A simultaneous equations model of commercial and industrial lending

and the use of derivatives by US banks

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JEL Classification: G12, G21

Keywords: Banking, Financial innovation, Derivatives

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1. Introduction

The use of derivatives by banks, and the implications for banks’ risk management practices, represents a major topic for debate among academics and practitioners. Derivative instruments provide banks with the opportunity to hedge their exposure to financial risks including interest rate risk, foreign exchange risk and credit risk. Derivative instruments also provide banks with the opportunity to earn additional income by providing risk management services. Diamond (1984) and Brewer et al. (2000) suggest banks use derivatives to reduce the costs associated with monitoring borrowers. Therefore the use of derivatives is complementary to the banks’ traditional intermediation activities. However, Thobecke (1995) argues that unrestricted growth in the use of derivatives may threaten financial market stability. This argument is based on the view that trading in derivatives is primarily a substitute for traditional lending activities, and an alternative source of income and profit.

Graddy and Kyle (1979) consider the banking firm as a multi-product, multi-factor and profit maximizing economic unit, in which decisions concerning output, pricing and the use of inputs are taken simultaneously. Previous studies of the relationship between bank lending and the use of derivatives have not always considered the simultaneous nature of the decision to use derivatives on the one hand, and decisions concerning the volume of lending on the other hand. In the models developed by Heinecke and Shen (1995) and Shyu and Reichart (2002), the decision to use derivatives is dependent on lending activity, which is assumed to be exogenous. Brewer et al. (2000) estimate a model in
which the scale of lending activity is dependent on whether the bank uses derivatives. The decision to use derivatives is treated as an endogenous variable, but no allowance is made for the possibility of a simultaneous relationship between the volume of lending and the use of derivatives.

In this study, the relationship between derivative usage and lending growth is examined in a two-equation model, which allows for simultaneity between a continuous ‘growth of lending’ dependent variable, and a binary ‘use of derivatives’ dependent variable. The model is estimated using a two-stage probit least squares procedure. The paper is organized as follows. Section 2 discusses the relationship between bank lending activity and the use of derivative instruments. Section 3 describes the specification of the empirical model. Section 4 describes the data sources. Section 5 presents and interprets the empirical results. Finally, Section 6 summarises and concludes.

2. The relationship between bank lending and the use of derivatives

Banking intermediation theory suggests that by accepting deposits from the public and lending to entrepreneurs who require capital, banks play a pivotal role in the allocation of liquidity. Monitoring borrowers, and overcoming the difficulties created by information asymmetry, represents an important aspect of the bank’s specialist function. In recent years, however, banks have undergone a process of disintermediation, due to increasing competition for traditional lending business from other capital market participants. Figure 1 plots data on total assets and C&I lending for all FDIC insured commercial banks in the

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1 Brewer et al. (2000) suggest C&I (commercial and industrial) lending is particularly well suited for this type of investigation, as C&I loans frequently include covenants that produce diversification benefits for the lender.
US for the period 1939-2004. Figure 2 plots the ratios of interest income to total assets, and non-interest income to total assets. The trend towards disintermediation is reflected in Figures 1 and 2 as follows. First, the total assets of US banks have grown faster than their C&I lending since the 1980s. Second, non-interest income has grown faster than interest income over the same period.

While the process of disintermediation has continued in recent years, the use by banks of derivative instruments has increased rapidly. Figure 3 plots the total assets and the notional value of all derivative contracts held by US commercial banks for the period 1991-2004. Deshmukh et al. (1983) suggest interest rate uncertainty encourages banks to reduce their reliance on traditional lending activities, and increase their involvement in the provision of services for which fees can be charged, such as transacting derivatives on behalf of customers. The use of derivatives not only enables banks to earn more income from non-traditional sources, but also enables them to hedge various financial risks, including interest rate risk, foreign exchange risk and credit risk. By hedging, systematic risk, which cannot be managed through a strategy of portfolio diversification, can be reduced or eliminated (Diamond, 1984).

The rapid growth of derivatives markets has generated debate concerning the economic rationale for these instruments, and their costs and benefits. According to Brewer et al. (2000), trading in derivatives might be seen by banks as a substitute for traditional lending activity. Peek and Rosengren (1997) suggest banks with a relatively thin capital base have an incentive to use derivatives for speculative purposes, because of the moral hazard problem associated with deposit insurance. Duffee and Zhou (2001) suggest the
development of the credit derivative market, which temporarily transfers loan risk to outsiders, could promote enhanced risk sharing. However, banks with a mix of high- and low-quality loans may choose to shed the latter using credit derivatives, but retain the former, destroying the pooling equilibrium in the loan-sale market. The overall effect is an increase in the expected deadweight loss associated with bank insolvency. Kiff et al. (2003) suggest that while credit risk transfer instruments help towards more effective risk management, they may also introduce new sources of risk. For example, there is a moral hazard problem if lenders opt not to screen borrowers whose loans can subsequently be transferred as part of a credit derivative transaction.

