Risk Management in Agricultural Banks: An Application of Endogenous Switching Model

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Abstract

Based on the results from endogenous switching regression, this paper shows that derivatives activities partially mitigate the negative effects of credit risks and interest risks during and after 2008 crisis and improve agricultural banks' profitability. In particular, without the use of derivatives, user banks would have had 12% lower profitability.

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Introduction

The role of derivatives in commercial agricultural banks has not been studied because derivatives use by these banks grew mostly in the past decade. By 2011, about 10% of the agricultural banks used derivatives, and a focus on this aspect of agricultural banks' activities is becoming important. Moreover, the financial crisis of 2008 brought into question the effectiveness of derivatives in banks, especially because there is a perception that (large) banks use derivatives mainly for speculative purpose rather than for risk hedging. We study how derivatives use in agricultural banks, the lending specialty group with lowest average assets, is related to their profitability. We estimate an endogenous switching model of agricultural banks' performance, which allows to control for banks' endogenous choice to participate or not in the derivatives market.

The vast majority of the community banks, which participated in the derivatives market by 2011, entered derivatives markets after the banking deregulation of 1999[1],[2] but still little is known what affect derivatives on different types of community banks. In this paper we also compare the performance of derivative user agricultural banks to that of other lending specialty community banks[3], such as mortgage specialist, consumer loan specialist, commercial real estate loan (CRE) specialist, and commercial and industrial loan (C&I) specialist.

Advances in financial theory and computerization made financial derivatives important/popular risk instrument. Compared to traditional on-balance-sheet risk management

[1] Call report data shows that less than 1% community banks participated in the derivatives markets before the deregulation in 1999. But by 2011 about 16% of community banks, which include 10% of agricultural specialists, 16% of Commercial Real Estate (CRE) specialists, 16% of Mortgage specialists, 20% of multi-specialists, and 15% of non-specialty banks, participated in the derivatives market.

[2] The Gramm–Leach–Bliley Act of 1999 allowed consolidation of commercial banks, insurance companies, security firms and investment banks, making it possible for the commercial banks to benefit from economies of scope.

[3] We follow the definition used in FDIC Community Banking Study (2012) to identify community banks and lending specialty groups. Appendix 2 includes details on the classification.

techniques, risk management through financial derivatives, usually referred to as off-balance-sheet activities, is less costly, could substitute for expensive capital and give firms flexibility to reach desired risk exposure. Therefore, financial derivatives became popular and were playing increasing role in risk management in commercial banks in the past few decades. According to a report by Office of the Comptroller of the Currency (OCC), the notional value of the derivatives activities of commercial banks has reached $231 trillion in 2011 compared to only $17 trillion in 1995.

The fast explosion of the derivatives activities and their effect on banks' performance has attracted significant attention. Hedging theory suggests that derivatives activities could improve banks' profitability and reduce risk. The risk is hedged through derivatives when the gains from the derivatives offset or reduce the losses in cash or spot market (Gorton and Rosen, 1995). However, due to the structure of the derivatives contract, trading in derivatives for profits may expose commercial banks to unlimited loss. In fact the financial crisis of 2008 wiped out all independent investment banks as well as many commercial banks.

The literature suggests that there is no way to separate banks' risk hedging activities from speculating and dealership activities. Previous research documents that participation in derivatives market has high fixed cost (Brewer et al. 1996, 2000, 2001; Carter and Sinkey, 1998; Sinkey and Carter, 2000; Koppenhaver, 1990; Kim and Koppenhaver, 1993). Most community banks, especially agricultural banks, which usually have limited funding sources and participate mainly in end-user derivatives market, are unlikely to take speculating derivatives positions and would mainly use derivatives to hedge. Large banks are more likely to take speculating derivatives positions but among agricultural banks, which have the lowest average total assets compared to other lending specialists groups, there are likely very few that will focus on

speculating rather than risk management. Thus, we make another contribution to the literature because we study how derivatives activities in relatively small agricultural banks, likely used for risk hedging, affected these banks' profitability.

Simple means comparisons show that derivatives using agricultural banks are more profitable than non using banks even during and after the recent financial crisis on average. However, due to the heterogeneity of banks and the endogeneity of a bank' choice to participate in the derivatives market, direct comparison of the agricultural banks' profitability between user and non-user banks may lead to misleading results. Thus, we study the impact of derivatives on banks' performance by estimating the endogenous switching model on the banks' performance, which allows us to control for the endogenous selection problem, build a counterfactual analysis, and evaluate the user banks' profitability if they did not participate in the derivatives activities.

The next section discusses the current literatures on derivatives contracts' effects and agricultural banks. Section 3 discusses empirical models and data; and section 4 will discuss the empirical results. Finally, section 5 will summarize and conclude the paper.

Literature review

The role of derivatives in commercial agricultural banks has not been studied because derivatives use by these banks grew mostly in the past decade. The predominant agricultural banking literature is focused on, or motivated by, the 1980s farm credit crisis, when increased competition from S&Ls, interest rate volatility, and farm real estate bubble lead to the failure of 1,617 commercial banks during 1980s and early 1990s, of which 78 percent were agricultural banks (FDIC, 1997). Belongia and Gilbert (1990) identify the lack of diversification into assets other than loans and the high proportion of agricultural loans as primary causes for the farm credit crisis, while affiliation with large bank holding companies was associated with lower

probability of failure of agricultural banks. Since consolidation of agricultural bank followed the crisis, consequent studies explored efficiencies and economies of scale and scope as well as banks' response to regulation changes which removed restrictions on intrastate, interstate, and international banking (Belongia and Gilbert. 1990; Gilbert, 1991; and Ahrendsen et al., 1995, Featherstone and Moss, 1994; Neff et al., 1994; Dias and Helmers, 2001; Choi and Stefanou, 2006; Choi et al. 2007; and Settlage et al., 2009).

