

# Can the Ag Credit Survey Predict National Credit Conditions?

*By Brian C. Briggeman and Christopher Zakrzewicz*

With the farm boom ending in 2009, many farmers have become less able to repay short-term loans. As farm profit margins erode and farm loan delinquencies rise, some in the agricultural industry worry that lending standards will tighten—as they did in the farm debt crisis of the 1980s.

One barometer of future agricultural credit conditions is agricultural bankers. Experience and access to information give these bankers a unique perspective on agricultural credit conditions. In fact, several Federal Reserve banks survey agricultural bankers in their district to tap this source of information.

But how reliable are regional Federal Reserve agricultural credit surveys? And can a regional survey shed light on future loan delinquencies and credit standards nationwide?

This article examines the Federal Reserve Bank of Kansas City's *Survey of Agricultural Credit Conditions* to explore these questions. The first section describes the relationships between farm income, repayment rates, and loan delinquencies. The second section explains what the Kansas City Survey reveals about current and expected loan repayments in the

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district—and how reliable its predictions are. The third section explores the relationship between the Survey’s predictions for farm loan repayments in the Tenth District and farm loan delinquencies on a national scale. The fourth section tests whether the Survey’s forecasts for district credit requirements can predict changes in credit standards nationwide.

The article concludes that the *Survey of Agricultural Credit Conditions* reliably predicts farm loan repayment rates in the district and provides valuable insight into future farm loan delinquencies and credit standards nationwide. The most recent Survey data suggest that the nation’s farm loan delinquencies will continue to rise in the year ahead, which may cause collateral requirements to stay elevated heading into 2010.

## I. AGRICULTURAL CREDIT CONDITIONS DETERIORATE

The farm sector was not immune to the recent recession and financial crisis. Falling demand for agricultural products cut net farm incomes by nearly 40 percent in 2009, increasing financial stress on farm operations. Declining net farm incomes have hindered farmers’ ability to repay loans, causing farm loan delinquencies to rise from historical lows.

The relationship between net farm income, farm loan repayments, and the volume of delinquent farm loans provides a clear picture of agricultural credit conditions. As net farm incomes fall, farm loan repayments also tend to fall, leading to a rising volume of delinquent farm loans. Conversely, when incomes rise, repayment rates rise, and delinquencies fall. Consequently, a rising volume of delinquent farm loans indicates rising stress in credit markets.

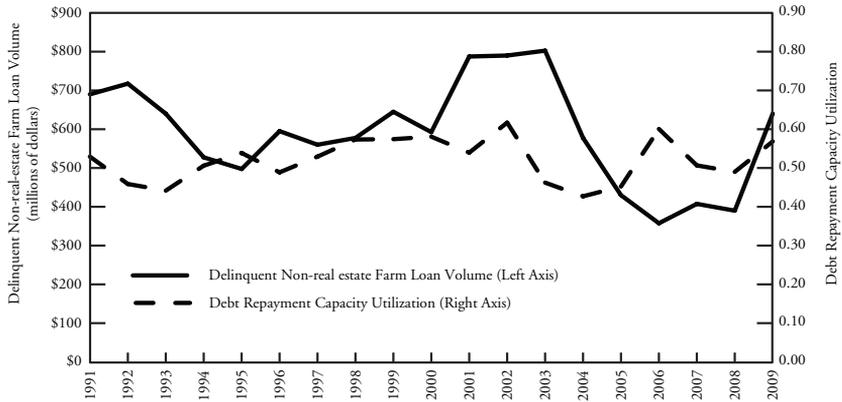
Rising delinquent non-real estate farm loans (loans more than 90 days past due) are preliminary signs of stress in agricultural credit markets. Non-real estate farm loans are typically used to pay for working capital needs. They are short-term in nature and often have the most flexible loan terms. As a result, these short-term loans are the first to be extended or “rolled over” before delaying payments on longer-term real estate loans.