The empirical literature on the use of derivatives by banks investigates the factors that influence the decision to transact derivatives, and the implications of the use of derivatives for banks’ risk management practices. Bank size, maturity gap, net interest margin and capital structure have been shown to be important determinants of the decision to use derivatives (Kim and Koppenhaver, 1993; Carter and Sinkey, 1998; Brewer et al., 2000; Sinkey and Carter, 2000). Derivatives have been shown to be effective in reducing interest rate risk (Shanker, 1996; Venkatachalam, 1996). According to Schrand and Unal (1998), the use of derivative instruments forms part of a coordinated risk management policy, wherein banks make continuous incremental adjustments to their portfolios of risk-bearing assets, so as to maintain a preferred or optimum total risk level. Heinecke and Shen (1995), Brewer et al. (2000) and Shyu and Reichart (2002) report evidence that the use of derivatives is complementary to C&I lending. Whether or not a bank uses derivatives is one factor (alongside other traditional demand- and supply-side factors) determining the size of its C&I loan portfolio. Jagtiani (1996) suggests
banks are more likely to trade in derivatives in order to generate income when their lending activities are constrained.

3. **A simultaneous equations model for the growth of C&I lending and the use of derivatives**

Traditional lending activity and non-traditional activities including trading in derivatives both have important implications for risk management on the part of banks. Following the discussion in the previous section, it seems reasonable to assume that banks take their risk management decisions simultaneously and in a coordinated manner. Section 3 develops a simultaneous equations model to describe the decisions of US banks concerning growth of lending and the use of derivatives, and identifies the covariates of the growth of lending and the use of derivatives equations.

Possible relationships between the decision concerning the volume of C&I lending and the decision concerning the use of derivatives are now considered. A composite null hypothesis is: first, that growth of C&I lending has no impact on the decision to use derivatives; and second, the outcome of the decision whether to use derivatives has no impact on the growth of C&I lending. There are two possible alternatives. First, banks that use derivative instruments can expand their traditional lending more rapidly because of the increased flexibility in risk management afforded by derivative usage. Second, banks whose traditional lending is expanding more slowly are more likely to consider trading in derivatives as an alternative source of income and profit. In the case that the composite null hypothesis is false, either or both of these alternative hypotheses might be true. If both are true, however, the relationship between the growth of lending and the use
of derivatives is not straightforward. On the one hand, using derivatives may allow a bank to expand its traditional lending more rapidly, suggesting a positive relationship; but on the other hand, substitution between traditional lending and derivative trading may give rise to a negative relationship. The simultaneous equations model that is developed in this section has sufficient flexibility to accommodate both of these aspects of the relationship between the growth of lending and the use of derivatives.

The specification of the simultaneous equations model is as follows:

\[ \text{CIGROW}_{it} = \gamma_1 \text{DER}_{it} + \beta_1' X_{it} + u_{it} \]  \hspace{1cm} (1)

\[ \text{DER}^*_{it} = \gamma_2 \text{CIGROW}_{it} + \beta_2' Y_{it} \]  \hspace{1cm} (2)

where \( \text{CIGROW}_{it} \) is the rate of growth in bank i’s C&I lending between years \( t-1 \) and \( t \); \( \text{DER}^*_{it} \) is a latent (unobserved) variable which determines the probability that bank i uses derivatives in year \( t \); \( X_{it} \) is a vector of covariates for the growth in C&I lending equation; and \( Y_{it} \) is a vector of covariates for the use of derivatives equation. The decision whether or not to use derivatives is modelled as follows:

\[ \text{DER}_{it} = 1 \text{ if } \text{DER}^*_{it} + v_{it} > 0 \text{ and } \text{DER}_{it} = 0 \text{ if } \text{DER}^*_{it} + v_{it} < 0. \]

where \( \text{DER}_{it} = 1 \) if bank i used derivatives in year \( t \) and \( \text{DER}_{it} = 0 \) otherwise. The disturbance terms are \( u_{it} \sim N(0, \sigma_u^2) \) and \( v_{it} \sim N(0,1) \).

Because of the simultaneous nature of the relationship between \( \text{CIGROW}_{it} \) and \( \text{DER}_{it} \), the direct application of standard estimation techniques such as OLS in the case of (1), and probit or logit in the case of (2), would produce biased and inconsistent estimates of the coefficients. The endogeneity of \( \text{CIGROW}_{it} \) and \( \text{DER}_{it} \) results in the violation of the
classical assumption of zero covariance between the covariates and the disturbance terms. If CIGROW_{it} and DER_{it} were both continuous, the endogeneity problem could be circumvented using a simultaneous equations estimation procedure such as two-stage least square (2SLS). In the present case, the binary structure of DER_{it} necessitates the use of an adjusted version of 2SLS, known as two-stage probit least squares (2SPLS) (Maddala, 1983).

