Monetary Policy and Agricultural Lenders' Risk Appetite

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Introduction

Farm loan risk is influenced by monetary policy and the financial health of the agricultural sector. The agricultural sector experiences its own business cycle, which isn't always in sync with the broader U.S. business cycle. Times may be good for farmers when times are bad for most other consumers. Agricultural lenders are affected by both of these cycles; on the demand side, borrowers' ability to repay is affected by the health of the agricultural sector; on the supply side, interest rates faced by leveraged lenders are influenced in large part by macroeconomic factors. This paper investigates how the Federal Reserve's monetary policy decisions affect banks' loan risk-taking. We also study how the agricultural business cycle affects loan risk-taking. We are primarily interested in how risk-taking varies based on the share of agricultural loans in a bank's loan portfolio.

There is an extensive literature on monetary policy and its effects on banks' risk-seeking behavior. Research by Dell'Ariccia, Laeven, and Suarez (2017) show that risk rating of new loans made in a given quarter is inversely related with the federal funds rate, and Jiménez et al. (2014) find that easing monetary policy contributes to riskier lending. These and other studies have shown monetary policy to have heterogeneous effects across banks (Dell'Ariccia, Laeven, and Suarez 2017; Jiménez et al. 2014; Chodorow-Reich 2014; Altunbas, Gambacorta, and Marques-Ibanez 2010; Buch, Eickmeier, and Prieto 2011; Ioannidou, Ongena, and Peydró 2008). Less research has been done on how the federal funds rate affects individual sectors. If the change in banks' risk-taking in response to a change in interest rates is conditional, in part, on observable bank characteristics, then it is reasonable to expect significant differences in how lending behavior changes between sectors. We aim to investigate the risk-responsiveness of agricultural banks relative to non-agricultural banks with respect to both monetary policy and the economic performance of the agricultural sector.

This study is the first to join research in agricultural finance with research on the interaction between bank risk-taking and shifts in U.S. monetary policy. The majority of prior research that has looked into the nuanced effects of monetary policy on lending activity has sought to explain differences in banks' responsiveness to interest rates with differences in capital ratios between institutions. We extend this work into the literature of agricultural finance by compar-

ing changes in risk-taking behavior between institutions with different levels of risk exposure to the agricultural industry. More specifically, we take a look at how agricultural banks change the riskiness of their agricultural loan portfolios in response to changes in monetary policy in comparison to how non-agricultural banks change their loan portfolio risk. We use data from the Federal Reserve's Survey of Terms of Bank Lending to Farmers, which we refer to as the Survey of Terms. Survey of Terms data has not yet been used in academic research. We present research using a similar survey, the Survey of Terms of Business Lending, in the following section.

Literature Review

The effective federal funds rate (EFFR), also known as the overnight rate, is the interest rate at which commercial lenders borrow from one another in overnight markets. It is primarily determined by short-term interest rates set by the Federal Reserve. The EFFR determines loan interest rates by increasing a bank's cost of funds; when a bank's cost of funds goes up, it will raise interest rates charged to borrowers. High loan interest rates can increase default risk for borrowers under financial stress. The positive correlation between the cost of a loan and its probability of default is the main link between loan risk and monetary policy. Some borrowers will find themselves unable to afford new or existing loans when interest rates are high. This can lead to lower repayment rates on outstanding lines of credit and fewer new loans taken out by higher-risk borrowers. Lenders may respond to high interest rates by lending to more creditworthy borrowers, foregoing loan risk premiums in favor of relatively high returns on safer assets.

B. S. Bernanke and Gertler (1995) note that, while monetary policy is understood to affect spending via the interest rate pass-through effect, it also operates via a credit channel. The credit channel amplifies the effect of an increase in the federal funds rate by increasing the difference between a firm's cost of external debt and the cost of retained earnings, which is the rate of return required by shareholders. Banks with lower capital ratios will see their margins compress more than less levered banks and change their borrowing behavior in excess of what they might have

done if not for their liabilities. This is an example of how the structure of credit markets can ”amplify” the effects of monetary policy. Within this vein of research are observations of the specific effects of monetary policy on bank risk-taking. One such observation from B. Bernanke (1990) was that higher interest rates lead to a long-term reduction in the number and volume of loans issued by banks. Another mechanism at play is the ”flight to quality”, which is described by B. Bernanke, Gertler, and Gilchrist (1994) as the tendency of lenders to favor borrowers with fewer agency problems, or conflicts of interest, at the firm-level. Also, as pointed out by Dell'Ariccia, Laeven, and Suarez, agency problems typically scale with the leverage ratio of a bank. Although B. Bernanke, Gertler, and Gilchrist discuss agency problems from the borrower's side of the transaction as opposed to Dell'Ariccia, Laeven, and Suarez's focus on agency problems for the lender, the latter group of authors do find trends in their data that speak to the flight to quality explanation as written about by B. Bernanke, Gertler, and Gilchrist.