With farm incomes falling in 2009, delinquent non-real estate farm loan volumes have edged upward (Chart 1). Delinquent farm loan volumes have exceeded \$600 million during the year, up 70 percent from a year ago. Current volumes, however, still remain below levels

Chart 1

## NATIONAL DELINQUENT NON-REAL ESTATE FARM LOANS AND U.S. FARM SECTOR

Repayment Ability: 1991 to 2009



Source: Ag Finance Databook and USDA

of the last rise in delinquent farm loan volumes. From 1998 to 2002, falling net farm incomes helped push delinquent farm loan volumes to approximately \$800 million. During the farm debt crisis of the 1980s, delinquent farm loan volumes exceeded \$2 billion.<sup>1</sup> While today's delinquent loan volumes remain historically low, they are on the rise, signaling deteriorating agricultural credit conditions.

At the root of the delinquent loan problem is the farm sector's increasing inability to repay debt (Chart 1). While a national data series of loan repayment rates is not available, USDA provides information on farmers' capacity to repay loans. The Debt Repayment Capacity Utilization (DRCU) measure is a debt-to-income ratio. It divides the amount of outstanding debt and interest for the U.S. farm sector by the amount of farm income available to service debt and interest.<sup>2</sup> A DRCU of 1 indicates that farmers have just enough income to service their outstanding debt. Values above 1 indicate farmers lack the capacity to service their debts, while values below 1 indicate they have more than enough income to do so.<sup>3</sup>

The DRCU is influenced by farm incomes, debt levels, and interest rates. When farm incomes rise, farmers have more capacity to pay off debt and the DRCU declines. The opposite occurs when farm incomes

fall. The projected 40 percent decline in farm incomes in 2009 has contributed to a 16 percent rise in the DRCU, from 0.49 to 0.57. In contrast, farm debt levels are anticipated to fall 2 percent in 2009, which has actually lowered the DRCU. Similarly, lower interest rates have trimmed interest payments on debt and contribute to lower DRCU levels. Today, the projected 2009 DRCU is rising due to depressed net farm incomes—but the measure still remains well below 1.

Changes in farmers' capacity to repay loans tend to predict changes in delinquency rates. For example, annual farm loan delinquency rates have a strong correlation with the prior year's DRCU. A simple one-year lag correlation of 0.5 shows that the current DRCU tends to rise and fall with next year's delinquency of non-real estate farm loans. Therefore, a rising DRCU tends to lead a rise in delinquent farm loans. The current increases in both the DRCU and delinquent non-real estate farm loans raise concerns that future agricultural conditions might continue to deteriorate, especially with lower farm income levels.

## II. THE AG CREDIT SURVEY

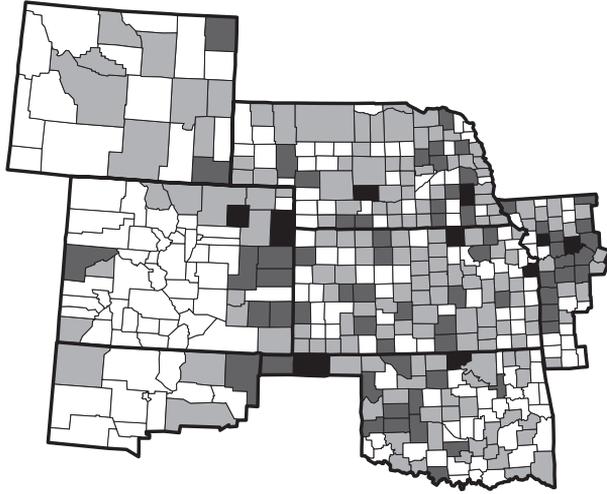
While national delinquent farm loan volumes and the DRCU describe current national agricultural credit conditions, neither provides information regarding the future. Moreover, the DRCU is only available once a year. To access more timely information about both current and expected farm loan repayment trends, many analysts consult regional surveys published by the Federal Reserve.<sup>4,5</sup> Kansas City's *Survey of Agricultural Credit Conditions* is one of these. This section finds that the trends it reports are a reliable predictor of the future path of regional repayment rates. The following sections explore whether the Survey's regional predictions shed light on national conditions.