The details of 2SPLS are as follows. The first stage of the estimation procedure involves the estimation of the following reduced form model:

\[ \text{CIGROW}_{it} = \pi_1'Z_{it} + \varepsilon_{it} \]  \hspace{1cm} (3)
\[ \text{DER}_{it}^{**} = \pi_2'Z_{it} \]  \hspace{1cm} (4)

where \( Z_{it} \) is a vector containing all of the exogenous variables that appear in either \( X_{it} \) or \( Y_{it} \) or both. \( \text{DER}_{it}^{**} \) is a latent variable, such that \( \text{DER}_{it} = 1 \) if \( \text{DER}_{it}^{**} + \nu_{it} > 0 \) and \( \text{DER}_{it} = 0 \) if \( \text{DER}_{it}^{**} + \nu_{it} < 0 \). The disturbance terms are \( \varepsilon_{it} \sim N(0,\sigma^2_{\varepsilon}) \) and \( \nu_{it} \sim N(0,1) \). (3) can be estimated using OLS and (4) can be estimated using probit.

The second stage of the 2SPLS estimation procedure involves the substitution of the fitted values of the dependent variables from the first-stage estimations of (3) and (4), denoted \( \hat{\text{CIGROW}}_{it} \) and \( \hat{\text{DER}}_{it}^{**} \) respectively, for \( \text{CIGROW}_{it} \) in (2) and \( \text{DER}_{it} \) in (1):

\[ \text{CIGROW}_{it} = \gamma_1 \hat{\text{DER}}_{it}^{**} + \beta_1'X_{it} + u_{it} \]  \hspace{1cm} (5)
\[ \text{DER}_{it}^{**} = \gamma_2 \hat{\text{CIGROW}}_{it} + \beta_2'Y_{it} \]  \hspace{1cm} (6)

where \( \text{DER}_{it} = 1 \) if \( \text{DER}_{it}^{**} + \nu_{it} > 0 \) and \( \text{DER}_{it} = 0 \) if \( \text{DER}_{it}^{**} + \nu_{it} \).
(5) can be estimated using OLS, because $\hat{D\text{ER}}_{it}$ is a linear function of $Z_{it}$ only, and $D\text{ER}_{it}$ is therefore uncorrelated with $u_{it}$. Likewise (6) can be estimated using probit because $\hat{C\text{IGROW}}_{it}$ is a linear function of $Z_{it}$ only, and $C\text{IGROW}_{it}$ is uncorrelated with $v_{it}$. However, adjusted standard errors are required for the estimated coefficients of (5) and (6), because the unadjusted standard errors are based on $D\text{ER}_{it}$ and $C\text{IGROW}_{it}$, and not (as they should be) on $\hat{D\text{ER}}_{it}$ and $\hat{C\text{IGROW}}_{it}$.

Below, three separate versions of this model are reported, for three different definitions of the binary dependent variable. In Model 1, $D\text{ER}_{it} = 1$ if bank i transacted any derivative instruments in year t, and 0 otherwise. In Model 2 $D\text{ER}_{it}$ is replaced by $I\text{RT}_{it}$, defined in the same way in respect of interest rate derivatives only; and in Model 3 $D\text{ER}_{it}$ is replaced by $C\text{DX}_{it}$, defined in the same way with respect to credit derivatives only. Comparisons between the three estimated models should reveal whether there are differences in the patterns of association and variation revealed by the model for different types of derivative instrument.

*Determinants of the growth of C&I lending*

The literature on the determinants of growth in bank lending identifies several variables as candidates for inclusion in $X_{it}$. Several researchers have examined the relationship between local or regional economic indicators and bank performance. Regional indicators include: Gross State Product (GSP), the regional analogue of Gross Domestic Product

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2 For details of the calculation of the adjusted standard errors, see Keshk (2003).
(GDP); employment growth; personal income growth; and commercial and residential real estate values. Avery and Gordy (1998) find state-level economic variables explain about half of the variation in the volume of bank lending over the period 1984-95. Calomiris and Mason (2000) find county- and state-level economic indicators influenced bank survival rates during the Great Depression. Berger et al. (2000) find aggregate state- and regional-level variables influenced the persistence in return on assets for US banks. Calza et al. (2001) find variations in bank lending are related to macroeconomic variables, including fluctuations in real GDP and short-term and long-term real interest rates.

