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Interest-rate derivatives and bank lending

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Abstract

We study the relationship between bank participation in derivatives contracting and bank lending for the period 30 June 1985 through the end of 1992. Since 1985 commercial banks have become active participants in the interest-rate derivative products markets as end-users, or intermediaries, or both. Over much of this period significant changes were made in the composition of bank portfolios. We find that banks using interest-rate derivatives experience greater growth in their commercial and industrial (C&I) loan portfolios than banks that do not use these financial instruments. This result is consistent with the model of Diamond (Review of Economic Studies 51, 1984, 393–414) which predicts that intermediaries' use of derivatives enables increased reliance on their comparative advantage as delegated monitors. © 2000 Elsevier Science B.V. All rights reserved.

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During the 1980s and 1990s, interest-rate derivatives gave banks opportunities to manage their interest-rate exposure and to generate revenue beyond that available from traditional bank operations. As a result, banks have

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accumulated large positions in these off-balance sheet assets. While banks have become more active participants in the derivative products markets, their role as credit providers has diminished. Previous research on credit accessibility has focused on determining the effects of a bank financial conditions or capital requirements on the provision of credit. [1] By contrast, despite large bank-held positions, there is limited empirical research on the implications of derivatives for intermediation. This paper adds to this research by examining the effects of the use of interest-rate derivative products on the commercial and industrial (C&I) lending activity of US commercial banks.

Our sample represents all FDIC-insured commercial banks with total assets greater than US$300 million as of 30 June 1985 that have a portfolio of C&I loans. Using this sample, we extend extant models of C&I loan growth to include a measure of a bank's use of interest-rate derivatives and find that C&I loan growth is positively related to the use of interest-rate derivatives from 30 June 1985 to 31 December 1992. These results suggest that interest-rate derivatives allow commercial banks to lessen their systematic exposures to changes in interest rates, thereby increasing their ability to provide more intermediation services.

Additionally, we find that this positive association holds for both swaps and futures contracts, suggesting that either form of contract permits management of systematic risk and that the observed demand for the customization features of swap contracts may address concerns beyond management of systematic risk. Consistent with previous banking research, we find that C&I loan growth is positively related to capital ratios and negatively related to total assets.

The positive relation between derivatives use and C&I loan growth is consistent with the notion that derivatives markets allow banks to increase lending activities at a greater rate than they would have otherwise. However, it also is possible that a bank's C&I activity might affect its decision to use derivatives. We address the endogeneity between bank lending and derivatives activity in several ways. First, we replace the actual derivatives-use variable with the predicted probability that an institution will use derivatives in a given period. The probit specification for this instrumental variable is based on Kim and Koppenhaver (1992). Our main results remain when we include predicted derivatives use in the C&I loan rather than actual derivatives use.

Second, we estimate our base model of C&I loan growth for two subsamples of banks for which the derivatives and lending decisions are unrelated by construction. The first subsample contains banks that never use derivatives during the sample period. The second subsample contains banks that always

[1] See Sharpe and Acharya (1992), Berger and Udell (1994) and Bernanke and Lown (1991).

use derivatives during the sample period. The coefficients from the subsample of banks that never use derivatives during our sample period are used to predict loan growth for a sample that began using derivatives during our sample period. We find that the base model underpredicts the C&I loan growth of banks choosing to use derivatives. Similarly, coefficients obtained from a sample of banks that always employ derivatives are used to predict loan growth for banks that halted derivatives use during our sample period. For these institutions, the base model overpredicts loan growth of banks choosing to stop using derivatives. Together these results offer further support that interest rate derivatives enable banks to increase the growth rates of their C&I loan portfolios.

Overall, our results suggest that the C&I loan portfolios of banks using derivatives experience greater growth than banks that do not use derivatives. Thus, excessive regulatory constraints on commercial banks' participation in derivative contracting may result in lower lending growth.

The remainder of this paper proceeds as follows. Section 1 describes the sample and data sources. The empirical specification for C&I lending is discussed in Section 2. Section 3 discusses the empirical methodology. Section 4 examines the association between banks' participation in derivatives and growth of credit extensions. Section 5 summarizes our main findings.

1. Sample description and data sources

1.1. Sample description

The sample of banks includes FDIC-insured commercial banks with total assets greater than US$300 million as of 30 June 1985. Of these institutions, we exclude those banks that have no commercial and industrial loans. Our sample begins with 734 banks in June 1985 and ends with 480 in December 1992. A fraction of the bank sample is liquidated before the end of the sample period. These institutions are included in the sample before liquidation and are excluded from the sample for the periods after liquidation. Banks that merge during the sample period are included in the sample. Thus, construction of the sample produces no survival bias. Balance sheet data and information on banks' use of interest-rate derivative instruments are obtained from the *Reports of Condition and Income* filed with the Federal Reserve System.

1.2. Lending activity

Because the accessibility of credit depends importantly on banks' roles as financial intermediaries, loan growth is a meaningful measure of intermediary activity. [2] We use C&I loan growth as a measure of lending activity because it is an important channel for credit flows between the financial and productive sectors of the economy.

Table 1 presents year-end data for bank lending activity for our sample banks for the 1985–1992 period. Data for four subsets of institutions classified by total asset size are also reported in panels B through E. While C&I loans account for a large fraction of loans in banks' portfolios, the average ratio of C&I loans to total assets, declines from about 19.0% at the end of 1985 to 14.2% at the end 1992 for the entire sample. Most of the decline occurs from year-end 1989 to year-end 1992. As panels B through E report, this decline exists across different-sized banks with the largest decline occurring for banks having total assets greater than US$10 billion.

This downward trend in C&I lending, reported in Table 1, depicts an industry trend. Since the mid-1970s, there has been a decline in bank-intermediated credits. From year-end 1974 to year-end 1992, the proportion of C&I loans in bank portfolios also decreased from 21% to 16% of total bank assets. Concurrently, banks' share of short-term business credit declined substantially from 79% to 54%. [3] This significant decline in the banking share of total US short-term nonfinancial business-credit outstanding reflects increased competition for short-term business credit from nonbank credit suppliers such as finance companies. Further, rapid growth in the markets for commercial paper and other forms of "nonintermediated" debt during the 1980s and 1990s allowed many firms to bypass banks and sell debt securities directly in the open market. [4]

1.3. Interest-rate derivative products

During the period in which banks were becoming less important in the market for short and medium-term business credit, they were becoming increasingly active in markets for interest-rate derivative instruments as end-users, as intermediaries, or as both. We examine two main categories of interest-rate derivative instruments: swaps and the aggregate of positions in futures and forward contracts.

Forward and futures contracts create an obligation to exchange a stated quantity of an asset on a specified date at a predetermined rate or price. Unlike forward contracts, futures contracts involve third parties that specify contract terms designed to mitigate counterparty credit exposures. For example, unlike

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[2] See Kashyap et al. (1991), Sharpe and Acharya (1992) and Bernanke and Lown (1991).