### *Survey description*

Each quarter, the Kansas City Survey asks agricultural bankers in the Tenth District to report on current credit conditions in their market area (Map).<sup>6</sup> Agricultural bankers are defined as managers of banks with a greater percentage of agricultural loans in their loan portfolio than the national average (approximately 15 percent). Agricultural bankers are in a unique position to provide insights into the path of

*Map*

## NUMBER OF RESPONDENTS TO THE FEDERAL RESERVE BANK OF KANSAS CITY'S SURVEY OF AGRICULTURAL CREDIT CONDITIONS



Note: White counties have no respondents, light grey counties have 1 respondent, dark grey counties have 2 respondents, and black counties have 3 or more respondents.

agricultural credit conditions because agriculture is an intensive user of debt capital.<sup>7</sup>

The Tenth District comprises more than 650 agricultural banks, which represent nearly 60 percent of all banks in the district. On a national scale, these banks represent nearly 30 percent of all agricultural banks. Moreover, more than 250 agricultural bankers respond to the Kansas City Survey.

A primary goal of the Survey is to gain agricultural bankers' perspectives on current and expected farm loan repayment rates.<sup>8</sup> In 2002, the survey was expanded to ask agricultural bankers about their expectations of agricultural credit conditions in addition to current trends. Specifically, the bankers are asked if they have experienced higher, lower, or no change in repayment rates over the past three months and if they expect higher, lower, or no change in rates over the next three months.

The Survey uses diffusion indexes to give clear indications of the current and expected path of loan repayment rates for non-real estate farm loans.<sup>9</sup> Current and expected diffusion indexes are determined by

subtracting the percent of agricultural bankers reporting lower repayment rates from the percent reporting higher rates and then adding 100. As a result, a diffusion index of 100 suggests no change in repayment rates, while an index above 100 means rising loan repayments, and an index below 100 means declining rates.

### *How reliable are farm loan repayment rate predictions?*

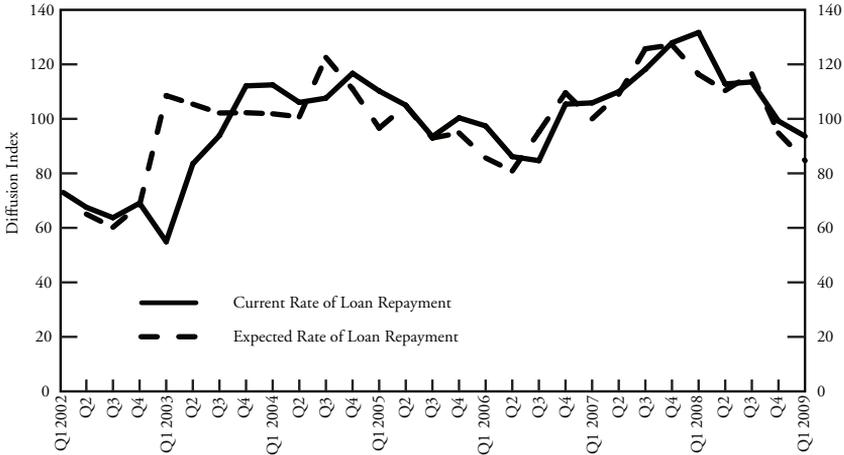
The current and expected diffusion indexes also provide a way to see how well agricultural bankers in the Survey predict future farm loan repayment rates in the district. Past current indexes can be checked against historical trends in net farm incomes. If the current and expected indexes closely follow each other throughout time, then the predictions are reliable. The same is true for forecasts of turning points in repayment rates.

The current repayment index tends to follow historical income trends in the farm sector (Chart 2). Coming off two years of declining farm incomes, the current rate of loan repayments remained low in 2002 as farmers began to return to profitability. In 2004, farm profits surged for both crop and livestock operators, and loan repayment rates rose above 100. A small dip in repayment rates occurred in 2006 as profit margins were trimmed from their 2004-05 highs. Farm profits rebounded, however, with the run-up in commodity prices in late 2007 and 2008, which led to higher loan repayment rates. More recently, commodity prices have come down from their recent highs, farm profitability has declined, and the current loan repayment index now lies below 100, with more agricultural bankers reporting that loan repayments on non-real estate farm loans have declined.