The growth of lending equation includes as a covariate GSPRO\textsubscript{jt}, the ratio of GSP to GDP in year t, where GSP is for state j in which bank i’s head office is located. EMPGROW\textsubscript{jt} is the rate of growth of employment in state j between years t–1 and t. Positive coefficients on GSPPRO\textsubscript{jt} and EMPGROW\textsubscript{jt} are anticipated. The rate of growth in bank lending may be influenced by the intensity of competition in the local banking market. Competition tends to reduce the rents that accrue to lenders, and shorten the average duration of the borrower-lender relationship. Conversely, highly concentrated financial markets create opportunities for non-competitive behaviour, resulting in higher prices and higher profits (Besanko and Thakor, 1987; Berger and Hannan, 1989; Pilloff and Rhodes, 2002; Jiménez et al., 2006). In this study, HERF\textsubscript{jt} is the Herfindahl index, defined as the sum of squared market shares of all banks whose head offices are located in state j (the state in which bank i’s head office is located). Market shares are calculated
using total assets data.\textsuperscript{3} A negative coefficient on $\text{HERF}_{jt}$ would reflect the anticipated inverse relationship between concentration and the growth of lending.

Among the bank-specific determinants of bank lending, perhaps the most widely cited group of factors derive from the need for compliance with regulatory capital requirements (Berger et al., 1999; Brewer et al., 2000). Broadly speaking, a bank can achieve compliance either by raising new capital, or by reducing the size of its C&I loan portfolio (Bernanke and Lown, 1991; Peek and Rosengren, 1995; Barajas et al., 2005).\textsuperscript{4} Included among the covariates of the growth of lending equation is $\text{RWC}_{it-1}$, bank i’s risk-weighted asset to capital ratio in year $t-1$. A bank that needs to reduce this ratio may do so by reducing the size of its C&I loan portfolio (or at least by targeting a lower rate of growth in this portfolio). Accordingly, a negative coefficient is anticipated.

Interest rates influence the demand for loans through their effect on the cost of borrowing. High interest rates may deter high-quality borrowers in particular, reducing the average quality of the banks’ loan portfolios (Shay, 1970; Hancock and Wilcox, 1998). PRIME$_{t-1}$ is the prime interest rate in year $t-1$: the rate at which banks lend to their most creditworthy borrowers. The employment growth and prime interest rate covariates are lagged by one year to allow for a time delay in their impact on C&I lending.

\textsuperscript{3} Bank i’s market share is the ratio of bank i’s assets to the sum of the assets of all banks whose head offices are located in state j.

\textsuperscript{4} For example, there is evidence that US banks avoided issuing new securities in order to meet the risk based capital requirements at the year-end 1990. Capital-deficient banks resorted to decreased loan growth in order to meet the requirements (Furlong, 1992; Laderman, 1994; Hancock and Wilcox, 1998). According to Keeton (1999), during the period 1990-97 the average rate of growth of C&I lending was faster during phases when credit standards were being relaxed, and slower during phases when credit standards were being tightened.
The quality of a bank’s current loans portfolio may have implications for the growth of lending in future years (Sharpe and Acharya, 1992; Keeton, 1999; Brewer et al., 2000). Publicly available measures of loan portfolio quality, such as loan charge-offs, loan loss allowances, and ‘past due’ and ‘nonaccrual’ loan classifications reflect loan portfolio quality with a time-lag: current loan loss provisions reflect lending decisions made in previous years (Shriives and Dahl, 1992). NETCHGOFF$_{it-1}$, the ratio of the loans charge-off to assets, appears as a covariate in the growth of lending equation. A negative coefficient is anticipated.

**Determinants of the use of derivatives**

A separate literature on the determinants of the use of derivatives by banks suggests a number of candidate variables for inclusion in $Y_{it}$. Several researchers suggest that in order to deal in derivatives, banks need to surmount various entry barriers. There is a need for specific financial, human and intellectual capital resources, as well as advanced internal control systems and a sufficiently high franchise value (Kim and Koppenhaver, 1993; Carter and Sinkey, 1998; Brewer et al., 2000; Sinkey and Carter, 2000; Shyu and Reichart, 2002). The covariates that control for entry barriers in the use of derivatives equation are LTA$_{it}$, the natural logarithm of total assets, and SUBASSET$_{it}$, the ratio of subordinated debts to total assets. Positive coefficients on these covariates are anticipated.

Santomero and Trester (1998) argue that increased liquidity enables banks to assume more credit and insolvency risk. This suggests holding additional liquid assets may be viewed by banks as an alternative to hedging. Accordingly, LIQUID$_{it}$, the ratio of liquid assets to total assets, is included among the covariates in the use of derivatives equation.
A negative coefficient is expected, on the grounds that less liquid banks are more likely to transact derivatives.