Other studies find the same overall negative effect of interest rates set by a central banking authority on the riskiness of lenders' loan portfolios. Fishburn and Porter (1976) put forth a model of bank risk-taking that is a function of the risk-free rate and an institution's risk aversion; assuming that banks do not exhibit decreasing absolute risk aversion, an increase in the return on a safe asset will always incentivize a bank to increase their monitoring effort, thus lowering their loan portfolio risk (ibid.). More recent literature finds evidence for this theory in data. Maddaloni and Peydró (2011) show that lower interest rates leading up to the 2008 financial crisis reduced banks' incentive to monitor their loan portfolios, thus resulting in lower lending standards. Similar effects are found outside of the U.S. as well, from Bolivia (Ioannidou, Ongena, and Peydró 2008) to Spain (Jiménez et al. 2014). One theory that has been heavily investigated in financial literature is the search for yield effect, which predicts a negative relationship between interest rates and bank risk-taking (Buch, Eickmeier, and Prieto 2011; Delis and Kouretas 2011; Jiménez et al. 2014). Banks with lower capital ratios, and thus higher leverage, fund more of their investments and loans with money raised via debt and deposits, which means that a reduction in the return on safe assets will incentivize a highly levered bank to seek riskier investments with higher expected returns, conditional on repayment (Dell'Ariccia, Laeven, and Suarez 2017). Jiménez et al. find a more negative effect of interest rates on loan

risk for less capitalized banks, which is evidence of a search for yield effect. Dell'Ariccia, Laeven, and Suarez find a less negative effect for less capitalized banks, which is indicative of a risk-shifting effect. The risk-shifting effect actually predicts a positive relationship between bank risk-taking and interest rates. However, since this positive effect may be outweighed by the negative effects predicted by the search for yield effect and the classical model set forth by Fishburn and Porter, the net effect of interest rates on risk is often negative.

Finance literature has used microdata from the Federal Reserve's Survey of Terms of Business Lending to examine the impact of monetary policy and business cycles on loans made by commercial banks (Black and Rosen 2016; Dell'Ariccia, Laeven, and Suarez 2017; Li, Loutskina, and Strahan 2019). Dell'Ariccia, Laeven, and Suarez use loan risk rating data from the Survey of Terms of Business Lending to examine bank risk-taking under tightening monetary policy. The authors find a significant negative relationship between the effective federal funds rate and the average risk rating of discretionary loans made during the report period. Black and Rosen and Li, Loutskina, and Strahan study how loan supply responds to changes in the federal funds rate. Black and Rosen hypothesize that tightening monetary policy reduces the supply of loans via a shortening of loan maturity. They show that an increase in the federal funds rate is associated with a 3.3% decrease in average loan term lengths. Using the same data on loan maturity from the Survey of Terms of Business Lending as Black and Rosen, Li, Loutskina, and Strahan show that banks with deposit market power issue longer-maturity loans than banks operating in more competitive, less concentrated markets. The Survey of Terms of Business Lending collects loan-level information similar to what is collected by the Survey of Terms of Bank Lending to Farmers. The Survey of Terms is described below.

Data

Each quarter, the Federal Reserve releases the Survey of Terms to commercial banks who issued agricultural loans. The survey collects information from commercial banks on loans made during the first full business week of the second month of each quarter. Recipients are chosen via stratified sampling methods, and response is voluntary. The survey collects loan-level data

on farm loan terms that includes face value, nominal rate of interest, maturity date, primary purpose, federal insurance status, collateral, risk rating, and syndication status. Information on loan risk rating has been available since 1997, so this is the earliest year we use in our analysis. The survey data is joined with call report data that reports bank-level information such as total assets, Tier 1 capital, and agricultural loan volume.