As the current index rises and falls, so does the expected index. In the first quarter of 2002, when the survey was expanded, more agricultural bankers felt that loan repayment rates were going to decline in the second quarter, and the current index did indeed fall in the second quarter. Since 2002, a strong relationship has existed between the expected and current indexes. In fact, the indexes have a correlation of 0.72. And, a straightforward linear regression shows that over half of the variation in the current index was explained by movements in the expected index.<sup>10</sup>

Chart 2

## CURRENT AND EXPECTED RATE OF NON-REAL ESTATE FARM LOAN REPAYMENT DIFFUSION INDICES (2002 TO 2009)



Source: Federal Reserve Bank of Kansas City's *Survey of Agricultural Credit Conditions*

Moreover, the expected repayment index predicts turning points, or directional changes, three months before they actually happen. Predicting turning points is difficult because new information throughout the year tends to change the outlook for net farm incomes. For example, in August 2009, USDA revised upward the number of planted corn acres, which contributed to falling corn prices and subsequent declines in projected net farm incomes. Nevertheless, since 2002 the expected index has forecast roughly 80 percent of the turning points in the current index (Table 1).<sup>11</sup>

### III. FORECASTING NATIONAL FARM LOAN DELINQUENCIES

With its record as a reliable barometer of future loan repayment rates and turning points for the region, it is natural to ask if Kansas City's *Survey of Agricultural Credit Conditions* can do the same for the nation. Given the relationship between loan repayment rates and delinquencies, district repayment rates might indeed be a leading indicator of national farm loan delinquency trends. This section tests whether the Survey's current and expected loan repayment rate indexes in the past have led the national farm loan delinquencies.

Table 1

QUARTERLY PREDICTION OF MOVEMENT IN THE RATE OF  
NON-REAL ESTATE FARM LOAN REPAYMENT (2002 TO 2009)

		Expected Rate of Loan Repayment	
		Upward Movement	Downward Movement
Current Rate of Loan Repayment	Upward Movement	12	3
	Downward Movement	2	11

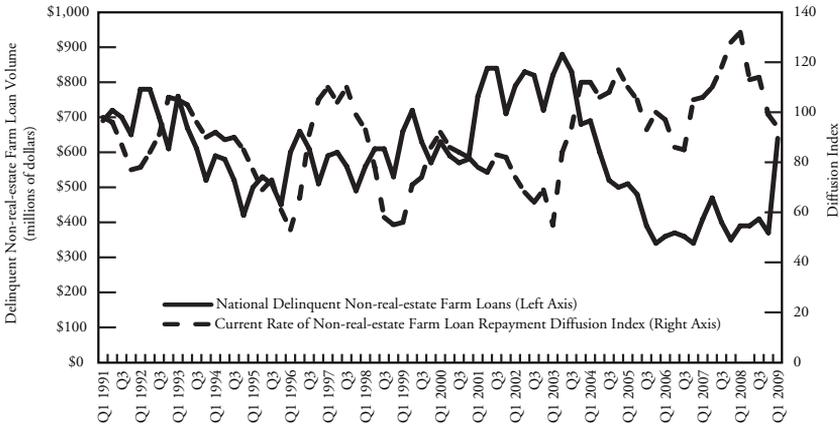
*The current index and national delinquencies*

The Survey's current index for the district tends to rise and fall inversely with the volume of national delinquent farm loans (Chart 3). From 2000 to 2003, crop and livestock incomes fell nationwide, and district loan repayment rates plummeted. With these repayment rates depressed, national farm loan delinquencies subsequently jumped nearly \$300 million. In 2008, commodity prices spiked and the current repayment index surged to over 130, its highest level since 1988. In response, national farm loan delinquencies fell sharply. Today, falling repayment rates in the district are closely followed by surging national delinquencies. Further confirmation of this inverse relationship between the Survey's current index and delinquent farm loan volumes nationwide is a fairly strong negative correlation of -0.44.<sup>12</sup> In addition, a straightforward regression of district repayment rates and national delinquencies finds that the Survey's current index explains about a third of the variation in national farm loan delinquencies.<sup>13</sup>

The timing of the Survey should help the bolster relationship between the current repayment rate index and reported farm loan delinquencies. At the end of each quarter, district bankers report their repayment rates. Roughly at the same time, agricultural bankers nationwide report their delinquent farm loans on their Consolidated Reports of Condition and Income forms, commonly known as call reports. So, bankers simultaneously report loan repayment rates and the volume of delinquent farm loans.

