. Once the sample is restricted to non-financial firms, the results indicate that regulated firms tend to issue debt with longer durations than non-regulated firms, a finding consistent with the hypothesis that government regulation can effectively control agency problems such as underinvestment, risk shifting, and asset substitution. As an alternative specification, I also test the hypothesis that regulated firms have longer durations by introducing an interaction term (INTERACTION) between REGULATE and FINANCIAL (a binary variable for financial firms). As shown in Tables 17 and 18, coefficient estimates on INTERACTION are negative and statistically significant, suggesting that regulated financial firms have shorter durations.

A binary variable for syndicated issues (SYNDICATE) is used to test the hypothesis that syndicated offerings have longer durations. Supporting Dennis and Mullineaux (1999) and Highfield (2005), regardless of sample selection, the fourth test regarding agency problems indicates that syndicated offerings have longer durations than

Table 17 Regression Models

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The dependent variable for all regressions is bond duration. S&P HIGHRATE is a binary variable for bonds issued by firms rated as AAA, AA, or A by S&P at the time of issuance. S&P LOWRATE is a binary variable for bonds issued by firms rated as B, CCC, and D by S&P at the time of issuance. SYNDICATE is a binary variable for bond issues that are syndicated. LNTOTALCAP is the natural logarithm of the total capitalization of the issuing firm. (MV/BV) is the issuing firm's market-to-book ratio. The control variables (not presented) include (Debt/Equity), the total-debt-to-equity ratio, and MULTIPLE, a binary variable for multiple issues by the same firm. INTERACTION is the interaction term between REGULATE and FINANCIAL binary variables. The t-statistics for each coefficient reported in parentheses are calculated using heteroscedasticity-consistent standard errors (HCSEs), and statistical significance is displayed by the use of one (10%), two (5%), and three (1%) stars.

	All Issues
INTERCEPT	9.88***
	(19.81)
S&P INVEST	0.85***
	(5.49)
MV/BV	-0.07
	(-0.65)
INTERACTION	-1.76***
	(-11.04)
LNTOTOTALCAP	-0.28***
	(-8.27)
DERATIO	0.01**
	(2.46)
SYNDICATE	1.39***
	(18.90)
MULTIPLE	0.02
	(0.36)
R-SQUARE	0.1570
ADJ R-SQUARE	0.1563
H_0: (MV/BV) =(Debt/Equity) = LNTOTALCAP = 0	62.20***
OBSERVATIONS	8627

Table 18 Regression Models

The sample contains 8,627 debt instruments placed in U.S. markets between January 1, 1990 and December 31, 2002. The dependent variable for all regressions is bond duration. S&P HIGHRATE is a binary variable for bonds issued by firms rated as AAA, AA, or A by S&P at the time of issuance. S&P LOWRATE is a binary variable for bonds issued by firms rated as B, CCC, and D by S&P at the time of issuance. SYNDICATE is a binary variable for bond issues that are syndicated. LNTOTALCAP is the natural logarithm of the total capitalization of the issuing firm. (MV/BV) is the issuing firm's market-to-book ratio. The control variables (not presented) include (Debt/Equity), the total-debt-to-equity ratio, and MULTIPLE, a binary variable for multiple issues by the same firm. INTERACTION is the interaction term between REGULATE and FINANCIAL binary variables. The t-statistics for each coefficient reported in parentheses are calculated using heteroscedasticity-consistent standard errors (HCSEs), and statistical significance is displayed by the use of one (10%), two (5%), and three (1%) stars.

	All Issues
INTERCEPT	10.98***
	(20.73)
S&P HIGHRATE	0.28***
	(3.99)
S&P LOWRATE	-0.34
	(-1.01)
MV/BV	-0.07
	(-0.70)
INTERACTION	-1.76***
	(-11.70)
LNTOTOTALCAP	-0.24***
	(-8.71)
DERATIO	0.01**
	(2.40)
SYNDICATE	1.44***
	(19.24)
MULTIPLE	0.19 *
	(0.63)
R-SQUARE	0.1564
ADJ R-SQUARE	0.1556
H_0: (MV/BV) = (Debt/Equity) = LNTOTALCAP = 0	59.78***
OBSERVATIONS	8627

their non-syndicated counterparts. As shown in Tables 15 and 16, all coefficients for SYNDICATE are statistically significant. This finding is consistent with the proposition that long-term loans help control agency problems associated with bank monitoring and rent extraction.