[3] Data was obtained from various issues of the Federal Reserve Bulletin and refer to the last Wednesday-of-the-month series for all commercial banks in the US.

[4] See Laderman (1991) and Rosengren (1990).

Table 1
Lending activity for FDIC-insured commercial banks with total assets greater than US$300 million as of 30 June 1985. Year-end, 1985–1992

	1985	1986	1987	1988	1989	1990	1991	1992
Panel A: All banks								
Avg. total assets	2711.1	3023.6	3264.2	3566.2	3893.4	4225.8	4480.9	4872.5
Avg. C&I loans/total assets	0.1896	0.1868	0.1826	0.1829	0.1779	0.1704	0.1529	0.1424
No. of obs.	727	694	652	611	586	550	518	480
Panel B: Total assets < US$500 million								
Avg. total assets	394.42	401.02	402.52	407.13	412.16	407.30	408.39	405.36
Avg. C&I loans/total assets	0.1760	0.1676	0.1541	0.1574	0.1405	0.1464	0.1432	0.1335
No. of obs.	234	183	143	117	85	63	55	45
Panel C: US$500 million ⩽ Total assets < US$1 billion								
Avg. total assets	694.82	691.84	696.55	708.31	703.73	709.38	720.72	731.73
Avg. C&I loans/total assets	0.1887	0.1829	0.1745	0.1698	0.1675	0.1514	0.1397	0.1294
No. of obs.	192	195	187	169	168	161	153	131
Panel D: US$1 billion ⩽ Total assets < US$10 billion								
Avg. total assets	2910.98	2974.33	2986.22	3145.21	3222.03	3283.19	3379.99	3287.55
Avg. C&I loans/total assets	0.1940	0.1934	0.1934	0.1924	0.1864	0.1767	0.1518	0.1406
No. of obs.	274	284	287	288	293	281	264	255
Panel E: Total Assets ⩾ US$10 billion								
Avg. total assets	35116.41	32668.65	30954.24	29885.59	29606.74	28039.12	28174.64	28781.23
Avg. C&I loans/total assets	0.2687	0.2618	0.2546	0.2494	0.2393	0.2328	0.2148	0.1956
No. of obs.	27	32	35	37	40	45	46	48

forward contracts that are settled at their termination, futures contracts are settled each day. Thus, one can think of a futures contract as a portfolio of daily forward contracts. Despite these differences, the effectiveness of forward and futures contracts for adjusting exposures to market risk is very similar. Consequently, bank reporting practices aggregate disclosures of these contracts. Following these reporting practices, we treat forward and futures contracts as equivalent.

Interest-rate futures and forward markets experienced substantial growth from 1987 to 1991. The total face value of open interest in interest-rate futures reached US$2.16 trillion, on a worldwide basis, at the end of 1991, nearly 483% higher than that at year-end 1987. [5] Within the US, the total face value of open interest in futures contracts was US$1.7 trillion for short-term interest-rate futures contracts and US$54 billion for long-term interest-rate contracts by year-end 1991. For open futures positions, US banks reporting to the Commodity Futures Trading Commission (CFTC) were most actively involved in short-term interest-rate futures contracts. Our sample of bank-reported positions accounts for 15% and 11%, respectively, of the long and short positions taken by all banks in short-term interest-rate futures contracts (BIS/Promisel, 1992).

Beyond interest-rate forwards and futures, banks also report their use of interest-rate swaps. In its simplest form, an interest-rate swap is an agreement between two parties obligating each to make payments based on the net of two interest rates at predetermined settlement dates. One interest-payment stream is fixed, and the other is based on a floating-rate index such as the six-month London Interbank Offer Rate (LIBOR). Interest rate payments are based on the same principal amount that is itself never exchanged, and therefore, is called the notional principal amount.

Since the introduction of swaps in the mid-1980s, activity has increased dramatically. At the end of our sample period, the aggregate notional value of outstanding US interest-rate swaps was US$1.76 trillion, about 225% higher than the amount in 1987 (International Swaps and Derivatives Association, ISDA). Of those outstanding swaps, 56% had maturities between one and three years. In contrast, only 10% had maturities of ten years or more.

Table 2 presents the notional principal amounts outstanding and frequency of use of interest-rate derivatives by banks from year-end 1985 to year-end 1992. As in Table 1, data are reported for the entire sample of banks and for four subsets of banks sorted by total asset size.

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[5] Interest-rate forward contracts are commonly referred to as forward rate agreements. Because these contracts are traded in the OTC markets, data on the growth of the market is not readily available.

As evidenced by the growth of the derivatives markets, banks increased their participation in the interest-rate derivatives market over the sample period. This increased use of interest-rate derivatives and the concurrent downward trend in lending activity reported in Table 1 suggest that derivatives use might be substituting for lending activity. We consider this hypothesis in the empirical analysis reported in Section 4.

Despite the growth in the frequency of use of both types of financial instruments, certain patterns emerge. First, during most of the sample period, the fraction of banks using interest-rate swaps is greater than the percentage using interest-rate futures and forwards. At the end of 1985, 23.8% and 16.8% of banks report using interest-rate swaps and futures-forwards, respectively. By the end of 1992, the percentage using swaps nearly doubled to 44.6 and the percentage using futures rose to 20.6%. Except banks with total assets exceeding US$10 billion, most categories of banks show a similar pattern. More than 90% of banks with total assets exceeding US$10 billion report using both types of financial instruments throughout the sample period. Swap dealers are included in this group of banks. These dealers often use interest-rate futures-forward contracts to manage the net or residual interest-rate risk of their overall swap portfolios. [6]

Second, while the percentage of banks participating in the over-the-counter swap market increases over the sample period, the proportion of banks using interest-rate futures and forward contracts falls. This decline is most notable between year-end 1989 and year-end 1990. Finally, except banks with total assets greater than US$10 billion, less than 25% of the banks report having open positions in both interest-rate swaps and interest-rate futures and forwards.

2. A specification for intermediation

The association between banks' intermediation and their use of derivatives can be measured by examining the relationship between the growth in bank C&I loans and banks' involvement in interest-rate derivative markets. The first step in this analysis is the development of a testable specification for bank lending. Following Sharpe and Acharya (1992), we relate the change in C&I loans relative to the previous period total assets ($\mathrm{CILGA}_{j,t}$) to a set of variables representing supply and demand factors ($\boldsymbol{x}_{j,t-1}$) for bank j during period $t-1$ through t. To allow for the impact of banks' use of derivative instruments on

[6] See Group of Thirty (1993) for a discussion of the evolving role of financial institutions as dealers in the swap market.