Chart 3

### CURRENT RATE OF NON-REAL ESTATE FARM LOAN REPAYMENT DIFFUSION INDEX AND NATIONAL DELINQUENT NON-REAL ESTATE FARM LOAN VOLUMES (1991 TO 2009)



Source: Federal Reserve Bank of Kansas City's *Survey of Agricultural Credit Conditions* and USDA

Not only are these two agricultural credit condition measures negatively correlated, but the current repayment index leads national delinquent farm loans. With data from 1991 to 2009, a vector autoregression (VAR) analysis can test whether the current index leads national delinquencies. The results show that the previous quarter's rate of loan repayment is inversely correlated with next quarter's volume of delinquent farm loans.<sup>14</sup> Therefore, if the current loan repayment index rises, then next quarter's national delinquent farm loan volumes tends to fall. Conversely, if the current index falls, next quarter's national delinquent loan volumes rise.

#### *The expected index and national delinquencies*

The current index is a three-month leading indicator of national delinquent farm loan volumes. Given the relationship between the current and expected loan repayment rate indexes, the expected index might also be an indicator of national farm loan delinquencies. Despite some concerns, researchers have found that expectations from survey respondents or opinions on future activity can be reliable indicators used to forecast quantitative values (Hee; Kulshreshtha, Spriggs, and Akinfemiwa; Leuthold). A similar approach is applied to testing the ability of the

Survey's expected repayment index to predict the future path of national delinquent farm loan volumes. The analysis finds that the expected index is in fact a six-month leading indicator of national delinquencies.

The path of the expected index from 2002 to 2009 is nearly identical to the current index. Therefore, like the current index, the expected index rose from 2003 to 2008, while national farm delinquencies fell. Today, the expected index is declining while delinquent farm loans are rising. Using VAR analysis to test the expected index's predictability over time would not be especially helpful because too few data points are available. Instead, contingency tables are used to measure how well the expected index has forecast the volume of national delinquent farm loans in the past.

As shown earlier, repayment rates and delinquencies are negatively correlated. Thus, if the expected loan repayment rate was forecast to rise in the past, delinquent farm loan volumes should have fallen. Over its 28 quarters of forecasting, the Survey has correctly predicted the directional movement of national delinquent farm loans 19 times (Table 2). In other words, the Survey's prediction success rate is 68 percent.

This predictability is stronger than that of futures prices to predict changes in spot prices in the hog market. Naik and Leuthold used a similar method to predict hog prices and found that at best they were able to forecast the future direction of hog prices 58 percent of the time. Bessler and Brandt developed a series of statistical models to forecast the future direction of the same set of hog prices, and their highest prediction success ratio was 67 percent. Given these findings, one can be confident that the Survey provides reliable information about the future path of national delinquent farm loans.

The ability of the repayment rate index to forecast delinquencies has been consistent over time—even during turbulent times. Forecasts of today's economy are clouded with uncertainty, but the Survey has still done a credible job of forecasting the future path of national delinquent farm loans. Since the start of the recent recession (fourth quarter 2007), the forecast rate of loan repayment has correctly predicted the path of national delinquent farm loans in four out of six quarters.

Thus, the expected index of the Survey serves as a reliable barometer of national delinquent farm loans six months into the future. The agricultural bankers provide their forecast of loan repayment rates for

Table 2

QUARTERLY PREDICTION OF MOVEMENT IN THE RATE OF NON-REAL ESTATE FARM LOAN REPAYMENT AND NATIONAL DELINQUENT NON-REAL-ESTATE FARM LOAN VOLUME (2002 TO 2009)

		Expected Rate of Loan Repayment	
		Upward Movement ↗	Downward Movement ↘
Path of Delinquent Non-real estate Farm Loans	Upward Movement ↗	4	9
	Downward Movement ↘	10	5

the next three months, and loan repayment rates lead national delinquent farm loan volumes by an additional three months.

**IV. IMPLICATIONS FOR AGRICULTURAL CREDIT STANDARDS**

With the prospects of rising loan delinquencies, agricultural credit standards are likely to change. Higher risks of loan defaults may cause agricultural bankers across the nation to tighten credit.