Relative to previous financial crises impacts, the 2008 financial crisis had less of an impact on agricultural banks, because they were in a better position to manage risks and because agriculture as a sector was doing better than the rest of the economy (Briggeman et al., 2009; Ellinger, 2009; Hartarska and Nadolnyak, forthcoming). While delinquencies have been increasing, the share of problem loans of agricultural lenders remains less than 50% of that of non-agricultural banks (Briggemann, 2011; Ellinger, 2011). Recent work on derivatives use by agricultural banks suggest that hedging to reduce risk benefited agricultural banks while in non-agricultural banks (likely speculative) derivatives operations reduced profitability and increased risk level (Shen and Hartarska, 2012).

Most agricultural banks that entered the derivatives market after the regulation changes in 1999 and 2000 continue to use derivatives to hedge risk, but remain relatively small and are thus vulnerable to inappropriate hedging. Therefore, we believe it is possible to separate the risk hedging effect from the speculating effects of derivative use by analyzing derivatives activities of agricultural banks. In the post crisis environment, the huge losses of financial institutions due to derivatives trading have reinvigorated a debate on the purpose of derivatives - speculation or risk hedging. The academic literature on the effects of derivatives on bank's performance has

identified both positive and negative impacts and provided ambiguous empirical evidence likely due to the fact that speculation and hedging remain difficult to distinguish.

The mainstream capital structure irrelevance theory developed by Modigliani and Miller (1958) argues that in a perfect world, the equity value of a commercial bank is not affected by its hedging activities. However, market imperfections, such as existence of tax, contracting cost, and information asymmetries, create incentives for firms to hedge due to the potential benefits from increased equity value and reduced cash flow variations, from reduced tax liability, bankruptcy cost and managerial risk aversion (Smith and Stulz, 1985).

The financial intermediation theory developed by Diamond (1984) and Froot and Stein (1998) implies that hedging observable or tradable risks and non-tradable risks, allows commercial banks to obtain optimal benefits from portfolio diversification and intermediation services, to enjoy lower monitoring costs, and to reduce use of costly external financing. Thus, risk hedging derivatives activities serve as complements to the banks' lending activities.

Some of the empirical literature supports the financial intermediation theory. For example, Gorton and Rosen (1995) study commercial banks during 1985 – 1993 and find that the change in banks' net income due to the change in interest rate is partially offset by the opposite change in net income from the interest rate hedges, and thus interest rate swaps have helped commercial banks to hedge most of the systematic risks. Zhao and Moser (2009b) find that with both on- and off-balance sheet risk management methods, maturity gap matching and interest rate derivatives, BHCs effectively reduced their interest rate sensitivity of equity value during 1998-2003. Brewer, Minton and Moser (1996) find that interest rate risk was lower for derivatives user S&Ls during 1985–1989. Studying the effects of macroeconomic shocks on interest rate risk management of commercial banks, Purnanandam (2007) finds that derivatives using banks make less or no

adjustment to the on-balance sheet maturity gaps and do not cut lending when the Federal Reserve tightens monetary supply, which indicates that derivatives activities could help smoothing of commercial banks' cash flows.

Other work, however, finds that derivatives increase commercial banks' risk-taking. By extending the two-factor market model developed by Flannery and James (1984), Hirtle (1997) examines the relationship between derivatives activities and BHCs' interest rate sensitivities of stock return between 1986 and 1994. He finds that the interest rate derivatives increased BHCs' interest rate exposure and this effect varied for BHCs of different size with stronger effects for large dealer BHCs. Based on the dealer model developed by Ho and Saunders (1981) and Allen (1988), Angbazo (1997) analyzes the effects of off-balance sheet (OBS) activities on the banks' net interest margins during 1989-1993. He finds that while OBS activities improved banks' profitability by allowing participation in activities otherwise restricted with debt or equity financing, OBS activities increased banks' exposure to liquidity and interest rate risk. Recently, Hassan and Khasawneh (2009a) compare the risk effects of different derivatives contracts based on three main risks measures: systematic risk (β), standard deviation of the stock returns, and implied volatility. They find that while interest rate swap contracts are risk reducing products across all three risks measures, other derivatives contracts (option, future and forward) are positively correlated to systematic market risk (β). Meanwhile, the study by Instefjord (2005) suggests that credit risk derivatives increase bank risks and credit derivatives trading could hurt bank stability.

Empirical Approach

Banks earn profits from accepting and managing risks. Traditionally, commercial banks serve as intermediaries between depositors and borrowers, profiting from the difference of the interest

they charge for loans and the interest they paid to depositors. Banks' performance can be measured by net interest margin (NIM), which reflects the extra charge of loans to compensate the commercial banks for taking risks. Assuming that a bank is a risk-averse dealer, Ho and Saunder (1981), Allen (1988) and Angbazo (1997) use the dealership framework to explain the banks' NIM which is modeled as determined by several risk factors, including credit risk or default risk, liquidity risk, interest risk, concentration risk and operating risk. Banks' profitability (NIM) is modeled as a function of series of bank risk factors.

(1) $$NIM = F(Default\ risk;\ Interest\ risk;\ Liquidity\ risk;\ Capital\ adequacy;\ Management)$$

Since 1980, however, commercial banks started offering services to earn non-interest-rate (sensitive) incomes and their share in banks' operating revenue has been steadily increasing in the past few decades. To address these changes, rather than NIM as the dependent variable, we use the return on assets (ROA) which better reflect banks' total operating performance.

Commercial banks are heterogeneous and their decision to participate or not in the derivatives market is endogenous to their performance, thus a direct comparison of the banks' profitability between user and non-user banks may lead to misleading results. We study the impact of derivatives on banks' performance by estimating an endogenous switching model on the banks' performance. This allows us to control for the endogenous selection problem and to build a counterfactual analysis, and therefore evaluate banks' profitability even if they did not participate in the derivatives activities.

In more general form the performance models:

(2) $$ROA = X\beta_1 + I\beta_2 + \varepsilon$$

Where ROA is the measure for profitability of the commercial bank, *X* is a vector of endogenous variables suggested by the dealership model and spelled out in (1), and *I* is the dummy variable which identifies derivatives user agricultural banks.