Table 2
The use of interest-rate swaps and interest-rate futures by FDIC-insured commercial banks with total assets greater than US$300 million as of June 30, 1985. Year-end, 1985–1992

	1985	1986	1987	1988	1989	1990	1991	1992
Panel A: All banks								
Users of swaps (%)	23.73	30.50	32.21	35.19	37.37	43.46	45.73	44.58
Avg. ratio to total assets[a]	0.0482	0.0631	0.0994	0.1297	0.1793	0.2014	0.2210	0.2565
Users of futures/forwards (%)	16.74	19.14	19.48	19.97	22.53	20.00	19.11	20.63
Avg. ratio to total assets[b]	0.0484	0.0536	0.0619	0.0920	0.1025	0.1924	0.3259	0.3059
Users of both swaps and futures/forwards (%)	11.39	14.10	14.72	15.39	16.89	16.36	16.22	17.29
No. of obs.	727	694	652	611	586	550	518	480
Panel B: Total assets < US$500 million								
Users of swaps (%)	5.93	7.07	7.69	8.55	7.06	11.11	21.82	17.39
Avg. ratio to total assets[a]	0.0148	0.0199	0.0211	0.0372	0.0710	0.0531	0.0731	0.1048
Users of futures (%)	2.54	1.63	2.80	0.00	1.18	0.00	0.00	0.00
Avg. ratio to total assets[a]	0.0254	0.0445	0.0430	0.00	0.0158	0.00	0.00	0.00
Users of both swaps and futures (%)	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	234	183	143	117	85	63	55	46
Panel C: US$500 million ⩽ Total assets < US$1 billion								
Users of swaps (%)	9.90	16.41	14.97	17.16	13.69	22.36	23.53	23.66
Avg. ratio to total assets[a]	0.0390	0.0355	0.0257	0.0477	0.0549	0.0524	0.0779	0.1152
Users of futures (%)	4.69	8.21	4.28	5.32	7.14	4.35	3.27	3.82
Avg. ratio to total assets[b]	0.0447	0.0120	0.0363	0.0194	0.0221	0.0242	0.0151	0.0457
Users of both swaps and futures (%)	0.52	3.08	2.67	1.78	1.19	1.24	1.31	0.76
No. of obs.	192	195	187	169	168	161	153	131
Panel D: US$1 billion ⩽ Total assets ⩽ US$10 billion								
Users of swaps (%)	41.24	47.89	47.39	48.26	51.20	54.09	54.55	50.20
Avg. ratio to total assets[a]	0.0364	0.0403	0.0509	0.0607	0.0801	0.0950	0.1216	0.1406
Users of futures (%)	29.56	29.93	28.57	27.43	29.01	22.78	21.97	20.78
Avg. ratio to total assets[b]	0.0460	0.0445	0.0343	0.0382	0.0468	0.0571	0.1214	0.0844

Users of both swaps and futures (%)	20.07	22.54	20.21	19.79	21.50	17.79	17.42	16.08
No. of obs.	274	284	287	288	293	281	264	255
Panel E: Total assets ⩾ US$10 billion								
Users of swaps (%)	100.00	96.88	100.00	100.00	100.00	97.78	97.83	97.92
Avg. ratio to total assets[a]	0.1215	0.2094	0.3714	0.4781	0.6392	0.7146	0.6933	0.6913
Users of futures (%)	96.30	90.63	94.29	91.89	85.00	86.67	78.26	85.42
Avg. ratio to total assets[a]	0.0623	0.1042	0.1389	0.2361	0.2728	0.4448	0.6985	0.6238
Users of both swaps and futures (%)	96.30	87.50	94.29	91.89	85.00	84.44	78.26	85.42
No. of obs.	27	32	35	37	40	45	46	48

[a] Average ratio to total assets equals the ratio of the notional principal amount of outstanding swaps to total assets for banks reporting the use of swaps.
[b] Average ratio to total assets equals the ratio of the principal amount of outstanding futures to total assets for banks reporting the use of futures or forwards.

loan growth, we also include various measures of participation in interest-rate derivative markets ($\mathrm{DERIV}_{j,t}$) in the following regression specification:

$$\mathrm{CILGA}_{j,t} = \frac{\mathrm{CIL}_{j,t} - \mathrm{CIL}_{j,t-1}}{A_{j,t-1}} = f(\mathrm{DERIV}_{j,t}, \boldsymbol{x}_{j,t-1}), \tag{1}$$

where $\mathrm{CIL}_{j,t}$ and $\mathrm{CIL}_{j,t-1}$ are the C&I loans outstanding for bank j in period t and $t-1$, respectively; $A_{j,t-1}$ is the book value of total assets for bank j in period $t-1$.

2.1. Traditional supply and demand factors

The literature on the determinants of bank lending suggests several possible supply and demand factors ($\boldsymbol{x}_{j,t-1}$). Sharpe and Acharya (1992) and Bernanke and Lown (1992), among others, suggest that capital requirements influence the growth of bank-loan portfolios. A bank with too little capital relative to required amounts could attempt to improve its capital position by reducing its assets. One way a bank can do this is by decreasing its investments in C&I loans. This strategy is preferred to equity issues when issuing equity is costly. Thus, banks with weak capital positions are less able to increase their loan portfolios while fulfilling their regulatory capital requirements. In contrast, banks with stronger capital positions have greater capacity to expand loans and still meet regulatory requirements.

We include a measure of banks' capital–asset ratios (CARATIO) in the empirical specification for C&I loan growth to control for the effect of capital requirements on C&I lending activity. CARATIO is measured as the ratio of total equity capital to total assets at time $t-1$. If banks with low capital–asset ratios adjust their lending to meet some predetermined target capital-to-asset ratio, we would expect a positive relationship between CARATIO and C&I loan growth.

The quality of a bank's loan portfolio is another factor that has been found to affect loan growth. Using C&I loan charge-offs as a proxy for loan quality, Sharpe and Acharya (1992) document that C&I loan quality is negatively related to C&I loan growth. Following Sharpe and Acharya (1992), we measure loan quality as the ratio of C&I loan charge-offs in period $t-1$ to total assets in period $t-1$ (CILCOFA). [7] Besides measuring loan quality, a low charge-off ratio can also be indicative of a stronger economic activity in a bank's geographic region of operations. Finally, the ratio of C&I loan charge-offs to total assets could capture the impact of regulatory pressures on loan growth because

[7] As indicated, the loan charge-off variable comes under regulatory influence. To determine the relevance of this oversight, we also used provisions for loan losses. The results reported here were not affected.

regulators often apply pressure to banks to increase their rates of charge-offs. Loans to developing countries (LDC) and real-estate loans are recent examples. Each of these reasons suggests those banks with lower charge-offs should be viewed as financially stronger than banks with higher charge-offs, *ceteris paribus*. Subsequently, CILCOFA is expected to have a negative association with C&I loan growth.