Without a measure of how tight national credit markets are, Kansas City’s *Survey of Agricultural Credit Conditions* may provide the clearest picture. In many ways, the Tenth District is a microcosm of national agriculture. Based on the 2008 Farm Income and Costs data from the Economic Research Service, the value of agricultural production in Tenth District states is evenly split between livestock and crops. District agricultural production includes cattle, hog, dairy, and poultry production in addition to corn, soybeans, wheat, cotton, and specialty crop production such as edible beans and beets. Much like the U.S. as a whole, Tenth District agricultural production cannot be classified as being primarily either crop or livestock or a specific commodity.

Just as the Survey reports diffusion indexes for current and expected rates of loan repayment, it also reports diffusion indexes for current and expected collateral requirements. Both indexes tend to rise and fall

together during periods of rising and falling national delinquent farm loan volumes (Chart 4).<sup>15</sup>

From 2002 to 2003, national delinquent farm loans nearly reached \$900 million, the highest level since the farm debt crisis of the 1980s. In response, both the current and expected collateral requirement indexes reached their respective peaks. Between 2004 and 2008, national delinquent farm loans fell to historical lows, reaching less than \$400 million. During this time, more agricultural bankers reported they were lowering collateral requirements than bankers raising them, indicating that credit was more readily accessible.

Today, agricultural bankers have responded to the surge in delinquencies by raising collateral requirements.<sup>16</sup> Movements of the current and expected indexes follow each other nearly in lockstep, as shown by the 0.91 correlation between the two.<sup>17</sup> And, the expected index explains 85 percent of the variation in the current index.<sup>18</sup>

Too few observations are available to conduct a VAR analysis to test the predictability of the expected collateral requirement index. But a contingency table confirms that the expected index leads the current index (Table 3). Agricultural bankers have correctly projected the future path of collateral required 80 percent of the time.

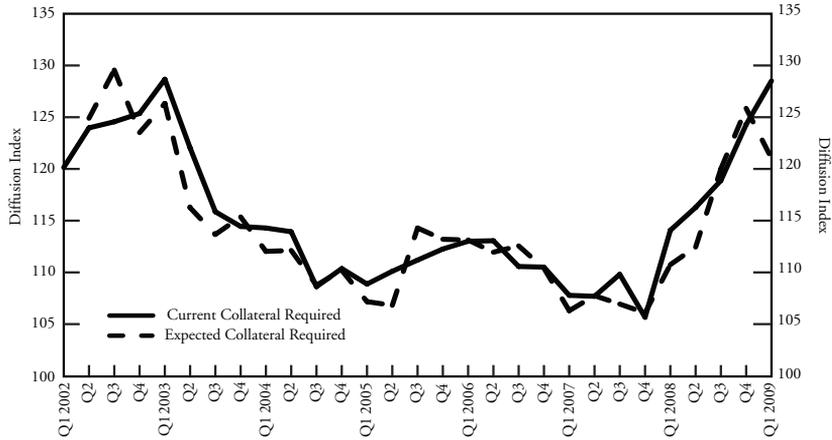
One reason agricultural bankers have such high prediction success is that they control the amount of collateral required for loans. Still, agricultural bankers are not correct all of time. When wrong, they tend to tighten credit standards more than expected. All six incorrectly forecast quarters occurred because agricultural bankers expected to ease collateral requirements but did not.

In early 2009, agricultural bankers expected credit access to ease, but conditions actually tightened. Rising deposits and improving financial markets influenced agricultural bankers to forecast lower collateral requirements in mid-2009. But falling net farm incomes and rising delinquencies contributed to the rising collateral requirements.

Agricultural bankers are forecasting higher farm loan delinquencies, and the current collateral required index may continue to climb. In other words, access to credit nationwide is likely to remain tight heading into 2010.

Chart 4

CURRENT AND EXPECTED COLLATERAL REQUIRED ON NON-REAL ESTATE FARM LOAN DIFFUSION INDICES (2002 TO 2009)



Source: Federal Reserve Bank of Kansas City's *Survey of Agricultural Credit Conditions*

Table 3

QUARTERLY PREDICTION OF MOVEMENT IN THE COLLATERAL REQUIRED ON NON-REAL ESTATE FARM LOANS (2002 TO 2009)

		Expected Collateral Required	
		Upward Movement	Downward Movement
Current Collateral Required	Upward Movement	10	6
	Downward Movement	0	12

## V. CONCLUSIONS

The Federal Reserve Bank of Kansas City's *Survey of Agricultural Credit Conditions* has been used to predict district and national conditions since 2002. This article examined the reliability of the forecasts made by agricultural bankers in the Survey regarding loan repayment rates and collateral requirements. The analysis found that these forecasts are reliable. The analysis also found that the survey's indexes of Tenth District agricultural credit conditions predict national trends in loan delinquencies and credit standards.