It is important to note that agricultural credit associations, farm credit banks, and other Farm Credit System (FCS) lending institutions are not included in the Survey of Terms. In 2023, FCS institutions held almost half of total outstanding U.S. farm debt, according to the USDA ERS's Farm Income and Wealth Statistics report; commercial banks held just over one-third of farm debt that same year (Mashange 2025). This means that the sample of banks included in the Survey of Terms is not representative of institutions that hold the majority of farm debt. Any results from this analysis should be considered applicable only to U.S. commercial banks that lend to farm operators.

We will use the Ag Economy Barometer, developed by Purdue University and CME Group, as a measure of the health of the agricultural sector. The Ag Economy Barometer is measured using data from a quarterly survey of economic sentiment and financial outlook. Purdue University collects quantitative and qualitative data from agribusiness professionals to assess both current sentiment and future expectations for the agricultural economy. Survey respondents are asked to compare current conditions with past farm performance and with future expectations.

Agricultural Banks

Table 1: Variable Averages by Share of Ag Loans (Quartiles)

Variable	1^{st} Quartile	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
Total Assets (Log)	16.55	12.95	12.23	11.69
Tier 1 Capital Ratio	0.11	0.14	0.14	0.16
Deposit to Asset Ratio	1.33	1.20	1.19	1.20
Net Income to Total Assets	0.02	0.02	0.02	0.02
Loan Amount	150923.50	62398.90	73949.62	84264.49
Interest Rate	6.87	7.28	7.29	7.27
Risk Rating	3.25	2.83	2.89	2.59
Maturity (Months)	37.28	31.94	27.29	25.97

To produce the summary statistics in Table 1, we divide banks into quartiles based on the concentration of agricultural loans in their loan portfolio. This variable comes from bank call reports. Banks with the lowest ratios of agricultural loans to total loans are in the first quartile, while banks with the highest ratios are in the fourth quartile. Banks in the latter category are considered to be specialized lenders. Specialized lenders tend to be smaller institutions, with the vast majority holding under $1B in assets. They typically have higher Tier 1 capital ratios than less specialized bank, which means they are less leveraged. They also offer, on average, lower-risk, smaller, more expensive loans than the least ag-focused banks in the Survey of Terms.

Methods

Conceptual Model

Our approach to answering the question of whether there is a significant difference in how agricultural banks change their loan risk exposure as opposed to non-agricultural banks is based on the model developed by Dell'Ariccia, Laeven, and Marquez (2014). The authors base their research on two different categories of models through which we may observe the interaction between monetary policy and bank risk-taking. Portfolio allocation models predict an inverse relationship between interest rates and bank risk-taking. As monetary policy tightens, the expected return on less risky assets increases by more than the expected return on risky assets for projects of similar scopes. This effect takes place primarily via a monitoring channel in which high interest rates increase the marginal benefit of monitoring, which in turn increases the optimal level of monitoring and thus decreases the overall riskiness of the bank's portfolio (Dell'Ariccia, Laeven, and Suarez 2017). Altogether, according to these models, banks are incentivized to move away from investments that have a higher probability of default under tightening monetary policy. On the other hand, moral hazard models that incorporate agency problems offer ambiguous predictions on the relationship between interest rates and the riskiness of a bank's portfolio. Agency problems arise when there are conflicts of interest among a business's stakeholders. We consider two main effects captured by this class of model: the first is a risk-shifting effect, which predicts a positive relationship between interest rates and

portfolio risk; the second is a search for yield effect, which, as in portfolio theory, predicts an inverse relationship. Which of these effects dominates is a function of a bank's asset-liability mismatch. Higher interest rates will lead to risk-shifting in cases where a bank invests in assets with longer maturities with short-term funding. This is known as maturity mismatch and is an example of an agency problem. The more severe the mismatch in asset-liability maturities, the greater the risk-shifting effect. For institutions with long-term liabilities and short-term assets, the search for yield effect dominates. Theoretical models of search for yield see institutions such as pension funds and life insurance companies invest in less risky short-term assets with increasing interest rates, resulting in an inverse relationship similar to that predicted by models of portfolio allocation. However, the magnitude of the search for yield channel is a function of the bank's leverage or level of capitalization, as is the magnitude of the risk-shifting channel.