As pointed out by Bernanke and Lown (1991) and Williams-Stanton (1996), regional economic conditions should influence bank C&I loan growth. Banks in states with weak economic conditions are likely to have fewer profitable opportunities than banks in states with stronger economies. We include the growth rate in state employment ($\mathrm{EMPG}_{j,t-1}$) in the empirical specification as a proxy for local economic conditions, conditions that are not captured by the other explanatory variables. If state employment growth is a proxy for economic conditions, one would expect a positive relation between this variable and C&I loan growth, *ceteris paribus*.

2.2. Measures of derivatives activities

To learn the effect of derivatives on bank lending activity, our specification includes DERIV as a variable measuring bank participation in derivatives (the construction of this variable is discussed in Section 3). [8] The coefficient on DERIV summarizes the impact of derivatives activity conditional on adequately incorporating the intermediating process in the remaining terms of the specification. Inclusion of this variable allows us to investigate whether derivatives activity is complementing or substituting for lending activity. Diamond's (1984) model of the intermediary role of banks, is an example from a class of models that rely on ex ante information problems to motivate loan contracting and explain why derivatives use and lending might be complementary activities. [9] In his model, banks optimally offer debt contracts to "depositors" and accept debt contracts from "entrepreneurs". Banks' intermediating roles stem from their ability to economize the costs of monitoring loan contracts made with entrepreneurs. To reach these economies, depositors must delegate monitoring activities to banks. However, delegation of monitoring results in an incentive problem labeled "delegation costs". These costs can be reduced through diversification, provisional on the independence of

[8] Brewer et al. (1994) use an indicator variable to measure derivatives participation. This approach raises an endogeneity question. In subsequent sections of this paper, we introduce an instrumental-variables approach to address these issues.

[9] For other models suggesting a complementarity between derivatives use and lending activity see Stein (1995) and Calomiris and Wilson (1996).

risks stemming from the contracts made between entrepreneurs and their banks. The presence of systematic risks in these loan contracts implies the usefulness of derivatives as a third form of contracting. Diamond explains that derivative contracts allow banks to reduce the 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, enables banks to intermediate more effectively. Diamond's (1984) model predicts that derivatives activity will be a complement to lending activity. Subsequently, we would expect a positive coefficient estimate on DERIV.

Alternately, the increase in derivatives documented in Table 2 with the decline in lending activity documented in Table 1 suggests that banks might use derivatives as a replacement for their traditional lending activities. Bank revenues from participating in interest-rate derivative markets have two possible sources. One source of revenue comes from banks' use of derivatives as speculative vehicles. Gains from speculating on interest-rate changes would enhance revenues from bank-trading desks. A second source of income is generated when banks act as OTC dealers and charge fees to institutions placing derivative positions. Pursuit of either of these activities as replacements for the traditional lending activities of banks would imply that derivatives will be a substitute for lending activity. If these activities are substitutes, we would expect a negative coefficient on the DERIV variable.

Banks also participate in derivative markets as dealers acting as counterparties to intermediate the hedging requirements of their customers. In this capacity, dealers maintain a portfolio of customized swap contracts and manage the interest-rate risk of this portfolio using interest-rate futures contracts. The liquidity and relative ease with which futures positions may be reversed allows banks to hedge the residual interest-rate risk in their OTC swap portfolios effectively. Banks also may take positions in OTC swaps and exchange-traded futures contracts to exploit arbitrage opportunities between these two markets. To incorporate these dealer dimensions of the derivatives-usage question, we also estimate Eq. (1) using two additional measures in place of DERIV to gauge banks' use of interest-rate derivatives: SWAPS which measures participation in swap contracting and FUTURES that measures participation futures and forward contracting.

From the above discussion, a specification for Eq. (1) can be written as

$$\mathrm{CILGA}_{j,t} = \alpha_0 + \sum_{t=2}^{T} \alpha_t D_t + \beta_1 \mathrm{CARATIO}_{j,t-1} + \beta_2 \mathrm{CILCOFA}_{j,t-1} + \beta_3 \mathrm{EMPG}_{t-1} + \beta_4 \mathrm{DERIV}_{j,t} + \varepsilon_{j,t}. \quad (2)$$

In Eq. (2), D_t is a period indicator variable equal to unity for period t and zero otherwise; $\varepsilon_{j,t}$ is an error term; other variables are as previously defined.

Table 3
Summary statistics for 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	0.0017	0.0227	18158
Supply and demand factors ($\boldsymbol{x}_{j,t-1}$)				
Capital to asset ratio	CARATIO	0.0663	0.0214	18419
C&I loan chargeoffs over assets	CILCOFA	0.0017	0.0037	18,278
Employment growth	EMPG	0.0045	0.0172	18,418
Log total assets	LOG_A	14.1384	1.1557	18,159
Additional supply and demand factors used in robustness tests				
Lagged CILGA	(defined above)			
Unused credit lines to total assets	UNLC	0.1697	0.1968	18136
Classification variables				
Book value swaps zero (0-YES, 1-NO)	SWAPS	0.34	0.47	19635
Book value futures zero (0-YES, 1-NO)	FUTURES	0.20	0.40	19635
Derivatives dealer (0-NO,1-YES)	DEALER	0.04	0.20	19635
Foreign bank (0-NO,1-YES)	FOR	0.02	0.14	19635

[a] Means and standard deviations for all variables used in the empirical analyses. The statistics are computed over the period from June 1985 to December 1992.

Table 3 reports summary statistics for the variables used in the estimation of Eq. (2) plus the variables used in the robustness tests of Section 3. The mean of quarter-to-quarter changes in C&I loans scaled by values of beginning-of-quarter total assets is 0.17% over the full sample period. During this period, the average capital to asset ratio is 6.63%. Consistent with the data presented in Table 2, 34% of our sample banks reported using interest-rate swaps during the sample period. In contrast, 20% reported using interest-rate futures or forward contracts. Finally, OTC dealers and subsidiaries of foreign banks only comprise four and two percent, respectively, of the sample bank observations.

3. Empirical methods

If the decision to participate in derivatives is exogenous to the lending choices made by banks, an indicator variable for derivatives use during each period adequately captures participation in derivatives. However, the derivative-use decision to use derivatives may be made jointly with the C&I lending decision. Consequently, the specification of the DERIV variable requires attention.

A Hausman specification test was conducted to examine this exogeneity issue. [10] The test compares the coefficient and its standard error on the indicator variable measuring derivatives use with the coefficient and standard error on an instrumental variable for derivatives use. As stated in the introduction, this instrumental variable is obtained from a probit specification based on Kim and Koppenhaver (1992). This probit specification includes the log of bank assets, net-interest margin, a binary variable indicating whether the bank was a derivatives dealer, the capital-to-asset ratio, and the concentration ratio for each bank's primary market area as explanatory variables. Using this specification and Eq. (2) in the Hausman test, the null hypothesis rejects the exogeneity of the indicator variable at the 1% significance level. Consequently, expected derivatives use based on Kim and Koppenhaver (1992) is used as an instrument for derivatives participation (DERIV).