The Survey confirms that agricultural credit conditions are deteriorating both in the district and nationwide. The U.S. farm sector has become less able to repay its outstanding debt, causing the volume of delinquent loans to rise. In turn, default rates have climbed, and agricultural bankers have responded by tightening access to credit. While these trends are expected to continue into 2010, the prospect of another 1980s farm debt crisis is minimal.

## ENDNOTES

<sup>1</sup>Because of its unusual nature, data from the 1980s farm debt crisis is not shown. Using data from this period could skew insights about the future evolution of agricultural credit conditions (Paulson and Sherrick),

<sup>2</sup>The following assumptions and calculations are taken from the Economic Research Service of the USDA and can be found at [http://www.ers.usda.gov/Briefing/farmincome/glossary/def\\_drcu.htm](http://www.ers.usda.gov/Briefing/farmincome/glossary/def_drcu.htm). A maximum loan payment is calculated by taking the farm sector's income for debt coverage (net cash income plus interest payments) divided by an assumed minimum debt coverage ratio (1.25:1):

$$\text{Maximum Loan Payment} = \frac{(\text{Farm Sector Net Cash Income} + \text{Farm Sector Interest Payments})}{\text{Minimum Debt Coverage Ratio}}$$

This maximum loan payment is then multiplied by the present value of an annuity of \$1 at the average non-real estate interest rate ( $r$ ), taken from the Agricultural Finance Databook, for a hypothetical repayment term ( $n$ ) of 7 years:

$$\text{Debt Repayment Capacity} = \text{Maximum Loan Payment} * \frac{1 - (1 + r)^{-n}}{r}$$

Finally, debt repayment capacity utilization is calculated by taking the total farm sector debt divided by the calculated debt repayment capacity as shown in:

$$\text{Debt Repayment Capacity Utilization} = \frac{\text{Total Farm Sector Debt}}{\text{Debt Repayment Capacity}}$$

<sup>3</sup>The only time the U.S. farm sector experienced a DRCU measure above 1 was during the 1980s farm debt crisis. For a discussion of the DRCU during the 1980s farm debt crisis see Briggeman, Gunderson, and Gloy.

<sup>4</sup>The Chicago, Dallas, Minneapolis, Richmond, and San Francisco Federal Reserve Banks conduct their own agricultural credit surveys in addition to the Kansas City survey.

<sup>5</sup>Other Federal Reserve Banks conduct similar agricultural credit surveys, but the data necessary to conduct this study, namely the expectations of future agricultural credit conditions, is not publicly available. However, the data that is reported in the Agricultural Finance Databook shows that most credit conditions tracked by each Federal Reserve Bank survey are positively and highly correlated. For example, the Kansas City and Chicago agricultural credit surveys both report a diffusion index on the rate of repayment and collateral required dating back to 1991. The correlation between these two indices for both surveys is at or above 0.58. Most other indices across the other Federal Reserve agricultural credit surveys show a similar high level of positive correlation.

<sup>6</sup>Credit conditions agricultural bankers respond to for their market area are: demand for loans, availability of funds, rate of loan repayment, renewals or extensions, amount of collateral required, referrals to correspondent banks, and referrals to nonbank credit agencies.

<sup>7</sup>The Agricultural Income and Finance Outlook of the USDA's Economic Research Service (2009) states that 70 percent of farm households have no outstanding debt, *but* these farm households are smaller, older, and work more off of the farm for their primary source of income. The agricultural debt lies with those farm households that operate larger farms and rely more heavily on farm income as a source of repayment and monies to cover living expenses.

<sup>8</sup>Agricultural bankers began reporting current farm loan repayment rates in 1980 and expected rates in 2002.