The decision to use or not to use derivatives is voluntary and affected by unobserved factors such as managerial preference and the results from the above model are subject to the self-selection problems. If the decision to use derivatives is subject to self-selection, it is likely that user banks' profitability reacts systematically differently from the non-user banks' profitability. Unobserved variables may affect both the decision to use derivatives and the profitability of the user and non-user agricultural banks. In this case, the endogenous switching model, developed by Maddala and Nelso (1975) and Maddala (1986), controls for the endogenous selection problem and also allows the user and non-user banks' profitability to react differently to the risk factors. Therefore, the profitability functions on derivatives user and non-user banks are estimated simultaneously with the decision function:

(3) $$Y_{1i} = X_{1i}\beta_1 + \varepsilon_{1i} \;\; if \; I_i = 1$$

(4) $$Y_{2i} = X_{2i}\beta_2 + \varepsilon_{2i} \;\; if \; I_i = 0$$

(5) $$Y_{3i}{}^{*} = Z_i\gamma - \nu_i$$

(6) $$I_i = 1 \; iff \; Y_{3i}{}^{*} \geq 0$$

(7) $$I_i = 0 \; iff \; Y_{3i}{}^{*} < 0$$

Where *Z* is a vector of variables which affect the derivatives use decisions. The above equations are estimated with maximum likelihood method. The covariance matrix for the above equations is as follows:

(8) $$\Omega = \begin{bmatrix} 1 & . & . \\ \sigma_{21} & \sigma_1^2 & . \\ \sigma_{31} & . & \sigma_2^2 \end{bmatrix}$$

Where σ_1^2 is the variance for ε_1, σ_2^2 is the variance for ε_2, σ_{21} is the covariance for ε_1 and ν, σ_{31} is the covariance for ε_2 and ν. Meanwhile, we assume $\sigma_\nu^2=1$. The loglikelihood function for the above equations is as follows:

(9) $lnL = \sum_{i=1}\{I_i\,[ln(F(\eta_{1i})) + ln\,(f(\varepsilon_{1i}/\sigma_1)/\sigma_1)] + (1-I_i)\,[ln(1-F(\eta_{2i})) + ln(f(\varepsilon 2i/\sigma 2)/\sigma 2)]$

Where F is a cumulative normal distribution functions, f is a normal density function, and

(10) $$\eta_{ji} = \frac{(Z_i\gamma+\rho_j\varepsilon_{ji})/\sigma_j}{\sqrt{1-\rho_j{}^2}}\; j = 1,2$$

Where ρ_j is the correlation coefficient between ν and ε_i. After estimating the model the conditional expectation could be calculated: [4]

(11) $E(Y_{1i}|I_i = 1, x_{1i}) = x_{1i}\beta_1 + \sigma_1\rho_1 f(Z_i\gamma)/F(Z_i\gamma)$
(12) $E(Y_{1i}|I_i = 0, x_{1i}) = x_{1i}\beta_1 + \sigma_1\rho_1 f(Z_i\gamma)/(1-F(Z_i\gamma))$
(13) $E(Y_{2i}|I_i = 1, x_{2i}) = x_{2i}\beta_2 + \sigma_2\rho_2 f(Z_i\gamma)/F(Z_i\gamma)$
(14) $E(Y_{2i}|I_i = 0, x_{2i}) = x_{2i}\beta_2 + \sigma_2\rho_2 f(Z_i\gamma)/(1-F(Z_i\gamma))$

The counterfactual effects or the effects of derivatives activities in this case, which is represented by the difference in the outcomes if the individual is in the other group, could be estimated after estimating the above models:

(15) $Diff_{1i} = E(Y_{1i}|I_i = 1, x_{1i}) - E(Y_{1i}|I_i = 0, x_{1i})\; for\;\; I_i = 1$
(16) $Diff_{2i} = E(Y_{2i}|I_i = 1, x_{2i}) - E(Y_{2i}|I_i = 0, x_{2i})\; for\;\; I_i = 0$

Previous research shows that participation in derivatives market has high fixed cost, associated with implementing efficient hedging strategy and these costs are a barrier for small banks' ability to hedge (Brewer et al. 1996, 2000, 2001; Carter and Sinkey, 1998; Sinkey and Carter, 2000; Koppenhaver, 1990; Kim and Koppenhaver, 1993). Therefore, large banks or small banks which are part of the bank holding companies (BHC) may get access to the sophisticated

[4] The endogenous switching regression is estimated with the users written commands "movestay" in Stata.

hedging techniques. Call report data showed that most user banks enter the derivatives market after deregulation of 1999. Apart from the risk factors in the profitability model, dummy variable which identifies the bank that is affiliated to a BHC, the size of the bank, and another dummy variable which identifies the deregulation of 1999 are also added in the decision model to improve identification.

Data

Quarterly bank data used to construct the community bank sample comes from the Report of Condition and Income (Call Reports) from Federal Reserve Bank of Chicago between 1995 and 2012 (Q3). Following the definition by FDIC (2012), commercial banks are excluded from sample for the community banks if they specialized on providing services other than saving and lending services, held more than 10% in foreign assets, and fell in certain specialty groups, such as credit card, Industrial Loan Companies, banker's bank, trust company, and consumer nonbank bank. In the remaining banks, we also exclude banks with total assets larger than $10 billion for the majority of the sample's periods, because they tend to operate nationwide rather than in the relatively closed geographic area. We exclude banks with total assets between $1 billion and $10 billion, which held less than 33% of total assets in loans or less than 50% of assets in core deposits in the majority of the sample's periods[5]. Banks merged with, or acquired by, other banks during the sample period are also excluded. The final dataset includes 6,921 community banks with 1,056 agricultural specialists (1,021 agricultural single specialists), 1,322 commercial real estate (CRE) specialists (149 CRE single specialists), 1,289 Mortgage specialists (326 mortgage

[5] Following the FDIC (2012) definition, the total assets for banks are assumed to grow at growth rate of 5.7% annually with $1 billion or $10 billion total assets at the end of the sample period (2012 Q3). The asset size check is performed for year-end report only.

single specialists), 358 C&I Specialist (71 C&I single specialists), 94 consumer specialists (38 consumer single specialists) 2,485 Multi-specialists and 2,831 non-specialist[6].