Specifically, at each sample date t, we estimate the above probit specification for the probability that banks use derivatives. [11] The test procedure of Kiefer (1981) was also conducted to detect whether derivatives use at time t is dependent on derivatives use at time $t-1$. The null hypothesis of no dependence is rejected at standard significance levels. To incorporate this dependence over time, the first lag of the dependent variable is included in the probit specification. [12]

As previously mentioned, the use of interest-rate derivative instruments by banks increases during the sample period. To incorporate this dynamic effect, we estimate pooled cross-sectional time series regression equations. However, estimation of Eq. (2) with pooled cross-sectional time series data using OLS is potentially inefficient because of the possibility of firm-specific differences in the error terms and a time-varying error term in the sample. To address this issue, we follow Chamberlain (1982, 1984). Specifically, we treat each period as an equation in a multivariate system. This allows us to transform the problem of estimating a single-equation model involving both cross-sectional and time series dimension into a multivariate regression with cross-sectional data. By using this formulation, we avoid imposing a priori restrictions on the variance-covariance matrix, allowing the serial correlation and heteroskedasticity in the error process to be determined by the data.

In a further effort to deal with potential pooling issues, we also estimate Eq. (2) using cross-sectional regressions at each sample date. Coefficients from

[10] See Greene (1993, pp. 618–619).

[11] Because we estimate this regression for each quarter, we do not report the results of this first-stage regression in a table.

[12] Ideally, we would like a measure of derivatives use that indicates whether additional contracts were undertaken. This data is unavailable. As stated in the text, the notional amounts of derivatives reported is not an accurate measure of derivatives use because of reporting practices which tend to overstate the actual positions held by banks.

the thirty cross-section regressions were averaged. These averages are qualitatively the same as those for the basic model presented in the next section. Further, the means of these coefficients were more than two standard errors from zero suggesting that our pooling procedures do not overstate the significance levels reported here. [13] In the discussion of the empirical results in Section 4 we focus on the pooled cross-sectional time series regressions.

4. Empirical results

4.1. Base model results

We estimate Eq. (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 these pooled cross-sectional time series regressions using quarterly data from September 1985 to December 1992. Regression (1) of Table 4 examines the impact of fundamental supply and demand factors on C&I lending activity. This regression serves as a benchmark for examining the relation between derivatives activity and C&I lending.

Overall, our representation of the intermediation process using traditional supply and demand factors is consistent with the results of prior research. C&I loan growth is significantly and positively related to beginning-of-period capital–asset ratios (CARATIO). This result is consistent with the hypothesis that banks with low capital-asset ratios adjust their loan portfolios in subsequent periods to meet some target CARATIO. Like Sharpe and Acharya (1992), we also find a significant and negative association between C&I loan charge-offs CILCOFA and C&I loan growth. This negative relation is consistent with the charge-off variable capturing the impact of regulatory pressures, a strong economic environment or both. C&I loan growth is statistically and positively related to the previous period's state-employment growth (EMPG). Banks in states with stronger economic conditions, on average, experience greater C&I loan growth. Thus, one may interpret the negative coefficient on CILCOFA as capturing economic conditions (i.e., national) not captured by EMPG or the impact of regulatory pressures. Lastly, though not reported, the sum of coefficients on the time-period indicator variables is negative, consistent with the decrease in lending activity reported in Table 1.

[13] As these results do not differ materially from those reported in Table 4, they are not reported here. They are available on request.

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	(1)	(2)	(3)	(4)
CARATIO	0.0524	0.0625	0.0622	0.0608
	(2.19)**	(2.23)**	(2.24)**	(2.15)**
CILCOFA	−0.4420	−0.3810	−0.3793	−0.3744
	(−2.59)***	(−1.64)	(−1.64)	(−1.61)
EMPG	0.0363	0.0285	0.0281	0.0255
	(2.16)**	(1.59)	(1.56)	(1.42)
DERIV		0.0006		0.0007
		(4.04)***		(4.41)***
SWAPS			0.0002	
			(1.99)**	
FUTURES			0.0004	
			(2.52)***	
DEALER				−0.0045
				(−2.39)**
FOREIGN				0.0196
				(1.76)*
LAGGED CILGA				0.0094
				(0.56)
UNLC				0.0015
Observations	18017	14431	14396	14181
Adj. R^2	0.0370	0.0374	0.0373	0.0381

[a] All regression equations contain time period indicator variables. Standard errors are corrected for heteroskedasticity by the method of Chamberlain (1982,1984). Sample period: 1985:Q3 to 1992:Q4. Dependent variable = Quarterly change in C&I loans relative to last period's total assets

[b] Parenthetical t-statistics in parentheses are starred if the regression coefficients are significantly different from zero at the 10 (*), 5(**) and 1 (***) percent level. Variable definitions are the following. CARATIO = (Total Equity Capital$_{t-1}$)/(Total Assets$_{t-1}$). CILCOFA = (C&I Loan Charge-Offs$_{t-1}$)/(Total Assets$_{t-1}$). EMPG = (EMP$_{t-1}$−EMP$_{t-2}$)/EMP$_{t-2}$, where EMP equals total employment in the state in which the bank's headquarters are located. DERIV, FUTURES, and SWAPS are instrumental variables obtained from a probit specification for participation in the indicated derivatives markets. DEALER is one if the institution is listed as an ISDA member, zero otherwise. FOREIGN is unity if the institution is a foreign-owned institution, zero otherwise. LAGGED CILGA is the first lag of the dependent variable.

4.2. Inclusion of the derivatives-participation variables

Regressions (2) and (3) include different measures of derivatives activity. Regression (2) adds our instrumental variable for participation in any type of interest-rate derivative contract (DERIV). Regression (3) decomposes the DERIV variable into instruments for use of interest-rate swaps (SWAPS) and futures (FUTURES) representing the use of interest-rate futures and forwards. These instruments are estimated using the probit specification discussed in the previous section.

Comparing our derivatives-augmented regressions with the results for the base case, the coefficient estimates on CARATIO, CILCOFA, and EMPG are qualitatively similar to those in regression (1). However, the coefficients on CILCOFA and EMPG are not significant at usual levels.

Regression (2) of Table 4 says that banks using any type of interest-rate derivative, on average, experience significantly higher growth in their C&I loan portfolios. Given the regression coefficients and mean value of our explanatory variables included in regression (2), quarterly C&I loans are expected to grow by US$3.3 million. [14] To evaluate the impact of derivatives use, we recalculate the expected growth in C&I loans at one standard deviation above the mean of the predicted value for derivatives. After making this adjustment, quarterly C&I loan growth is expected to be US$4.5 million, 37.5% larger than at the average level of derivative use.