<sup>9</sup>There are advantages and disadvantages to these type of opinion-based questions. For a comprehensive discussion of these advantages and disadvantages, please refer to Keeton and Verba (2004).

<sup>10</sup>The estimated OLS regression model was:

$$\text{Current Loan Repayment Rate Index} = \frac{19.05}{(15.28)} + \frac{0.81}{(0.15)} \text{Expected Loan Repayment Rate Index} + \varepsilon,$$

and the R<sup>2</sup> was 0.52. Numbers in parentheses are the standard errors of the parameter estimates.

<sup>11</sup>Typically, contingency tables are used to forecast turning points, but Naik and Leuthold point out that this type of contingency table is too simplistic. Analyzing turning points ignores what *type* of turning point was forecasted. Was it a turning point that pointed towards an improvement in market conditions or deterioration? To avoid this criticism, contingency tables forecasting the directional movement of the rate of loan repayment are constructed.

<sup>12</sup>The nonparametric Spearman correlation coefficient between these two data series equals -0.44 and is statistically significant at the 1 percent level.

<sup>13</sup>This statement is based on the following OLS regression mode:

$$\text{National Delinquent Farm Loans} = \frac{1,106.77}{(153.45)} - \frac{5.79}{(1.52)} \text{Current Loan Repayment Rate Index} + \varepsilon,$$

and the R<sup>2</sup> was 0.33. Numbers in parentheses are the standard errors of the parameter estimates.

<sup>14</sup>The two equation vector autoregressive model is as follows,

$$\begin{aligned} \text{Current Loan Repayment Rate Index}_t &= \\ \alpha_1 + \sum_{i=1}^n \beta_{1i} \text{Current Loan Repayment Rate Index}_{t-i} + \sum_{i=1}^n \mu_{1i} \\ \text{National Delinquent Farm Loans}_{t-1} + \varepsilon_{1t}, \text{National Delinquent Farm Loans}_t &= \alpha_2 + \\ \sum_{i=1}^n \beta_{2i} \text{Current Loan Repayment Rate Index}_{t-i} + \sum_{i=1}^n \mu_{2i} \\ \text{National Delinquent Farm Loans}_{t-1} + \varepsilon_{2t}, \end{aligned}$$

where  $t$  is time;  $\alpha$ ,  $\beta$ , and  $\mu$  are parameters to be estimated;  $n$  is the optimal number of lags; and  $\varepsilon$  is the error term of each equation that is estimated as a white noise process. A total of one to ten lags were tested. Optimal lag length was determined to be one quarter by identifying the minimum Akaike Information Criterion and Schwarz Bayesian Criterion information tests, ensuring the system of equations was stationary (autoregressive characteristics polynomial roots are less than one in absolute value), and errors are white noise (Jarque-Bera normality

test). In addition, the Granger causality test, which is  $\chi^2$  distributed, for national delinquent farm loans being correlated with past values of the rate of loan repayment equals 6.84 with a p-value of 0.009. The Granger causality test of the rate of loan repayment being correlated with past values of the delinquent farm loans is 0.89 with a p-value of 0.345.

<sup>15</sup>One thing to note in Chart 4 is that each diffusion index is above 100. This means that since 2002, more agricultural bankers report raising collateral requirements than those not raising collateral requirements. This result is not too surprising given agricultural bankers are reporting about collateral on non-real estate farm loans secured by chattels or machinery and equipment, crops, and/or livestock. These items tend to fluctuate in value throughout the year, thus causing more agricultural bankers to report raising collateral requirements. Given this point, the focus of the collateral required diffusion index should be on directional movement rather than its level.

<sup>16</sup>Even though the expected collateral required diffusion index declined, it still remained above 100. Therefore, more agricultural bankers reported raising collateral requirements or tightening credit.

<sup>17</sup>The nonparametric Spearman correlation coefficient between these two series is 0.91 and is statistically significant at the 1 percent level.

<sup>18</sup>The estimated OLS regression model was:

$$\text{Current Collateral Required Diffusion Index} = \frac{9.97}{(8.53)} + \frac{0.92}{(0.08)} \text{ Forcasted Collateral Required Diffusion Index} + \epsilon,$$

and the  $R^2$  was 0.85. Numbers in parentheses are the standard errors of the parameter estimates.

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