The hedging effectiveness of derivatives for agricultural banks is measured by comparing the expected profitability of the banks, conditional on banks' participation in the derivatives market, for each period. Risk factors entering the above empirical models are consistent with the criteria used by FDIC to evaluate the commercial banks, namely the CAMELS rating which captures banks' capital adequacy, asset quality, management quality, earnings, liquidity and sensitivity to market risk[7]. Detailed variables construction and expected signs are presented in the Appendix 1. Default risk (or credit risk) is measured by loan charge offs (Charge-off) which is scaled by total loan portfolio and its increase is expected to be associated with lower profitability. Interest risk is measured by the short term maturity gap (Gap), constructed with the method similar to that by Flannery and James (1984), with banks' net short-term asset and liability scaled by earning asset. Increase in the gap is expected to decrease profitability in unfavorable market conditions and to increase profitability in favorable market conditions.

Liquidity risk is measured by the proportion of the banks' liquid assets scaled by total assets (Liquidity). Because liquid assets usually have lower return, increase in liquidity asset or decrease in liquidity risk will result in lower operating revenue and thus lower ROA, but the probability of financial distress is lower as well. Capital adequacy is measured by the asset-to-equity ratio (Leverage). Increase in leverage signals increased interest expense which signals increased insolvency risks, thus is associated with lower ROA.

[6] Appendix 2 includes detailed definition for each specialty groups. We follow the FDIC(2012) definition to classify lending specialty groups.

[7] The CAMELS rating system stands for capital adequacy, asset quality, management, earning, liquidity and sensitivity to market risk.

Following the method used by Angbazo (1997), management quality (Manage) is measured by the banks' earning assets scaled by total assets. Because management affects the allocation of assets which earn high interests (or liabilities which in turn pay low interests), it is expected to be positively associated with profitability. Logarithm of bank total asset, a dummy variable for BHC, which identifies banks affiliated to BHCs, and another dummy which identifies a period after the deregulation of 1999 are also included in the selection model.

Characteristics of derivatives user and non-user banks by lending specialty groups

**********Table 1**********

Table 1 contains summary statistics of key variables for the sample by single specialty groups for the period 1995 Q1 to 2012 Q3. As specialist, agricultural banks are the largest single specialty group by number of banks, they are the smallest institutions by assets with average $78 million total assets for 1,138 agricultural banks. Mortgage banks are the largest single specialty group by total assets with average $305 Million of assets for 380 mortgage specialists. Derivatives using banks in the sample are larger in size across all the specialty groups and the total assets for user banks are around 4 times of that for non-user banks.

Agricultural specialists have the largest number of derivative using banks although by 2012 Q3, these banks only represents 10% of all agricultural banks (119 users out of 1,138 agricultural banks). In other speciality groups over 15% are derivatives users (58 out of 380 mortgage specialist and 28 out of 176 CRE specialists are derivatives users). Meanwhile, higher portion of the derivatives users' are part of BHCs than the non-user banks across the specialty groups with 89% of derivative users are part of BHCs compared to 82% for non-users.

The group of derivative users as a whole is less profitable than the group of non-users. However, agricultural and CRE derivatives-user banks outperform nonuser banks in terms of profitability. Therefore, average profitability must be lowered because mortgage specialists derivative users are significantly less profitable. Agricultural banks are the most profitable specialty group on average during the sample periods with average 1% ROA on average compared to 0.8% for mortgage specialists and 0.8% for CRE specialists.

In terms of risk, all groups derivatives users charge off higher percent of their loan portfolios, are more leveraged, hold less liquid assets, grant more loans, and are have less interest rate risks than those of non-user derivatives users. Even though mortgage specialist suffered during the 2008 financial crisis, they have the least loan charge-offs (0.27%) on average during the whole sample period followed by agricultural banks with 0.36% of total loans are charged-off on average. Among the specialty groups, agricultural banks are least leveraged and have most earning assets. By derivatives activities, except for CRE specialists, non-users tend to grant more specialty loans than user banks with 32% of non-user agricultural banks' assets in agricultural loans compared to 30% for user agricultural banks.

Overall, compared to other specialty banks, agricultural banks are smallest in size, have more capital, are subject to less liquidity risk, use fewer derivatives, but are more profitable than the other banking groups. Consistent with previous findings, the off-balance sheet nature of risk management activities with derivatives, user banks have more on-balance sheet risks, such as credit risk, liquidity risk and interest risks. While simple mean comparison suggests that derivatives user banks are less profitable than non-user banks, we cannot conclude that derivatives activities hurt banks' profitability because specialists banks are heterogenous and

banks decision to use or not derivatives is endogenous. The empirical results from the next section reveal what is behind the differences in profitability

Empirical Results

Effects of risk factors on derivatives user and non-user banks by specialty groups

The results from endogenous switching regression applied on the panel with fixed effect on demeaned continuous variables by bank. Table 2a presents the endogenous switching regression results on the banks' profitability by specialty groups for the sample period between 1995 and 2012 (Q3). Because the 2008 financial turmoil has brought huge negative effects on banking, especially on mortgage specialists, we expect that the community banks may use derivatives differently (more prudential) after the financial crisis. Thus, we run the regression on the sub-sample period between 2008 and 2012 and the results are presented in Table 2b. The first column for each specialty groups are the first step probit regression on banks' choice to use derivatives and the next two columns presents the results for profitability of user and non-user banks. To control for the potential heterogeneity and autocorrelation problems, Huber-White robust standard errors are used and presented in the parenthesis.