This positive relation between derivatives use and C&I loan growth is consistent with Diamond's (1984) model of financial intermediation. In that model, interest-rate derivatives allow commercial banks to lessen their systematic exposures to changes in interest rates and by that increase their ability to provide more C&I loans. Further, given this positive coefficient estimate, one may conclude that, on net, derivatives use complements the C&I lending activities of banks. That is, the derivatives-use complementarities with lending dominate the extent to which derivatives activity substitutes for bank lending.

As previously stated, regression (3) decomposes the derivatives activity variable into participation in swaps (SWAPS) and futures-forward contracts (FUTURES) to examine the relative contributions of each type of derivatives activity in explaining C&I loan growth. The coefficient estimates on both SWAPS and FUTURES variables differ significantly from zero. These results suggest that use of both types of derivatives is associated with higher C&I loan growth.

Similar to our interpretation of regression (2), we evaluate the impact of derivatives use on quarterly C&I loan growth and relate this impact to average C&I loan growth. Evaluating the right-hand side variables, which are included in column 3, at their respective means, the quarterly change in C&I loans is predicted to be US$3.9 million. Re-evaluating both SWAPS and FUTURES at one standard deviation above their means, quarterly C&I loan growth is predicted to be US$4.7 million, which is 21.5% larger than at the average level of derivative use.

[14] In this and for the instances that follow, expected values of the dependent variable are calculated by multiplying the coefficients of the non-seasonal variables by their respective means. Multiplying this value by the mean of total assets gives average one-quarter C&I loan growth. Recall that the derivative-use variable is from a probit, so this variable is the mean of the standard-normal z values from those obtained from the quarterly probit regressions.

As a further check on the validity of our results, regression (4) considers the possibility of a spurious relation between C&I loan growth and derivatives use. We augment the regression (2) specification by adding variables measuring other characteristics of financial institutions that may explain lending activity during the sample period. Adding these variables addresses the concern that spurious correlation between lending activity and participation in interest-rate derivatives might be driven by unobserved correlations between derivatives use and potentially omitted variables.

We include the lagged dependent variable in the regression (LCILGA) to control for the possibility that the derivatives-participation variable is a proxy for growth potential. We also include a control for a foreign-firm effect by including an indicator variable equal to unity if a bank is a subsidiary of a foreign financial institution (FOREIGN). Anecdotal evidence suggests that the operations of foreign-owned banks are intended to facilitate the US operations of foreign industrial firms. Therefore, foreign-owned institutions may be expected to provide both loans and interest-rate derivatives to their customers, thereby inducing a positive coefficient.

Our sample of banks includes dealer institutions. Thus, we include an indicator variable to control for membership in the International Swaps and Derivatives Association (ISDA) to insure that the lending activity of this subsample of banks is not determining our results. DEALER is an indicator variable equal to unity if a bank is identified as swap dealer by the ISDA membership lists or listings published by Intermarket (1988, 1989), and zero otherwise. [15] Observations before 1988 were classified as dealers if the institution was included on the ISDA member list in 1988.

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. Banks committing to fill larger credit lines can be viewed as increasing their off-balance sheet exposures to credit risk. [16] Controls introduced for this possibility offer another means of separating loan growth from risk-taking motivations.

Results from the augmented regression (4) incorporate proxies for these other activities that may lead to a spurious positive association between derivatives activity and loan growth. As Table 4 reports, the coefficient on our instrument for derivatives activity (DERIV) remains positive and statistically significant after we include the controls for potential spurious results. In addition, the coefficient on the foreign-bank variable is positive and moderately significant, suggesting that growth in the C&I lending of foreign-owned banks

[15] Because the ISDA membership list only became available beginning the first quarter of 1987, the estimation covers the 1987:Q1–1992:Q4 sample period.

[16] We are indebted to Ed Kane who suggested inclusion of this off-balance sheet measure for risk taking.

is greater than that for domestically-owned institutions. The coefficient on the dealer variable is negative and significant, which is consistent with the notion that dealer activities substitute for lending activities. [17] Finally, the coefficient estimates on the lagged dependent variable and the ratio of unused lines of credit to total assets UNLC do not significantly differ from zero. [18]

As previously described, the log of total bank assets is included in the probit estimation that estimated the predicted use of derivatives. In this specification the coefficient estimate is positive and statistically significant at less than the 1% significance level. This result is consistent the anecdotal evidence that derivatives activity is primarily the province of large banks. Additionally, in the current specification, our dependent variable is scaled by total assets to control for bank size. However, if this scaling does not adequately control for size and if loan growth rates are greater for large banks then size becomes a source of a spurious relationship.

Thus, we also estimate additional intermediation and instrumental variable specifications that included the logarithm of total assets. In specifications for C&I loan growth where derivatives participation is included as a simple indicator variable, including an asset-size variable decreases the magnitude and significance of the coefficient on derivatives. We also estimate three instrumental-variable specifications for the use of derivatives. When the probit specification includes asset size, the results are similar to those reported in Table 4. Similarly, when the asset-size variable is included only in the C&I loan growth specification (regression 2), the coefficient on derivatives is positive and statistically, significant. However, if the asset size variable is included in both the probit and the intermediation specification, the coefficient on the derivatives-participation variable is negative and significant. We interpret this association as resulting from a strong collinear relation between our instrument for derivatives participation and total assets. Prior evidence suggests that size is related to derivatives use (see, for example, Géczy, et al., 1997, Kim and Koppenhaver, 1992, Tufano, 1996). Support for the position that asset size determines loan growth is less compelling. Further, it is our position that the

[17] In addition to including DEALER in the logit regression reported in Table 4 we perform two additional tests to examine whether dealer banks are driving our results that are presented in Table 4. First, we estimate an augmented logit regression (4) in which we include DERIV, DEALER, and the interaction DEALER and DERIV. The coefficient estimates on DERIV and DEALER are qualitatively similar, but the significance of the coefficient estimate on DERIV falls slightly. The coefficient estimate on the interaction term is negative and insignificant. Second, we exclude all dealer banks from the sample and re-estimated logit regression (4) without the DEALER indicator variable. Our main results remain.

[18] Following a reviewer's suggestion, the sample was split to eliminate the phase-in period for risk-based capital. The augmented (4) specification was estimated for two periods: the third quarter 1985 through year-end 1988 and the eight quarters of 1991 and 1992. In both periods the coefficient on the derivatives variable was positive and significant.

asset-size variable is most appropriately introduced in the probit specification for derivatives participation, and that size and growth are controlled for in the C&I loan specification by scaling C&I loan growth by total asset size and including the lagged dependent variable. [19]

4.3. Further robustness tests

Overall, the results in the previous section suggest that C&I lending activity is positively related to banks' participation in the derivatives market. This section and the Section 4.4 following present alternative routes to separate the risk-taking aspects of loan operations and derivatives activity. This evidence is ancillary in the sense that no single piece establishes the case. It is the consistency of the evidence that adds weight to the previous results.