Comparison of Duration and Maturity Empirical Findings

In the previous sections, I use the hypotheses that have been offered to test corporate debt maturity to examine firms' duration choices to determine if factors that influence firms' debt-maturity decisions also affect duration choices. Most of the results in this chapter support the findings of previous empirical work that examines the determinants of debt maturity except for two major hypotheses. Stohs and Mauer (1996) support the signaling hypothesis by Flannery (1986) and find that investment-grade issues have shorter maturity than speculative-grade issues. They also find strong support for the prediction of a nonmonotonic relationship between debt maturity and bond rating; firms with high or very low bond ratings use short-term debt. In contrast, I find that investment-grade firms issue debt having longer durations than their high-yield counterparts. I also find a direct relationship between bond duration and firm quality as measured by credit ratings. One possible reason for this finding is that high-quality firms are able to pay lower coupons because of their high credit ratings. As a result, their debts have longer durations than debt issued by low-quality firms. Similarly, low-quality firms are forced to issue short-term debt and to pay higher coupons because of their poor credit ratings. As a consequence, their debts have shorter durations than debt issued by their high-quality counterparts.

Conclusions

Much theoretical and empirical research focuses on the determinants of debt maturity. In this chapter, departure is made from earlier studies by examining the duration of debt issues. As an exploratory investigation, this chapter searches for potential linkages between the various theories and empirical findings from the previous literature on debt maturity and bond duration. I examine a sample of 8,627 debt issues from the Thomson Financial SDC Platinum database to identify the important factors in determining the length of duration of public, non-convertible debt. I use Macaulay's Duration as the dependent variable to test theoretical hypotheses where bond duration is influenced by signaling and asymmetric information as well as agency problems.

My study finds no support for the signaling hypothesis, nor does it find support for the theory of a nonmonotonic structure in credit ratings where firms with very high and very low credit ratings have shorter durations, while firms with intermediate credit ratings have longer durations. Instead, I find a direct relationship between bond duration and firm quality as measured by credit ratings. This evidence is in line with Diamond's (1991) hypothesis that risky firms are screened out of the long-term debt market.

For agency problems, the issuing firm's market-to-book ratio is used as a growth measure to test Myers' (1977) theory; however, no support is found in this essay for the hypothesis that high-growth firms have shorter duration. Alternatively, consistent with Carey et al. (1993) and Scherr and Hulburt (2001), I find that larger firms have shorter debt durations than their smaller counterparts. Thus, these findings contradict Myers' (1977) hypothesis that small firms have short-term debt to mitigate agency problems. Inconsistent with Smith (1996) and Barclay and Smith (1995), I find that regulated firms have shorter debt duration, with one exception: non-financial institutions. Once the sample is restricted to non-financial firms, the results indicate that regulated firms tend to issue debt with longer duration than non-regulated firms. Finally, strong evidence is found to support the hypothesis that syndicated public debt offerings, like syndicated bank loans, have longer duration than their non-syndicated counterparts.

In this essay (Chapter 4), I investigate whether any systematic characteristics lead firms to determine duration choices. Although this essay supports some work and raises questions with respect to other work, questions remain concerning the duration choice of debt issued by U.S. corporations. For example, why is duration a better measurement of a firm's interest-rate risk than maturity? Additional research on comparing both approaches may also contribute to understanding of the results presented here.

CHAPTER 5

CONCLUSIONS

This dissertation is a collection of three research essays examining (1) bank lending and interest-rate derivatives [Chapter 2], (2) use of interest-rate derivatives and bank holding company interest-rate risk [Chapter 3], and (3) duration of corporate debt issues [Chapter 4].

The first essay of this dissertation (Chapter 2) documents a positive relationship between derivative usage by U.S. banks and growth in their commercial and industrial loan portfolios. More specifically, it is found that the aggregate use of derivative instruments, in particular interest-rate options, interest-rate forwards, and interest-rate futures, is associated with higher growth rates in C&I loans. These findings are consistent with the results of earlier studies by Brewer, Minton, and Moser (2000) who examine the relationship between lending and derivative usage for a sample of FDIC-insured commercial banks between 1985 and 1992. This documented positive association is consistent with Diamond's (1984) hypothesis that derivative contracting and lending are complementary activities. Diamond's model predicts that banks can reduce the cost of delegated monitoring by holding a diversified portfolio. Engaging in derivative activities helps banks reduce the cost of monitoring contracts issued to their loan customers, thereby enabling banks to increase their lending activities without increasing the total risk level faced by the banks.