**********Table 2a**********

**********Table 2b**********

The results are consistent with the previous findings that larger banks and small banks affiliated to BHCs are more likely to use derivatives to hedge, especially during and after the financial crisis, even though mortgage specialists are actually less likely and (CRE) are not likely to hedge if affiliated to BHCs before the financial crisis. Results are also consistent with the facts that most derivatives users enter the market after the banking deregulation of 1999.

In terms of risk factors, loan charge-offs are not a factor affecting bank's decision to use derivatives except for the multi-specialists who are more likely to use derivatives to hedge with increase in loan charge-offs. Leverage or insolvency risks do not affect banks' decision of using derivatives during and after the financial crisis even though most banks are more likely to hedge if they have more equity capital (less leveraged and more insolvency risks) due to the extra protection required by equity holders for the whole sample period. Specialty groups are more likely to hedge with increased interest rate risks (Gap) for the whole sample period even though only multi-specialty and non-specialty banks consider interest rate risk a factor that affects their hedging decisions during and after the financial crisis. Contrary to expectation, multi-specialty and non-specialty banks are more likely to hedge with decrease in liquidity risks (increase in liquidity). Agricultural specialists' and Mortgage Specialists' hedging decisions are not affected by liquidity.

Profitability of user and non-user banks is affected differently by risk factors in different specialty groups. In both user and non-user banks, increased credit risks or loan charge offs is associated with lower ROA and with the effect larger for user banks. However, compared to the period before the financial crisis, user banks (excluding non-specialty banks) are less affected by the loan charge-offs than the non-user banks during and after the financial crisis. Meanwhile, compared to the period before the financial crisis, the non-user banks are actually more sensitive to the loan charge-offs during and after the financial crisis, while the user banks are less sensitive to the loan charge-offs. For example, ROA for user mortgage banks decreases 0.3% with 1% increase in charge-offs before the financial crisis but only decreases 0.2% during and after the financial crisis for mortgage specialists. But ROA for non-user mortgage banks only decrease 0.6% before the financial crisis but decreases 0.8% with 1% increase in loan charge-offs during and

after the financial crisis. Similarly, even though the negative effects of interest rate risks on ROA is also larger for user banks for the whole sample period, the effects are smaller for user banks after the 2008 financial crisis and agricultural banks are the least affected group. These results suggest that derivatives activities help mitigate the negative effects of credit risks and interest rate risks for user banks especially during and after the financial crisis.

For the whole sample period, the decrease in profitability due to increase in financial leverage or decreased equity capital is larger for user banks with one time increase in financial leverage for user agricultural banks associated with 0.18% decrease in ROA but about half the decrease or 0.09% for non-user banks. However, during and after the financial crisis, user and nonuser agricultural banks are equally affected (0.17%) by the decreased in equity capital.

Liquid assets usually have lower yield than other assets and increased holding of liquid asset is expected to affect negatively bank profitability. However, our results suggest that among the three single specialty groups, only non-user agricultural banks' profitability is hurt by the increase in liquid assets. Increase in liquid assets is negatively associated with profitability in multi-specialty and non-specialty banks, but this affect disappears and even reverses after the financial crisis.

Our results suggest that derivatives activities help mitigating, at least partially, the negative effects of credit risks and interest risks. User banks and agricultural banks are specialty group least affected by interest risks. This is important considering that most derivatives users started to use derivatives to hedge after the deregulation of 1999 and that smaller proportion of agricultural banks use derivatives compared to other specialty groups. Thus, risk management activities at agricultural banks, both on and off balance sheet are the more effective than the

other specialty groups and they already have mastered the sophisticated methods of risk management through derivatives.

Effects of derivatives activities on the profitability

**********Table 3a**********

**********Table 3b**********

After estimating the profitability equation for derivatives user and non-user agricultural banks, we estimate the effects of derivatives activities for both user and non-user banks according to equation (15) and (16) for the difference in profitability. These counterfactual effects are presented in Table 3a for the whole sample period between 1995 and 2012 (Q3) and in Table 3b for the sub-sample period between 2008 and 2012 (Q3).

For the whole sample period, by user and non-user of derivatives, user banks' profitability is different from that in not users. However, the differences exhibit different patterns across lending specialty groups. For users, profitability for agricultural, CRE and multi-specialty banks are higher than if they did not use derivatives. The difference for agricultural user banks are smallest, 0.14% increase in ROA for agricultural user banks compared to 2% increased in ROA for multi-specialty user banks. The profitability for mortgage user banks as well as non-specialty user banks is lower than that if they did not use derivatives. Given the fact that mortgage banks are much larger than other specialty groups and given that mortgage specialists have a longer history of derivatives activities, it is more likely that they not only used derivatives for risk management but also for profit or speculation and it is these speculations that hurt these banks' profitability.

For derivatives non-users, the difference in profitability if they used derivatives express similar pattern to that for user banks except that in agricultural banks the ROA is actually 0.05%

lower if they used derivatives. Therefore it seems that agricultural banks did not use derivatives because it was optimal to not use derivatives. However, agricultural banks are small and they are relatively new to the derivatives market, so is understandable that it takes longer for them to master the sophisticated techniques for risk management by using derivatives. Therefore, we expect that non-user agricultural banks will be better off at the later part of the sample period, especially during and after the 2008 financial crisis.

Table 3b presents the counterfactual effects for the sub-sample period between 2008 and 2012 (Q3). For derivatives users, the predicted ROA express the same patterns as for the whole sample period and mortgage as well as non-specialty banks are worse off due to their derivatives activities. Except for agricultural banks, the difference in ROA if they do not use derivatives is higher in magnitude than that for the whole sample period. This results suggests that the risk management activities during and after the financial crisis are more efficient for agricultural, CRE and multiple specialists. But due to the possible speculation activities and the huge increase in mortgage loans past dues, the predicted ROA for user banks are about 2.45% lower than that if they don't use derivatives compared to 0.39% for the whole sample period. However, for derivatives non-users, the predicted ROA is several times (about 0.7 to 3 times) higher if they use derivatives for all the specialty groups, even including mortgage specialists and non-specialty banks given the current balance sheet structure and risk levels. We interpret these results mean that community banks could benefit from the off-balance sheet risk management activities if derivatives are used for risk management purposes and not for speculating.