Absent our incorporation of simultaneity, the coefficients on derivatives activity in the previous section might be explained as risk taking by banks. For example, papers by Gorton and Rosen (1995a) and Stulz (1996), among others, suggest the bank might use derivatives to increase cash flow riskiness. Banks attempting to increase their risk might increase their lending activity and simultaneously use derivatives for purposes other than risk-reducing activities. Such behavior also would induce a positive association between derivative use and C&I loan growth.

If banks are pursuing this risk-taking strategy, expecting a greater number of failures by banks that report using interest-rate derivatives is reasonable. To examine this possibility, we test whether derivatives activity is a good predictor of bank failure.

During our sample period, 55 banks failed or required FDIC assistance to merge with other institutions. This group represents 7.49% of the institutions in the initial period of the sample. Under the null hypothesis that interest-rate derivatives do not influence bank failure, the percentage of derivative-using banks that fail should not exceed this unconditional expectation of the failure rate. However, we find that 6.18% of derivative-using banks fail during the sample, which warrants rejection of the null hypothesis. Moreover, this result implies that the percentage of banks that failed but report never using derivatives exceeds the expected failure rate of 7.49%: a result that strengthens the conclusion that derivatives use by banks is not associated with bank failure.

[19] As a further robustness check of our results, we also control for growth by including total asset growth in the regression specification. The coefficient estimate on asset growth is positive and significant. Our main results for the impact of derivatives on C&I loan growth are qualitatively similar.

To more closely examine the concurrent use of derivatives and bank failure, this experiment is repeated on a calendar year basis. Banks are categorized according to their derivatives use during each calendar year. The percentage of failing banks that use derivatives during that year is compared with the failure rate from the overall sample. In only one year (1992) the number of failed banks that use derivatives exceeds the expected number of failures under the null hypothesis of no effect. The results of these tests imply that interest-rate derivatives use does not predict an increase in the probability of bank failure. As bank failures should be related to their risk-taking activities, we conclude that derivatives are not used to increase bank risk levels during our sample period. [20]

Traditionally, banks have viewed loans and securities as substitutable assets. Consequently, when loan growth strengthens, anecdotal evidence suggests that banks become less willing to hold securities. By, contrast, when loan growth is weak, banks will tend to hold more securities. Additionally, banks can use investments in securities to manage the interest rate risk inherent in their core business (Beatty and Bettinghaus, 1997). Both actions suggest that an indirect effect of the positive impact of interest-rate swaps on loan growth is a negative relationship between the swap participation variable and growth of the security portfolio.

While not reported, we investigate the relation between investment securities and derivatives. Similar to Beatty and Bettinghaus (1997), we find a significant and negative association between banks' use of swaps and the growth in banks' security portfolios during the sample period. Thus, the use of interest-rate swaps is positively associated with C&I loan growth and negatively related with securities holdings. This combination of results also does not support the use of swaps for purposes other than risk management activities. While increases in C&I loans by banks using derivatives are consistent with risk taking activities, simultaneous declines in securities portfolios are not. The reductions in securities portfolios are consistent with banks' reduced needs to adjust the interest-rate sensitivity of their assets through adjustments in the composition of their security portfolio.

Finally, consistent with the results of Gorton and Rosen (1995b), we find that banks are not using derivatives for purposes other than risk management activities. Their paper examines the relation between net income and swap interest-rate sensitivity, finding that banks' losses (gains) on swap positions due

[20] A referee points out that this test does not account for biases introduced because some banks are regarded as being "too large to fail". Repeating the test for each year of our sample compensates for this bias. This compensation works because anecdotal evidence suggests that large banks were not prevented from failing in each year of the sample. Also, Boyd and Runkle (1993) find no evidence of a "too big to fail" policy during the years of our sample.

to interest rate changes are partially offset by gains (losses) in net income from interest rate hedges. This result is consistent with hedging activity by derivatives-using banks.

4.4. Examination of out-of-sample model predictions

In the regressions presented in Table 4, we use instrumental variables to control for the possibility that the lending decision and the decision to use derivatives are endogenous. As an alternative approach to deal with this endogeneity issue, we study the predicted lending behavior of bank subsamples classified by their participation in derivatives.

If banks' participation in derivatives leads to increases in their lending activity, then a predictive model based entirely on the traditional demand and supply determinants of intermediation – the capital ratio, loan charge-offs, economic conditions, and any secular trend – should underpredict the loan growth of banks that choose to use derivatives and overpredict the loan growth of banks that choose not to use derivatives. We classify the sample according to their decisions on the use of derivatives and estimate predicted lending growth for two subsets of sample banks. The "all-in" sample consists of those banks that use either swaps or futures throughout the sample period (3,282 observations). The "all-out" sample consists of those banks that use neither swaps nor futures at any point in the sample (11,653 observations). We estimate the following base model for intermediation for each of these samples:

$$\mathrm{CILGA}_{j,t} = \alpha_0 + \sum_{t=2}^{T} \alpha_t D_t + \beta_1 \mathrm{CARATIO}_{j,t-1} + \beta_2 \mathrm{CILCOFA} + \beta_3 \mathrm{EMPG}_{t-1} + \varepsilon_{j,t}. \quad (3)$$

These two regressions obtain two sets of coefficient estimates, one for the all-in sample and one for the all-out sample. To calibrate predicted loan growth for banks included in the all-in sample, the coefficient estimates from the all-out sample (those that never use derivatives during the sample period) are applied to the sample of all-in variables (those banks that use derivatives during the entire sample period). Average predicted loan growth (standardized by total assets) for the all-in sample is 0.0005. By contrast, average actual lending growth equals 0.0026. A paired-comparison test for the difference between these averages yields a *t*-statistic of 4.72 which suggests a statistically significant underprediction of lending activity by the base model of intermediation.

Similarly, when the all-in coefficient estimates are applied to the sample of the all-out variables, the average predicted loan growth for this latter set of banks is 0.0051, whereas the average actual loan growth for the all-out sample is 0.0012. These averages are statistically different at the one-percent level (t-statistic $= -18.81$). These results again suggest that derivatives participation predicts the extent of lending activity. Moreover, the results of both paired-comparison tests are consistent with the panel regressions of Section 3. If our model of intermediation is correctly specified, each approach suggests that the loan portfolios of banks participating in derivatives have larger quarterly changes in C&I loans than banks not participating in derivatives.

We perform another test to detect the effect of bank-held derivatives on the lending activity of institutions. Two samples are constructed using banks that used derivatives at some point during the sample period but not for the entire period. The first subsample includes institutions that do not use derivatives at the beginning of the sample period and later initiate the use of derivatives. The second subsample consists of banks using derivatives at the beginning of the sample period and at some later quarter stop this activity.

