Mapping Stress in Agricultural Lending

By Cortney Cowley

Repayment rates for farm loans have declined every quarter since the second quarter of 2013, suggesting heightened stress in agricultural lending. This stress could be amplified if the outlook for the agricultural sector remains downbeat. Farm income is expected to remain low in the coming years, and farm sector liquidity continues to deteriorate. If lower agricultural commodity prices and farm incomes persist, bankers will need to understand how regional and agricultural economic conditions—such as annual changes in crop revenues, off-farm income, and farm production expenses—affect farm loan repayment rates and contribute to stress in agricultural lending.

Declining loan repayment rates may lead to adverse outcomes for both banks and borrowers. When farm borrowers are unable to service short-term debt obligations, their ability to obtain financing decreases. In addition, if stress in agricultural lending intensifies, agricultural banks could become less able to lend to creditworthy farm borrowers. Farming operations require considerable funding to start, function, and grow. Many farmers borrow funds from agricultural banks to purchase land, farm machinery, livestock, and production inputs such as seed, fertilizer, and fuel. Often, these purchases spill over into local, rural economies. Therefore, when repayment rates decline and agricultural lenders are less able to lend to farmers, local economies and the general agricultural sector may experience worse outcomes.

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In this article, I use data from the Federal Reserve Bank of Kansas City's Survey of Agricultural Credit Conditions (Ag Credit Survey) to model and map the areas with the highest predictive probability of lower repayment rates—and, therefore, the highest probability of stress in agricultural lending. I find that lower crop revenues, lower off-farm income, lower farmland values, lower concentrations of farm earnings, and higher interest rates are associated with a higher probability of stress in agricultural lending. My results suggest that the largest increase in stress since 2002 occurred in 2016, the most recent year for which survey data are available, and that regions more commonly associated with cattle, wheat, and energy production have been more prone to stress over time.

Section I describes why and how repayment rates are used to measure stress in agricultural lending. Section II discusses the regional economic indicators and farm-level parameters most likely to contribute to lower repayment rates and stress at agricultural banks. Section III presents "heat maps" for the Tenth District, showing where stress in agricultural lending is more probable over space and time.

I. Measuring Stress in Agricultural Lending

Stress in agricultural lending has been measured in several different ways. The most common measures of stress in agricultural lending are loan repayment rates, loan delinquency rates, and loan defaults (Escalante, Song, and Dodson 2016; Featherstone, Roessler, and Barry 2006; Kim 2005; Oladeebo and Oladeebo 2008; Quaye, Nadolnyak, and Hatarska 2017; Singh 2017). Loan repayment rates track the pace at which borrowers repay loans, taking into account both the timing and amount of payments. A banker might report lower repayment rates if borrowers do not make loan payments on time. A banker might also report lower repayment rates if borrowers make payments that are on time but smaller than prescribed in the loan contract. Loan delinquency describes the failure to make loan payments when they are due. A loan becomes delinquent when a borrower has not made a payment on the loan in 30 or more days. Loan delinquency rates are calculated as the percentage of loans that are delinquent over a particular period of time, such as a quarter. Loan default, on the other hand, describes the failure to repay a loan. When a loan is delinquent for a certain period of time,

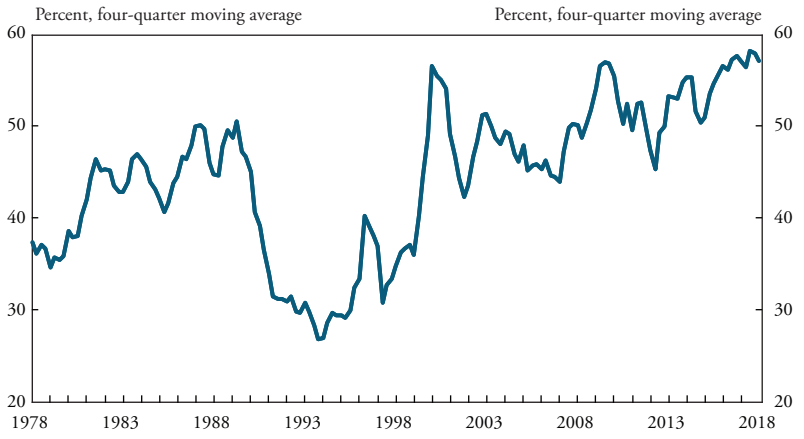
the lender will declare the loan to be in default. Once a loan is in default, the entire loan balance is due to the lender. The period of time between a loan being delinquent and transitioning to default can vary by lending institution, by loan, and by borrower. Typically, a loan must be delinquent for 90 days or more before a lender will declare that the loan is in default.