In response to growing competitive pressure in their traditional business activities, banks have diversified into non-interest earning activities, such as private banking, asset management, and fee-income generating services, including dealing in derivative instruments on behalf of clients. NIM$_{it}$, the ratio of net interest margin before credit losses to total assets, appears as a covariate in the use of derivatives equation. A negative coefficient would suggest that banks with lower profits from traditional intermediation activities might be under greater pressure to generate non-interest income by dealing in derivatives.

The need to comply with the regulatory capital requirements might represent a further motive for the use of derivative instruments. Accordingly, the ratio of risk weighted assets to total assets, CAPITAL$_{it}$, is included as a covariate in the use of derivatives equation. A positive coefficient would suggest banks are more likely to use derivatives when they already have sufficient capital to meet the capital requirements, while a negative coefficient would suggest banks use derivatives to hedge against the possibility of failing to achieve compliance.

Banks characteristically tend to borrow short and lend long, and consequently their portfolios are exposed to interest rate risk. Accordingly, banks may use derivatives in order to hedge exposure to unexpected changes in the maturity values of their assets. Banks that hedge by using derivatives can afford longer maturity gaps, while maintaining their total exposure at a desired level. ABSGAP$_{it}$, the absolute value of the difference
between assets and liabilities re-pricing or maturing within one year, divided by total assets, appears as a covariate in the use of derivatives equation. A positive coefficient would suggest banks use derivatives in order to hedge against maturity mismatch. Finally, the decision to use derivatives may also be influenced by the bank’s approach to the management of unexpected loan performance. Accordingly, LNLOSS_{it}, the yearly rate of change in the ratio of the provision for loan loss reserves to total loans, appears as a covariate in the use of derivatives equation. A positive coefficient would suggest banks use derivatives to hedge against unexpected loan performance.

4. Data sources and summary statistics

Section 4 describes the sources of the data used in the empirical analysis, and presents some summary statistics. The sample comprises annual data for the period 1997-2004 on all Federal Deposit Insurance Corporation (FDIC) insured commercial banks in the US that reported assets greater than US$300m and a non-zero C&I loans portfolio, according to the Reports of Condition and Income (usually known as the Call Reports). These criteria produce an unbalanced panel, comprising 873 banks in the start-year 1997, 1269 banks in the end-year 2004, and 8295 bank-year observations in total. In order to minimise problems of survivorship bias, entry to and exit from the sample are unrestricted.

Table 1 reports the numbers of observations by year, and the numbers of banks that did and did not transact derivatives by year, referred to as users and non-users of derivative instruments, respectively. Table 1 also reports the mean asset sizes and mean C&I loan

\[ \text{LNLOSS}_{it}, \] is the yearly rate of change in the ratio of the provision for loan loss reserves to total loans.

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5 The data are available at http://www2.fdic.gov/SDI/main.asp.
portfolio size for all sample banks, and for users and non-users. Among the user banks, the average ratio of C&I lending to total assets declined from 17.86% in 1997 to 11.33% in 2004. The corresponding figures for the non-user banks were 10.73% in 1997 and 10.65% in 2004.

Table 2 provides a summary list of covariate definitions, together with descriptive statistics for all sample banks and for the user and non-user banks, and a differences in means analysis. The descriptive statistics are calculated by pooling the data across banks and across years. The differences in means analysis indicates that there are some major differences between the characteristics of the average user bank and non-user bank. Specifically, the average user bank is larger in size, has a higher franchise value, holds proportionately less capital, has a larger C&I loans portfolio, and has a larger maturity mismatch.

5. Estimation results

Section 5 presents and interprets the estimation results of the simultaneous equations model for the growth of lending and the use of derivatives. Table 3 reports the estimations for Models 1, 2 and 3, in which the binary dependent variable refers to the use of any derivative instrument (Model 1), interest rate derivatives (Model 2) and credit derivatives (Model 3). In each case, the upper section of Table 3 shows the estimated growth of lending equation, and the lower section shows the estimated use of derivatives.

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6 The data on Gross State Product (GSP) and Gross Domestic Product (GDP) are obtained from the Bureau of Economic Analysis, US Department of Commerce. Employment data are obtained from the Current Employment Statistics of the Bureau of Labor Statistics, US Department of Labor.
equation. In each of the three models, the endogeneity of the ‘growth of lending’ and ‘use of derivatives’ dependent variables is confirmed using Hausman tests.

In the equation for $CIGROW_{it}$ in Model 1, the coefficient on $\hat{DER}_{at}^{**}$ is positive and statistically significant. This suggests banks that use any type of derivative instrument experience higher growth in C&I lending on average than banks that do not use derivatives. This finding, which is consistent with the results of Brewer et al. (2000) and Brewer et al. (2001), suggests banks with the capability to hedge against loan defaults using derivatives are able to sustain more rapid growth in their C&I loan portfolios. Banks with no such capability, or banks that are capable but decide not to exercise the choice of using derivative instruments, are obliged to exercise more restraint in their lending policies.