For each set of banks, we estimate cumulative prediction errors in loan growth as the difference between average predicted and average actual loan growth. Specifically, the coefficients from the all-out sample (banks that used neither swaps nor futures) are applied to the fundamental intermediation variables of the institutions that begin using derivatives to calculate their predicted loan growth. Average prediction errors are computed and then sorted by the number of quarters since the institution initiated its use of derivatives. The first quarter the institution uses derivatives during our sample period is event-date 0. On event-date 0, the sample consists of 88 banks. Cumulated average prediction errors are calculated for the 41-quarter window surrounding the first quarter of derivatives use (i.e., from event date −20 through event date +20). Fig. 1 plots these cumulative average predicted errors. Prediction errors are positive throughout the 41 event quarters, suggesting underprediction of lending activity by the base regression. Further, the rise in cumulative average prediction errors occurring at event-date 0 indicates sharp increases in lending activity at and following the first quarter in which derivatives are used.

Similarly, average predicted loan growth is calculated for the banks using derivatives at the beginning of the sample period and, at some point, stopped this activity using the all-in coefficient estimates. In this procedure, event-date 0 is the quarter in which derivatives activity stopped. On event-date 0, the sample consists of 29 banks. The mostly negative cumulative average prediction errors for this group of banks are plotted in Fig. 2. The results imply that banks halting the use of derivatives during the sample period lent at levels below those predicted by the levels of their fundamental intermediation variables. Further, the size of these prediction errors increases in the quarter that derivatives activity ceases and in the following quarters.

To assess the significance of user-to-nonuser or nonuser-to-user changes, the following procedure is adopted. The means of prediction errors for each event date are standardized by the standard deviation for that event date. These standardized quantities are summed for the pre- and post-event periods.

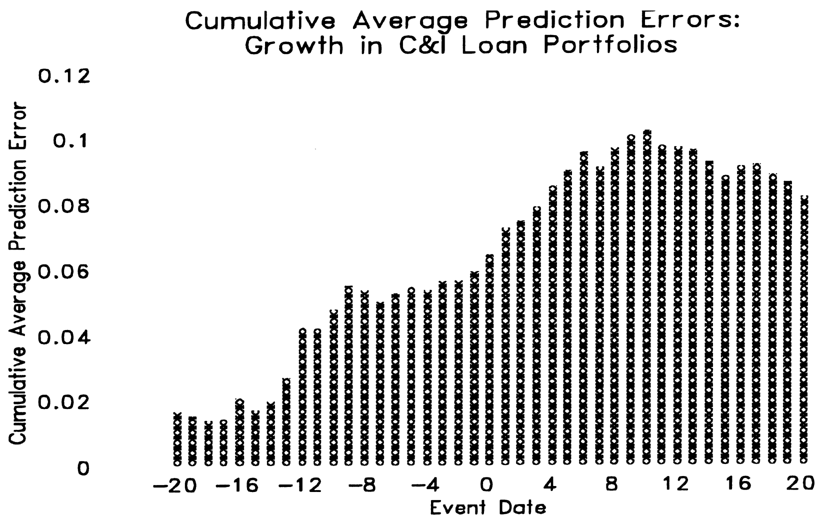

Fig. 1. For banks which began the sample period not using derivatives and later initiated the use of such instruments. Prediction errors equal the differences between actual growth in C&I loans and the growth predicted based on coefficients estimated for banks which did not use derivatives. These differences are averaged across banks and accumulated beginning twenty quarters prior to their adoption of derivatives and for the twenty quarters following. The sample includes 88 banks at event period zero.

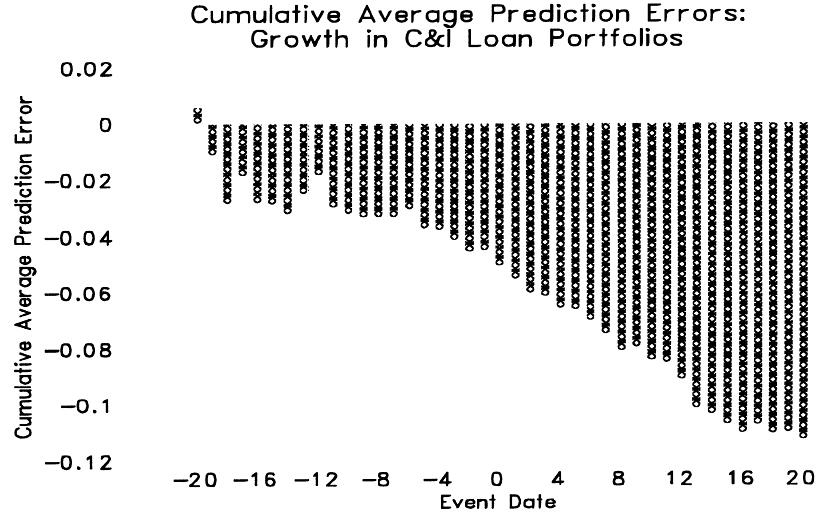

Fig. 2. For banks which began the sample period using derivatives and later stopped using them. Prediction errors equal the difference between actual growth in their C&I loans and the growth predicted based on coefficients estimated for banks which did use derivatives. These differences are averaged across banks and accumulated beginning twenty quarters prior to their cessation of derivatives and for the twenty quarters following. The sample includes 29 banks at event period zero.

Assuming a normal distribution for the prediction errors, the difference between pre- and post-event sums is standard normal. These differences are: 2.02 for the nonuser-to-user sample of 88 institutions, indicating significance at better than the 5% level; and 0.70 for the user-to-nonuser sample of 29 institutions, not significantly different from zero. The results for the nonuser-to-user sample are consistent with the results reported in Table 4 that derivatives use is positively associated with growth in lending activity.

The results in this subsection are consistent with the conclusion that use of derivatives is a predictor of increased lending activity. This, in turn, offers further support to our previous findings of a positive association between growth in lending activity and use of derivatives.

5. Summary and policy implications

Published surveys on the derivatives markets report that banks are using financial derivative instruments to complement their traditional lending activities and to hedge risk-exposure resulting from their lending and deposit taking activities. However, the concerns of regulators are that these derivative instruments substitute for lending, increase the riskiness of banks, and therefore, increase their reliance on federal safety net mechanisms such as deposit insurance and the Federal Reserve System's discount window.

In this paper, we document a positive relation between the use of interest-rate derivative instruments and the growth in commercial and industrial loans. This positive association is consistent with Diamond's (1984) model in a bank can reduce the cost of monitoring contracts issued by their loan customers by holding a diversified portfolio. This model suggests that derivatives lead to a reduction in delegation costs that, in turn, provide incentives for banks to increase their lending activities.

Our results suggest that restrictive policies for banks' derivatives activity have consequences for bank lending activity. The possibility that the use of interest-rate derivative instruments, in particular OTC swaps, is associated with higher growth rates in C&I loans, implies that restrictions on bank participation in financial derivatives could increase the rate of declines in bank lending activity.

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