The major finding of the second essay (Chapter 3) is that stock returns of a bank holding company using derivatives are less sensitive to interest-rate changes, controlling for balance sheet composition and asset size. This finding is consistent with the results of an earlier study by Schrand (1997) who studies a sample of publicly traded savings and loan associations (S&Ls) from 1984 to 1988. In addition, the findings in this essay are statistically and economically significant. In fact, the sample results suggest that a bank holding company, on average, would have to use $209.37 million of capital each year to shift the interest-rate beta down by 35 basis points if it did not use interest-rate derivatives to hedge against interest-rate risk. This result is consistent with Diamond's (1984) prediction that a bank can successfully use interest-rate derivatives to hedge against interest-rate risk. Furthermore, the sample results in this essay (Chapter 3) also suggest that restrictive policies for banks' derivative activities may have negative consequences in innovation promotion and more effective bank risk management. The possibility that the use of interest-rate derivative instruments is associated with lower bank holding companies' stock return interest-rate sensitivity implies that restrictions on bank participation in financial derivatives could prevent banks from managing interest-rate risk more effectively.

Much theoretical and empirical research focuses on the determinants of debt maturity. In the third essay (Chapter 4), departure is made from earlier studies by examining the duration of debt issues. A sample of 8,627 debt issues from the Thomson Financial SDC Platinum database is examined to identify the important factors in determining the length of duration of public, non-convertible debt. Macaulay's Duration is used as the dependent variable to test the theoretical hypotheses that bond duration is influenced by signaling and asymmetric information as well as agency problems.

The major finding of the third essay (Chapter 4) in this dissertation is that firm quality, as measured by credit rating, is directly related to bond duration. Evidence suggesting that bond duration is inversely related to firm size is also found. In addition, this essay also finds that regulated non-financial firms have longer bond durations and that syndicated offerings have longer durations than non-syndicated offerings.

Although the third essay (Chapter 4) supports some work and raises questions with respect to other work, questions still remain regarding the duration choice of debt issued by U.S. corporations. For example, why is duration a better measurement of a firm's interest-rate risk than maturity? Additional research comparing both measures may contribute to further understanding of the results presented here.

APPENDIX A

FIRST-STAGE ESTIMATION OF THE PROBABILITY OF DERIVATIVE USAGE

First-stage Estimation of Probability of Derivative Usage [a, b]

Variable	Mean Estimates	Standard Error
INTERCEPT	-5.4338	0.30143
OPPRF	-6.6702	3.7844
CARATIO	1.4606	0.2315
LNTOTASST	0.2958	0.0446
LAGDEPENDENT	3.4807	0.1187
OBSERVATIONS	232096	232096
PSEUDO R-SQUARE	0.2227	

[a] The probit specification is estimated for each quarter for 36 quarters from 1996 Q1 through 2004 Q4. The mean estimates and the standard error are the mean and the standard error of 36 coefficient estimates.

[b] The dependent variable for the first-stage regression is the probability of derivative usage. OPPRF is the sample banks' net interest margin. CARATIO is the sample banks' capital-to-asset ratio. LNTOTASST is the logarithm of the sample banks' total assets, and LAGDEPENDENT is the first lag of the dependent variable.

APPENDIX B

COEFFICIENT ESTIMATES ON THE TIME-INDICATOR VARIABLE FOR EACH REGRESSION OVER THE PERIOD FROM MARCH 1996 THROUGH DECEMBER 2004

Coefficient Estimates on the Time-indicator Variable for Each Regression over the Period from March 1996 through December 2004.