Farm loan repayment rates are good indicators of stress in agricultural lending for several reasons. The first reason is that they are correlated with indicators of farm liquidity. Since 2013, farm income has declined by more than 50 percent. Over the same period, farm debt, proxied by the demand for operating loans, increased significantly. Chart 1 shows that operating loans as a share of all non-real-estate loans reached a peak of nearly 60 percent in 2018. The sharp increase in current liabilities relative to current assets caused farm liquidity to decline significantly. Chart 2 shows that working capital on U.S. farms declined by more than 60 percent from its peak in 2012 to 2017. Limited liquidity, especially during periods of higher leverage, is stressful for both borrowers and lenders. Consequently, as leverage increased and working capital declined on U.S. farms, an increasingly large percentage of bankers reported lower farm loan repayment rates. As shown in Chart 2, working capital on U.S. farms and the percent of bankers reporting lower farm loan repayment rates have a strong, negative correlation of –0.80, suggesting that a 1 percent decline in working capital has been accompanied by a 0.80 percent increase in the share of bankers reporting lower repayment rates on farm loans. When working capital declines, farmers have fewer resources available to repay loans. Therefore, repayment rates appear to be a real-time indicator of stress in agricultural lending.

The second reason loan repayment rates are a good indicator of stress in agricultural lending is that they provide more complete information on the severity of agricultural stress than loan default and delinquency rates. From 2015 to 2016, a majority of agricultural lenders in most states in the Tenth District reported lower farm loan repayment rates (Chart 3, Panel A). In all states except Missouri, repayment rates seemed to indicate that stress was building from 2013 to 2016. Loan repayment rates did not worsen in 2017, but more than 40 percent of bankers in Kansas, Nebraska, and the Mountain States continued to

Chart 1

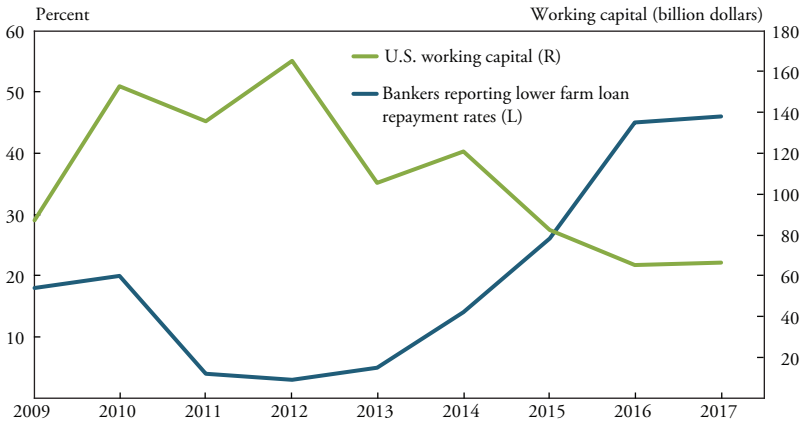
Operating Loan Share of Total Non-real-estate Farm Loan Volumes at Commercial Banks



Source: Federal Reserve Bank of Kansas City Agricultural Finance Databook, Table A.3.