Conclusion

This paper studies the effect of derivatives use on community banks' profitability. Because of high fixed cost of participating in the derivatives market, small banks, such as agricultural banks,

usually have limited funding sources and are unlikely to take speculating derivatives positions. Thus, the paper provides insights of impact of mainly risk hedging activities on profitability in banks.

We use an endogenous switching regression which allows to control for banks' the endogenous choice to select into user and non-user of derivatives and permits computing counterfactual effects. Derivatives activities help mitigating, at least partially, the negative effects of credit and interest risks and boost the positive effects of improved internal management in derivatives user banks during and after the 2008 financial crisis, which are consistent with previous work (Shen and Hartarska, 2012). The profitability of the agricultural banks is significantly higher if they use derivatives than if they do not use derivatives and the difference in profitability is increasing over time. These results are consistent with results by Avery and Berger (1991), who found that derivatives use increases profitability in small banks.

Our results also show that while the profitability of larger mortgage specialists is negatively affected by the derivatives activities, other specialty banks have successfully hedged with derivatives especially after the financial crisis. These results suggest that large commercial banks, especially mortgage specialists, suffered losses in the recent financial crisis possibly due to speculating rather than risk management derivatives activities. Mortgage specialists could benefit from the derivatives activities if they refocus on using derivatives to hedge rather than speculating after the financial crisis. We therefore conclude that the purpose of the derivatives – risk hedging or speculation–matters.

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Table 1 Summary Statistics, 1995-2012 (Q3)

Variable	AG		Mortgage		CRE		Multi-Specialty		Non-Specialty	
	Non-user	User	Non-user	User	Non-user	User	Non-user	User	Non-user	User
ROA (%)	1.1	1.1	0.84	0.67	0.67	0.84	0.63	0.57	1.0	0.95
	(1.0)	(1.0)	(1.7)	(0.7)	(1.7)	(1.6)	(1.8)	(1.9)	(1.5)	(1.7)
Charge-off (%)	0.4	0.4	0.3	0.4	0.5	0.7	0.4	0.6	0.7	0.6
	(1.1)	(1.0)	(0.8)	(0.9)	(1.3)	(1.2)	(1.2)	(1.3)	(88.4)	(1.3)
Manage (%)	98.4	97.3	97.6	97.5	96.7	96.4	97.4	96.7	97.7	96.7
	(1.4)	(1.6)	(1.7)	(1.4)	(2.3)	(2.4)	(2.1)	(2.2)	(2.2)	(2.3)
Leverage	9.7	10.3	10.1	10.9	10.8	10.9	10.3	10.8	9.8	10.6
	(2.5)	(1.9)	(2.7)	(2.1)	(36.5)	(3.6)	(3.8)	(3.1)	(2.9)	(3.7)
Gap (%)	30.5	28.5	29.9	28.2	29.9	28.9	32.5	32.1	31.3	26.8
	(66.7)	(18.3)	(20.6)	(17.7)	(22.7)	(21.7)	(24.5)	(26.9)	(21.1)	(20.7)
Liquidity (%)	32.0	25.0	30.8	26.5	29.2	26.0	23.7	20.2	40.0	30.6
	(12.9)	(10.9)	(12.8)	(11.5)	(12.6)	(11.6)	(11.8)	(9.6)	(16.1)	(12.6)
BHC (%)	85	96	72	73	82	87	64	79	79	93
	(0.4)	(0.2)	(0.5)	(0.4)	(0.4)	(0.3)	(0.5)	(0.4)	(0.4)	(0.3)
Loan Ratio (%)	62.8	69.1	63.7	67.5	64.0	67.3	70.5	73.5	54.1	62.5
	(12.3)	(10.9)	(12.4)	(11.4)	(12.2)	(11.4)	(11.6)	(9.9)	(15.4)	(12.5)
AG Loans (%)	32.3	29.5	3.0	1.8	2.9	2.7	2.4	1.6	7.2	5.7
	(11.0)	(10.2)	(4.3)	(3.3)	(4.1)	(3.1)	(5.2)	(3.5)	(6.8)	(6.1)
Mortgage Loans (%)	9.5	11.6	33.4	32.6	18.3	19.0	24.8	23.5	16.6	17.9
	(6.5)	(6.2)	(6.9)	(6.1)	(8.8)	(8.5)	(17.5)	(15.9)	(8.4)	(7.5)
Consumer Loans (%)	5.3	3.7	4.4	2.1	4.7	2.8	5.4	3.0	7.2	4.3
	(3.2)	(2.8)	(3.5)	(1.9)	(4.0)	(2.4)	(7.0)	(4.7)	(5.2)	(4.1)
CRE Loans (%)	6.1	10.6	14.5	18.3	26.9	29.2	24.1	27.0	12.6	19.0
	(6.1)	(8.9)	(9.9)	(12.3)	(13.3)	(15.5)	(18.3)	(18.1)	(10.2)	(12.5)
C&I Loans (%)	8.2	9.7	6.0	6.7	7.6	6.7	10.6	11.2	8.2	9.4
	(4.5)	(4.3)	(4.8)	(4.1)	(4.8)	(4.2)	(9.2)	(8.6)	(5.3)	(4.9)
Total Asset	70.9	250.8	256.0	795.8	204.0	735.4	226.1	867.7	157.8	818.9
(US$ Millions)	(83.3)	(246)	(441.5)	(1,500)	(337.8)	(1,205)	(342.7)	(1,192)	(301.6)	(1,307)
# of Entities (2012 Q3)	1,010	119	322	58	148	28	2,454	512	2,793	462