In contrast, in the equation for $DER_{at}$ in Model 1 the coefficient on $CIGROW_{at}$ is negative and significant. Accordingly, banks that are currently experiencing rapid growth in C&I lending are less likely to choose to use derivative instruments in the current year than banks whose growth in C&I lending is slower. This finding may be consistent with the notion that trading in derivatives is regarded by some banks as a substitute for traditional lending activities. Banks that are engaged in expanding their loan portfolios rapidly are more likely to abstain from using derivatives; conversely, banks whose loan portfolios are growing slower are more likely to become involved in non-interest bearing activities including trading in derivatives.
Overall, the two-stage probit least squares estimation results for Model 1 point towards rejection of the composite null hypothesis that was proposed in Section 3 of this paper, that growth in the C&I loan portfolio has no impact on the decision to use derivatives, and the outcome of the decision as to whether to use derivatives has no impact on the growth of C&I lending. However, the observed relationship between C&I lending and the use of derivatives is complex, with support being found for both of the alternative hypotheses developed in Section 3. On the one hand, banks that use any type of derivative instrument tend to experience higher growth in C&I lending than banks that do not use derivatives. This is consistent with the notion that banks with the capability to use derivatives to hedge against loan defaults are able to sustain more rapid growth in their C&I loans portfolios, while banks that do not use derivative instruments are obliged to exercise more restraint in their lending policies. But on the other hand, banks that are currently experiencing rapid growth in C&I lending are less likely to choose to use derivative instruments than banks whose growth in C&I lending is slower. This is consistent with the notion that trading in derivatives is regarded by some banks as a substitute for traditional lending activity. Banks that are engaged in expanding their loan portfolios rapidly are less likely to use derivatives, while banks with slower growth in lending are more likely to do so.

Among the other covariates in the equation for CIGROW$_{jt}$ in Model 1, the coefficient on GSPPRO$_{jt}$ is insignificant, but the coefficient on EMPGROW$_{jt}$ is positive and significant, indicating that banks located in states with higher employment growth experience faster loan growth. The coefficient on PRIME$_{t-1}$ is negative and significant, indicating that the demand for loans is sensitive to the cost of borrowing. However, the market
concentration measure HERF\textsubscript{jt} does not appear to be a significant determinant of the growth of C&I lending.

The two bank-specific covariates appear to be important determinants of the growth of C&I lending. The coefficient on RWC\textsubscript{it-1} is negative and significant, suggesting the banks’ lending policies are adjusted in accordance with the need to maintain compliance with the regulatory capital requirements. The coefficient on NETCHGOFF\textsubscript{it-1} is negative and significant, indicating that banks that have recently incurred relatively large loan charge-offs tend to adjust their C&I lending subsequently.\textsuperscript{7}

Among the other covariates in the equation for DER\textsubscript{it} in Model 1, the coefficients on LTA\textsubscript{it} and SUBASSET\textsubscript{it} are both positive and significant. These results are consistent with the notion that entry barriers have an impact on the propensity of banks to use derivatives. The coefficient on ABSGAP\textsubscript{it} is also positive and significant, suggesting banks with a significant maturity mismatch exposure are more likely to use derivatives in order to hedge this exposure. A negative and significant coefficient on NIM\textsubscript{it} suggests banks that operate with higher interest margins are less likely to use derivative products.\textsuperscript{8}

Again, this finding appears consistent with the notion that banks tend to view traditional lending activities and non-interest bearing activities as substitute sources of income: banks that operate with higher interest margins have less need to generate income from non-traditional activities. However, the coefficients on LIQUID\textsubscript{it}, CAPITAL\textsubscript{it} and LNLOSS\textsubscript{it} are all insignificant, suggesting the decision to use derivatives does not depend

\textsuperscript{7} Similar results are obtained by Sharpe and Acharya (1992), Keeton (1999) and Brewer et al. (2000).

\textsuperscript{8} A similar result is obtained by Carter and Sinkey (1998).
on the bank’s liquidity, its position relative to the regulatory capital requirements, or its current-year loan loss position.\(^9\)

With a few exceptions, the estimation results for Model 2 (in which the binary dependent variable IRT\(_{it}\) indicates use or non-use of interest rate derivatives) and Model 3 (CDX\(_{it}\) indicates use or non-use of credit derivatives) are similar to those for Model 1. The very close correspondence between the results for Models 1 and 2 is explained by the fact that interest rate derivatives were among the instruments used by a large majority of the banks classified as users of any derivative instrument.\(^10\) Therefore IRT\(_{it}\) in the use of derivatives equation in Model 2 is highly correlated with the DER\(_{it}\) in Model 1.