Dell'Ariccia, Laeven, and Suarez find evidence of a risk-shifting channel using data from the Federal Reserve's Survey of Terms of Business Lending. This survey collects non-agricultural loan-level data from commercial banks each quarter and includes the risk rating for each loan made since 1997 on a discrete scale from one to five. Similar to Jiménez et al., they use an interaction term between bank capital and the effective federal funds rate to determine whether there is a significant difference in risk-taking behavior with respect to changes in the federal funds rate between more and less well-capitalized banks. As mentioned previously, they find that the effective federal funds rate has a less negative effect for more levered banks. This theory of bank risk-taking is contingent on the concept of limited liability. Under limited liability,in the case of failure, a bank's shareholders are not responsible for repaying debts and liabilities, such as deposits, owed by the bank in excess of their own level of investment. Dell'Ariccia, Laeven, and Marquez capture this effect by deriving bank profit (represented with equation 1) with respect to monitoring effort:

$$\Pi = \left(q\left(r_L - r_D(1-k) - r_E k\right) - \frac{1}{2}cq^2 \right) L(r_L) \tag{1}$$

Π is a function of monitoring effort q, monitoring cost c, the interest rate on issued loans r_L, a downward-sloping loan demand curve $L(r_L)$, the deposit rate r_D, the bank's capitalization k, which equals 1 if the bank is fully capitalized and 0 if fully levered, the yield on equity $r_E = \frac{r^* + \xi}{q}$

as a function of the risk-free rate r^*, the equity premium ξ, and monitoring effort (Dell'Ariccia, Laeven, and Marquez 2014). For our purposes, we interpret the risk-free rate as representative of the effective federal funds rate.

Rewriting Π in terms of r^*:

$$\Pi = \left(q(r_L - r_D(1-k)) - (r^* + \xi)k - \frac{1}{2}cq^2 \right) L(r_L) \tag{2}$$

Taking first-order conditions of Equation 2 and solving for the profit-maximizing level of q in terms of r^*:

$$\hat{q} = min \left\{ \frac{r_L - r_D(1-k)}{c}, 1 \right\} \tag{3}$$

$$\hat{q}(k) = \frac{1}{2c} \left(r_L + \sqrt{r_L^2 - 4cr^*(1-k)} \right) \tag{4}$$

From Equation 4, we can see that when $k = 1$, $\frac{\delta \hat{q}(k)}{\delta r^*} = 0$; but when $k < 1$, $\frac{\delta \hat{q}(k)}{\delta r^*} < 0$. This is the risk-shifting effect: monitoring effort does not change for banks that are fully capitalized, but, due to limited liability, more levered banks will decrease their monitoring effort as the risk-free rate increases. However, note that this effect is often fully outweighed by pass-through and search for yield effects as previously described. This is why Dell'Ariccia, Laeven, and Suarez could only see a risk-shifting effect in the difference in overall negative effects of the effective federal funds rate on more versus less capitalized banks' risk-taking behavior.

While there are important differences in risk-taking behavior between more and less leveraged banks, this is not the focus of our research question. We want to isolate the impact of being a specialized agricultural lender on a bank's risk-taking response to a change in the federal funds rate. We include an interaction term between a bank's Tier 1 capital ratio and the federal funds rate to control for any risk-shifting or search for yield effect that may bias our coefficient results. Our estimation steps are outlined in the following section.

Empirical Methods

Our empirical model of bank risk-taking is most informed by Dell'Ariccia, Laeven, and Suarez. In our first and most simple representation, the risk rating σ of loan i given by a bank k in time t is a function of short-run interest rates r_t, loan-specific control variables X_{ikt}, bank-specific control variables Z_{kt}, and an error term:

$$\sigma_{ikt} = \beta + \alpha r_t + \Psi X_{ikt} + \Theta Z_{kt} + \varepsilon_{ikt} \tag{5}$$

We extend Equation (5) with the inclusion of bank-specific fixed effects, τ_k, which control for time-invariant heterogeneity among banks:

$$\sigma_{ikt} = \beta + \alpha r_t + \Psi X_{ikt} + \Theta Z_{kt} + \tau_k + \varepsilon_{ikt} \tag{6}$$