Table 2a Regression Results, 1995 Q1-2012 Q3

VARIABLES	AG			Mortgage			CRE			Multi-Specialty			Non-Specialty		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User
Ln(Total Asset)	1.293***			1.413***			1.122***			0.777***			1.026***		
	(0.031)			(0.067)			(0.062)			(0.071)			(0.121)		
BHC	0.429***			-0.220***			-0.055			0.098***			0.409***		
	(0.042)			(0.037)			(0.063)			(0.018)			(0.055)		
D2000	1.414***			0.139**			0.230**			0.361***			0.822***		
	(0.186)			(0.067)			(0.099)			(0.034)			(0.051)		
Charge-off	0.0002	-0.375***	-0.439***	0.028	-0.584***	-0.317***	-0.013	-0.445***	-0.512***	0.021**	-0.293***	-0.648***	0.00002	-0.001***	-0.302***
	(0.009)	(0.023)	(0.052)	(0.022)	(0.217)	(0.023)	(0.020)	(0.056)	(0.088)	(0.008)	(0.103)	(0.030)	(0.00001)	(0.0001)	(0.038)
Manage	-0.047***	0.143***	0.138***	0.033**	0.102***	0.128***	-0.012	0.189***	0.204***	-0.039***	0.231***	0.217***	-0.040***	0.171***	0.136***
	(0.010)	(0.006)	(0.018)	(0.015)	(0.029)	(0.030)	(0.014)	(0.016)	(0.031)	(0.005)	(0.017)	(0.019)	(0.008)	(0.010)	(0.050)
Leverage	-0.073***	-0.097***	-0.185***	-0.001	0.008	-0.064***	-0.003**	-0.001	-0.021***	-0.004*	0.012**	-0.043***	-0.016***	-0.040***	-0.119***
	(0.008)	(0.007)	(0.034)	(0.011)	(0.048)	(0.012)	(0.001)	(0.001)	(0.006)	(0.002)	(0.006)	(0.011)	(0.006)	(0.010)	(0.046)
Gap	-0.002***	-0.0001*	-0.005***	-0.004***	-0.003	-0.008***	-0.003**	-0.006***	-0.008***	-0.001***	-0.006***	-0.002**	-0.005***	-0.005***	-0.007***
	(0.0004)	(0.0001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.0003)	(0.001)	(0.001)	(0.0005)	(0.0003)	(0.002)
Liquidity	-0.001	-0.006***	0.000	-0.003	0.0003	0.003	-0.006**	-0.003	-0.007	0.002**	-0.020***	0.007**	0.003***	-0.005***	-0.001
	(0.001)	(0.000)	(0.002)	(0.003)	(0.008)	(0.003)	(0.002)	(0.002)	(0.007)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)
Constant	-3.759***	-0.005*	-0.051	-1.588***	0.023	-0.158	-1.700***	-0.055***	0.834**	-1.804***	-0.028***	2.697***	-2.800***	0.023**	-0.849
	(0.190)	(0.003)	(0.100)	(0.068)	(0.015)	(0.109)	(0.114)	(0.017)	(0.361)	(0.051)	(0.007)	(0.401)	(0.118)	(0.011)	(1.497)
ln(ε0)	-0.204***			0.352***			0.249***			0.395***			0.148***		
	(0.030)			(0.133)			(0.048)			(0.029)			(0.023)		
ln(ε1)	-0.282***			-0.607***			0.187**			0.675***			0.196		
	(0.079)			(0.076)			(0.080)			(0.099)			(0.255)		
ρ0	-0.073***			0.099			-0.215***			-0.102***			0.159*		
	(0.017)			(0.077)			(0.051)			(0.018)			(0.093)		
ρ1	0.047			0.111			-0.404**			-1.210***			0.426		
	(0.064)			(0.108)			(0.199)			(0.191)			(0.737)		
Observations	70,152			13,754			8,067			128,217			175,333		
Log Likelihood	-94,148			-26,574			-15,443			-267,215			-308,022		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2b Regression Results, 2008 Q1-2012 Q3

VARIABLES	AG			Mortgage			CRE			Multi-Specialty			Non-Specialty		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User	Select	Non-user	User
Ln(Total Asset)	0.465***			0.051			0.812***			0.564***			0.129		
	(0.109)			(0.247)			(0.141)			(0.056)			(0.091)		
BHC	0.428***			0.169***			0.360***			0.244***			0.429***		
	(0.063)			(0.048)			(0.085)			(0.024)			(0.044)		
Charge-off	0.014	-0.385***	-0.361***	-0.124*	-0.830***	-0.202***	-0.006	-0.513***	-0.454***	0.016**	-0.551***	-0.525***	0.001	-0.009	-0.305***
	(0.013)	(0.023)	(0.048)	(0.064)	(0.134)	(0.067)	(0.020)	(0.073)	(0.098)	(0.006)	(0.018)	(0.028)	(0.002)	(0.007)	(0.021)
Manage	0.0005	0.185***	0.042	-0.028	-0.101	0.095*	-0.029	0.221***	0.082	-0.002	0.093***	0.082***	0.030*	0.235***	0.117***
	(0.024)	(0.024)	(0.042)	(0.037)	(0.087)	(0.050)	(0.025)	(0.047)	(0.056)	(0.006)	(0.016)	(0.028)	(0.017)	(0.037)	(0.034)
Leverage	-0.010	-0.174***	-0.176***	0.010	0.028	-0.108**	0.00005	-0.0003	-0.072***	-0.006**	-0.004	-0.052***	-0.008	-0.025*	-0.117***
	(0.019)	(0.025)	(0.051)	(0.041)	(0.067)	(0.043)	(0.0003)	(0.001)	(0.027)	(0.003)	(0.015)	(0.013)	(0.014)	(0.014)	(0.045)
Gap	-0.003**	-0.007***	-0.003	-0.001	-0.011***	-0.005**	-0.001	-0.011***	-0.0004	-0.002***	-0.008***	-0.001	-0.002**	-0.013***	-0.006***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.0005)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Liquidity	-0.001	-0.003*	0.004	0.002	-0.013**	0.002	-0.009**	0.004	0.012	-0.001	0.001	0.005	0.003**	-0.006***	-0.006
	(0.003)	(0.001)	(0.005)	(0.005)	(0.007)	(0.006)	(0.004)	(0.006)	(0.012)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)	(0.005)
Constant	-1.750***	-0.008	1.963***	-0.995***	0.354***	1.232***	-1.309***	-0.125***	2.124***	-1.109***	-0.076***	3.360***	-1.384***	0.259***	2.055***
	(0.059)	(0.007)	(0.348)	(0.085)	(0.048)	(0.168)	(0.078)	(0.044)	(0.515)	(0.016)	(0.012)	(0.332)	(0.043)	(0.016)	(0.225)
ln(ε0)	-0.065			0.563***			0.543***			0.545***			0.456***		
	(0.072)			(0.148)			(0.064)			(0.032)			(0.039)		
ln(ε1)	0.212			-0.031			0.587***			0.942***			0.482***		
	(0.147)			(0.114)			(0.123)			(0.093)			(0.077)		
ρ0	-0.040***			1.234***			-0.237***			-0.123***			0.904***		
	(0.010)			(0.172)			(0.072)			(0.021)			(0.081)		
ρ1	-1.421***			-1.445***			-1.014***			-1.632***			-1.238***		
	(0.180)			(0.161)			(0.299)			(0.110)			(0.157)		
Observations	18,169			4,045			2,623			40,814			47,627		
Log Likelihood	-29,516			-8,446			-6,138			-97,567			-101,012		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3a. Counterfactual Effects, 1995 Q1-2012 Q3