Independent Variables	Regression (1)	Regression (2)	Regression (3)	Regression (4)
Intercept	-0.00521	-0.0054	-0.0054	-0.0055
	(-3.95) ***	(-1.72) *	(-1.73) *	(-1.49)
D2 (1996Q3)	-0.0075	-0.0023	-0.0023	0.0027
	(-5.67) ***	(-2.73) ***	(-2.74) ***	(1.91) **
D3 (1996Q4)	-0.0048	0.0004	0.0004	0.0016
	(-3.60) ***	(0.27)	(0.28)	(3.85) ***
D4 (1997Q1)	-0.0059	-0.0007	-0.0007	0.0022
	(-4.47) ***	(-0.87)	(-0.87)	(4.60) ***
D5 (1997Q2)	-0.0054	-0.0002	-0.0002	-0.0002
	(-4.05) ***	(-0.24)	(-0.24)	(-0.38)
D6 (1997Q3)	-0.0079	-0.0027	-0.0027	0.0014
	(-5.90) ***	(-2.84) ***	(-2.84) ***	(2.99) ***
D7 (1997Q4)	-0.0063	-0.001	-0.0011	0.0071
	(-4.64) ***	(-1.24)	(-1.26)	(1.18)
D8 (1998Q1)	-0.0004	0.0048	0.0048	0.0013
	(-0.27)	(0.80)	(0.80)	(3.15) ***
D9 (1998Q2)	-0.0064	-0.0012	-0.0012	-0.0006
	(-4.72) ***	(-1.43)	(-1.43)	(-1.37)
D10 (1998Q3)	-0.0084	-0.0032	-0.0032	0.0012
	(-6.18) ***	(-3.62) ***	(-3.63) ***	(2.30) **
D11 (1998Q4)	-0.0084	-0.0011	-0.0011	0.0013
	(-6.18) ***	(-1.26)	(-1.27)	(3.04) ***
D12 (1999Q1)	-0.0063	-0.001	-0.001	0.0020
	(-4.58) ***	(-1.13)	(-1.13)	(2.47) **
D13 (1999Q2)	-0.0062	-0.0005	-0.0006	0.0004
	(-4.55) ***	(-0.51)	(-0.55)	(0.49)
D14 (1999Q3)	-0.0051	-0.0021	-0.0021	0.0028
	(-1.50)	(-1.86) *	(-1.86) *	(4.25) ***
D15 (1999Q4)	-0.0067	0.0007	0.0007	0.0057
	(-1.94) *	(0.70)	(0.62)	(4.12) ***
D16 (2000Q1)	-0.0039	0.0033	0.0032	0.0026
	(-1.14)	(2.07) **	(2.03) **	(6.15) ***
D17 (2000Q2)	-0.0014	0.0002	0.0003	0.0004
	(-0.41)	(0.32)	(0.33)	(0.98)
D18 (2000Q3)	-0.0049	-0.0014	-0.0014	0.0059
	(-3.61) ***	(-1.51)	(-1.51)	(1.54)
D19 (2000Q4)	-0.0067	0.0035	0.0035	0.0010
	(-4.81) ***	(0.90)	(0.90)	(1.50)
D20 (2001Q1)	-0.0017	-0.0011	-0.0011	0.0016
	(-1.25)	(-1.06)	(-1.04)	(2.54) **
D21 (2001Q2)	-0.0063	-0.0009	-0.0009	-0.0012
	(-4.52) ***	(-1.05)	(-1.05)	(-2.07) **
D22 (2001Q3)	-0.0062	-0.0039	-0.0038	-0.0001
	(-4.84) ***	(-4.07) ***	(-4.07) ***	(-0.15)
D23 (2001Q4)	-0.0091	-0.0024	-0.0024	0.0006
	(-7.14) ***	(-2.29)	(-2.29) **	(0.49)
D24 (2002Q1)	-0.0077	-0.0017	-0.0017	0.0007
	(-5.95) ***	(-1.14)	(-1.13)	(1.28)
D25 (2002Q2)	-0.0069	-0.0019	-0.0019	-0.0014
	(-5.35) ***	(-2.16) **	(-2.15) **	(-2.37) **
D26 (2002Q3)	-0.0072	-0.0040	-0.0040	-0.0002
	(-5.59) ***	(-4.35) ***	(-4.34) ***	(-0.04)
D27 (2002Q4)	-0.0093	-0.0026	-0.0026	0.0003
	(-7.18) ***	(-2.75) **	(-2.73) **	(0.54)
D28 (2003Q1)	-0.0079	-0.0022	-0.0022	-0.0007
	(-6.07) ***	(-2.10) **	(-2.07) **	(-1.35)
D29 (2003Q2)	-0.0074	-0.0032	-0.0032	-0.0022
	(-5.66) ***	(-3.57) ***	(-3.55) ***	(-3.78) ***
D30 (2003Q3)	-0.0085	-0.0048	-0.0048	0.0001
	(-6.53) ***	(-5.27) ***	(-5.24) ***	(0.19)
D31 (2003Q4)	-0.010	-0.0023	-0.0023	0.0004
	(-7.74) ***	(-2.47) **	(-2.44) ***	(0.55)
D32 (2004Q1)	-0.0076	-0.0022	-0.0021	0.0002
	(-5.78) ***	(-2.14) **	(-2.11) ***	(0.35)
D33 (2004Q2)	-0.0074	-0.0022	-0.0022	-0.0008
	(-5.60) ***	(-2.31) **	(-2.28) ***	(-1.48)
D34 (2004Q3)	-0.0074	-0.0034	-0.0034	0.0001
	(-5.64) ***	(-3.83) ***	(-3.79) ***	(0.23)
D35 (2004Q4)	-0.0086	-0.0024	-0.0024	(0.079)
	(-6.58) ***	(-2.53) **	(-2.49) **	(2.16) **

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