If there is a pass-through effect of short-term interest rates on bank risk-taking, then we expect α in Equations (5) and (6) to be negative. However, Dell'Ariccia and Marquez (2013) note that this pass-through effect is partially offset by a risk-shifting effect when banks cannot adjust their leverage in response to changes in the federal funds rate. Banks' capital structures are taken as exogenous in these scenarios. Recall from the previous section that the risk-shifting hypothesis of monetary policy predicts a positive effect of interest rates on bank risk-taking. Dell'Ariccia, Laeven, and Suarez find that this effect is stronger for more levered banks with lower capital ratios. To control for risk-shifting or search for yield effects, we include an interaction between the bank's Tier 1 capital ratio and the federal funds rate:

$$\sigma_{ikt} = \beta + \alpha r_t + \Psi X_{ikt} + \Theta Z_{kt} + \gamma r_t T1_{kt} + \tau_k + \varepsilon_{ikt} \tag{7}$$

Note that Z_{kt} in Equation 7 includes the bank's Tier 1 capital ratio. The sign of γ will reveal evidence of either risk-shifting or search for yield effects in the Survey of Terms data. If α is significant and negative, which would be consistent with the existing literature, then a significant and positive γ would be evidence for a stronger risk-shifting effect; a negative γ would suggest a stronger search for yield effect. Although the coefficients estimated above

would be revealing in their own right, Equation 7 does not help us answer our research questions. We are interested in how a bank's level of agricultural loan concentration affects its risk-taking behavior with respect to changes in benchmark rates. We include an interaction between the federal funds rate and Tier 1 capital ratios in our baseline model to control for any risk-shifting or search for yield effects that may scale with the amount of agricultural loans in a bank's portfolio.

Our first research question addresses risk-taking in these markets by agricultural banks and non-agricultural banks with respect to changes in monetary policy. To investigate whether agricultural banks react differently than non-agricultural banks to changes in the federal funds rate, we include a variable that captures the percentage of a bank's loan portfolio that is made up of farm loans:

$$\sigma_{ikt} = \beta_0 + \beta_1 AgLoans_{kt} + \alpha_1 r_t + \alpha_2 r_t AgLoans_{kt} + \Psi X_{ikt} + \Theta Z_{kt} + \gamma r_t T1_{kt} + \tau_k + \varepsilon_{ikt} \quad (8)$$

The coefficient on the interaction term between the interest rate and the level of financial risk exposure a bank has to the agricultural sector, α_2 in Equation 8, captures the difference in net effect of interest rates on risk-taking for banks that are more or less invested in the agricultural sector. We expect α_1 to be negative, which would be consistent with previous literature showing that banks reduce the riskiness of loans they issue when the federal funds rate increases. If α_2 is also negative, then this implies that banks with more agricultural lending expertise are more responsive than less specialized lenders to changes in monetary policy. If α_2 is positive as we hypothesize, then specialized lenders are less responsive to an increase in benchmark rates since the sum of α_1 and α_2 would be less negative than α_1.

Our second research question asks the following: are specialized agricultural lenders more or less responsive to changes in the health of the agricultural economy than other lenders? To reiterate, we refer to responsiveness in this paper as the average risk-rating of new farm loans issued in a quarter. We will answer this question with a regression similar to that above. Instead of using the federal funds rate to estimate α_2, we use the Purdue Ag Economy Barometer:

$$\begin{aligned}\sigma_{ikt} =& \beta_0 + \beta_1 AgLoans_{kt} + \beta_2 Barometer_t + \alpha_1 r_t + \alpha_2 Barometer_t AgLoans_{kt} + \\ & \Psi X_{ikt} + \Theta Z_{kt} + \gamma r_t T1_{kt} + \tau_k + \varepsilon_{ikt}\end{aligned} \quad (9)$$

We include r_t in Equation 9 as a control for macroeconomic shocks that affect all banks and sectors. α_2 is our coefficient of interest. It is only interpretable in conjunction with β_2. If both β_2 and α_2 are positive and significant, then we can conclude that more specialized agricultural lenders are more responsive to changes in the health of the agricultural economy than less specialized lenders. However, if β_2 and α_2 are of opposite signs, interpretation is dependent on the magnitude of each coefficient and other model specifications. We hypothesize that the magnitude of a bank's reaction to a shift in the performance of a particular sector, in this case agriculture, is positively correlated with the bank's current financial risk exposure to that sector.

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