The main difference between the estimation results for Models 1 and 3 is that in the latter, there is no evidence of any simultaneity between the growth in C&I lending and use of credit derivatives dependent variables. Therefore it does not appear that the banks’ lending practices are influenced by their involvement in the use of credit derivative instruments specifically, and there is no evidence that trading in credit derivatives is viewed as an alternative to traditional lending activities as a source of income. These findings may reflect the fact that markets in credit derivatives have developed more recently than markets in other derivative instruments, including interest rate and foreign exchange derivatives (International Monetary Fund, 2006). During the time period covered by the present study, dealing in credit derivatives may have been viewed by most

\(^9\) The capital ratios of US banks have improved considerably following the implementation in 1992 of the Federal Deposit Insurance Corporation Improvement Act (FDICIA).

\(^{10}\) There are 2623 bank-year observations on the ‘any derivatives’ user group, and 2403 observations on the ‘interest rate derivatives’ user group. The ‘credit derivatives’ user group is much smaller, with only 187 bank-year observations.
banks more as an experimental activity than as a mainstream risk management or fees-based business activity.

6. Conclusion

Derivative instruments provide banks with the opportunity to hedge their exposure to financial risks, including interest rate risk, foreign exchange risk and credit risk. Derivative instruments also provide banks with the opportunity to earn additional income from trading, or by providing risk management services. The trend towards disintermediation since the 1980s is reflected in the fact that the total assets of US banks have grown faster than their C&I lending throughout this period, and non-interest income has also out-grown interest income. Meanwhile, the use by banks of derivative instruments has grown exponentially in recent years.

Previously in the banking literature, it has been suggested that banks use derivatives to reduce the costs associated with monitoring borrowers, and that the use of derivatives is complementary to the banks’ traditional intermediation activities. Elsewhere, it has been argued that trading in derivatives represents a substitute for the traditional lending activities of many banks, and an increasingly important alternative source of income and profit. According to this view, unrestricted growth in the use of derivatives may threaten financial market stability. This study has examined the relationship between derivative usage and lending growth by estimating a two-equation model, allowing for simultaneity between a continuous ‘growth of lending’ dependent variable, and a binary ‘use of derivatives’ dependent variable. Accordingly, these two important components of the banks’ overall risk management strategies are viewed as being decided simultaneously.
and in a coordinated fashion, rather than separately as they have been treated in most of the previous empirical banking literature.

The empirical model is estimated by means of a two stage probit least squares procedure, in which instrumental variables are used to correct for the endogeneity of the use of derivatives dummy in the growth of lending equation, and *vice versa*. An important feature of the empirical model is its recognition that growth of lending and use of derivatives have both endogenous and exogenous determinants. In an attempt to identify the potentially complex relationships between these two dependent variables, a broad range of control variables is included in the specification of both equations. The selection of these control variables is guided by the results of a number of previous studies in the empirical banking literature.

The simultaneous equations model permits the examination of a composite null hypothesis: that growth in a bank’s C&I loan portfolio has no impact on its decision to use derivatives; and the outcome of the use of derivatives decision has no impact on the growth of C&I lending. The alternative hypotheses are: first, banks that use derivative instruments can expand their traditional lending more rapidly because of the increased flexibility in risk management afforded by derivative usage; and second, banks whose traditional lending is expanding more slowly are more likely to consider trading in derivatives as an alternative source of income and profit.

In respect of derivative instruments in general, the estimation results point towards rejection of the composite null, with support found for each of the alternative hypotheses. On the one hand, banks that use any type of derivative instrument tend to experience
faster growth in C&I lending than banks that abstain from using derivatives. This seems consistent with the notion that banks that have the capability to use derivatives in order to hedge against loan defaults are able to sustain more rapid growth in their traditional lending, while banks with no such capability are obliged to exercise more restraint. But on the other hand, banks that are currently experiencing rapid growth in C&I lending are less likely to use derivative instruments than banks whose growth in C&I lending is slower. This seems consistent with the notion that trading in derivatives is regarded by some banks as a substitute for traditional lending activity. Banks that are engaged in expanding their loan portfolios rapidly are less likely to see the need to become involved in derivative trading, while banks with slower growth in lending are more likely to do so.