	Predicted ROA for Derivatives User			Predicted ROA for Derivatives Non-User		
Specialty Groups	ROA(Duser=1)	ROA (Duser=0)	Difference	ROA(Duser=1)	ROA (Duser=0)	Difference
AG Single Specialty	1.13	0.99	0.14***	1.08	1.14	-0.05***
	(0.53)	(0.42)	(0.17)	(0.64)	(0.44)	(0.34)
Mortgage Specialty	0.54	0.85	-0 .31***	0.69	0.86	-0.17***
	(0.36)	(0.52)	(0.26)	(0.35)	(0.50)	(0.26)
CRE Specialty	0.85	0.25	0.61***	1.59	0.667	0.92***
	(0.85)	(0.69)	(0.21)	(1.12)	(0.69)	(0.76)
Multiple Specialty	2.52	0.52	1.99***	3.59	0.651	2.94***
	(2.02)	(0.74)	(1.57)	(1.08)	(0.59)	(0.71)
Non-Specialty	0.86	1.23	-0.37***	0.11	1.01	-0.90***
	(0.63)	(0.28)	(0.47)	(26.14)	(0.26)	(26.04)

Standard Deviation in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3b. Counterfactual Effects, 2008 Q1-2012 Q3

	Predicted ROA for Derivatives User			Predicted ROA for Derivatives Non-User		
Specialty Groups	ROA(Duser=1)	ROA (Duser=0)	Difference	ROA(Duser=1)	ROA (Duser=0)	Difference
AG Single Specialty	1.12	1.06	0.06***	3.19	1.03	2.16***
	(0.45)	(0.47)	(0.13)	(0.47)	(0.52)	(0.11)
Mortgage Specialty	0.61	3.06	-2.45***	1.94	0.26	1.68***
	(0.30)	(0.61)	(0.37)	(0.29)	(0.94)	(0.74)
CRE Specialty	0.67	-0.09	0.77***	2.42	-0.11	2.53***
	(0.70)	(0.81)	(0.31)	(4.78)	(1.04)	(4.69)
Multiple Specialty	2.44	0.38	2.06***	4.57	0.612	3.96***
	(2.23)	(0.85)	(1.91)	(1.15)	(0.86)	(0.77)
Non-Specialty	0.79	2.78	-1.99***	3.10	0.605	2.49***
	(0.64)	(0.24)	(0.59)	(3.54)	(0.28)	(3.42)

Standard Deviation in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix1: Empirical Model Variables

Variables	Calculation	Predicted Signs in Profit Function
Dependent Variable		
Profitability	$\text{ROA} = \frac{\text{Net Income}}{\text{Total Asset}}$	-
Explanatory Variable		
Capital Adequacy	$\text{Leverage} = \frac{\text{Total Asset}}{\text{Equity Capital}}$	Negative
Liquidity Risk	$\text{Liquidity} = \frac{\text{Current Asset}}{\text{Total Asset}}$	Negative
Default Risk	$\text{Charge} - \text{off} = \frac{\text{Charge} - \text{Offs}}{\text{Total Loan}}$	Negative
Interest Risk	$\text{Gap} = \frac{\lvert\text{Net Short} - \text{term Asset}\rvert}{\text{Earning Asset}}$	Negative or Positive
Management	$\text{Manage} = \frac{\text{Earning Asset}}{\text{Total Asset}}$	Positive

Note: Data used in this study are from FDIC's Reports of Condition and Income (Call Report).

Appendix2: Definition of Lending Specialty Groups

Lending Specialty Group	**Definition**
Agricultural Specialists	Agricultural production loan plus loans secured by farmland greater than 20% of total assets
Mortgage Specialists	Residential Mortgage loans greater than 30% of total assets
Consumer Specialists	Credit card lines and other loans to individuals greater than 20% of total assets
Commercial Real Estate (CRE) Specialists	construction and development (C&D) loans greater than 10% of total assets OR total CRE loans (C&D, multifamily, and secured by other commercial properties) greater than 30% of total assets
Commercial &Industrial (C&I) Specialists	C&I loans greater than 20% total assets
Multi-Specialists	Meets more than one of the single-specialty definition above OR holds either retail loans* or commercial loans** greater than 40% of total assets
No Specialty	All other institutions

Source: FDIC

Note: All specialty groups require the bank to hold loans greater than 33% of total assets. *retail loans include 1-4 family residential real estate loans and loans to individual. **commercial loans include CRE loans and C&I loans.