These results seem to recommend a cautious but balanced approach to the regulation of the use of derivative instruments by banks. To the extent that derivatives represent a powerful and sophisticated tool in the banks’ armoury of risk management instruments, their use should surely be encouraged, since it contributes to the efficient functioning of capital markets. Indeed, the imposition of unnecessary restrictions by regulators may have damaging implications for the allocation of capital among borrowers. However, trading in derivatives may also have become an end in itself for some banks, whose margins in their more traditional lines of business have been under increasing competitive pressure in recent years. Unrestricted growth in the banks’ involvement in derivatives trading is likely to create new and perhaps unforeseen risks for those responsible for formulating and implementing the banks’ risk management strategies. This also suggests a continuing need for careful regulatory scrutiny, to ensure that derivative instruments are used in ways that do not jeopardise the stability of the banking and financial system.
References


Figure 1: C&I Loans, Total Assets: US Banks, 1938-2004

Source: Historical Statistics on Banking (HSOB)
Figure 2: Ratios of Interest Income and Non-Interest Income to Total Assets

Source: Historical Statistics on Banking (HSOB)
Figure 3: Nominal Value of Derivatives, Total Assets: US Banks, 1991-2004

Source: Historical Statistics on Banking (HSOB)
Table 1 Numbers of sample banks transacting derivatives by year, and means of total assets and C&I loans

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>1. Mean Total assets (US$ million)</strong></td>
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<td>Non-user banks</td>
<td>t-stat. for difference in means</td>
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<td>CIGROW(_{it})</td>
<td>C&amp;I loan growth / Total assets</td>
<td>0.011</td>
<td>0.008</td>
<td>1.876**</td>
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<td>Gross State Product / US Gross Domestic Product</td>
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<td>HERF(_{jt})</td>
<td>Herfindahl index, calculated using state-level total assets data</td>
<td>0.236</td>
<td>0.210</td>
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<td>PRIME(_{t-1})</td>
<td>Prime rate for lending at end of previous year</td>
<td>6.96</td>
<td>7.07</td>
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<td>RWC(_{it-1})</td>
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<td>0.132</td>
<td>0.139</td>
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<td>C&amp;I loan charge off</td>
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<td>ASSET(_{it})</td>
<td>Total assets (US$ million)</td>
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<td>LTA(_{it})</td>
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<td>SUBASSET(_{it})</td>
<td>Subassets / Total assets</td>
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<td>21.259***</td>
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<td>ABSGAP(_{it})</td>
<td>Absolute value of: (difference between assets and liabilities re-pricing or maturing within one year) / Total assets</td>
<td>0.184</td>
<td>0.136</td>
<td>13.122***</td>
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<td>NIM(_{it})</td>
<td>Net interest margin / Total assets</td>
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<td>0.044</td>
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<td>LIQUID(_{it})</td>
<td>Liquid assets / Total assets</td>
<td>0.309</td>
<td>0.311</td>
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<td>CAPITAL(_{it})</td>
<td>Risk weighted capital ratio</td>
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<td>0.138</td>
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<td>LNLOSS(_{it})</td>
<td>Rate of change in: (Provision for loan loss reserves / Total loans)</td>
<td>1.277</td>
<td>1.147</td>
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**Note**

*** denotes statistically different from zero, 1% level, two-tail test; ** 5% level; * 10% level.

The data are pooled over the period 1997-2004. The t-statistics are based on unequal group variances.
Table 3  Two stage probit least square (2SPLS) estimation results

<table>
<thead>
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<th>Dependent variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
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<td>CIGROW_it</td>
<td>0.00111*** (0.00027)</td>
<td>0.00136*** (0.00051)</td>
<td>0.00041 (0.00043)</td>
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<tr>
<td>IRT_it</td>
<td>-0.00765 (0.00779)</td>
<td>-0.00579 (0.01429)</td>
<td>-0.00886 (0.01403)</td>
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<tr>
<td>EMPGROW_it</td>
<td>0.00323*** (0.00098)</td>
<td>0.00326* (0.00180)</td>
<td>0.00323 (0.00171)</td>
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<tr>
<td>PRIME_t-1</td>
<td>-0.01045*** (0.00116)</td>
<td>0.00802*** (0.00123)</td>
<td>0.00835*** (0.00116)</td>
</tr>
<tr>
<td>HERF_it</td>
<td>0.00060 (0.00190)</td>
<td>0.00034 (0.00349)</td>
<td>0.00154 (0.00329)</td>
</tr>
<tr>
<td>RWC_it-1</td>
<td>-0.03558*** (0.00563)</td>
<td>-0.03353*** (0.01045)</td>
<td>-0.03758*** (0.00985)</td>
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<tr>
<td>NETCHGOFF_it-1</td>
<td>-0.41227*** (0.02633)</td>
<td>-0.41519*** (0.04841)</td>
<td>-0.39444*** (0.04552)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
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<tr>
<td>CIGROW_it</td>
<td>-8.49420** (4.23843)</td>
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<td>SUBASSET_it</td>
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<td>LNLOSS_it</td>
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<td>-0.00270 (0.00731)</td>
<td>0.00323 (0.01103)</td>
</tr>
</tbody>
</table>

Notes
Standard errors of estimated coefficients are reported in parentheses.
*** denotes coefficient statistically different from zero, 1% level, two-tail test; ** 5% level; * 10% level.