Chart 2

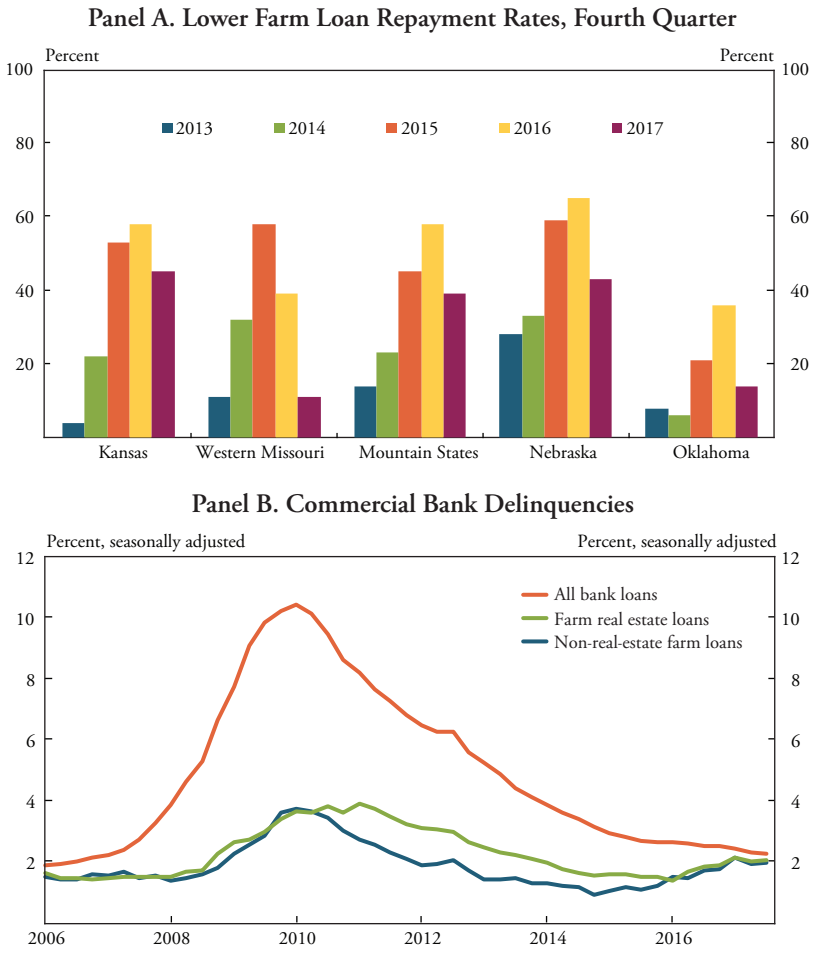
Farm Sector Liquidity and Farm Loan Repayment Rates



Sources: Ag Credit Survey and USDA.

Chart 3

Measures of Stress in Agricultural Lending



Notes: Mountain States (Colorado, northern New Mexico, and Wyoming) are grouped because of limited survey responses from each state. "Commercial bank delinquencies" includes the share of all past due, nonaccruing, and net charge-off loans. "All bank loans" includes all loans made at commercial banks.
Sources: Ag Credit Survey, Agricultural Finance Databook Tables B.2, B.3, B.4, B.5, and Board of Governors of the Federal Reserve System.

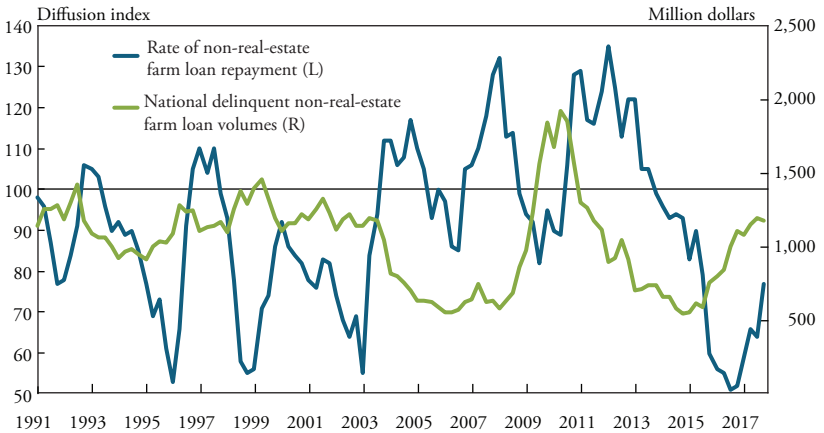
report lower repayment rates in their lending areas. In contrast, over the same 2013–17 period, delinquency rates on non-real-estate and real estate farm loans increased only marginally (Chart 3, Panel B). In fact, in 2017, loan delinquency rates on farm loans were still lower than the average delinquency rates for all other loans made at commercial banks. According to the USDA, farm income in the United States declined by more than 50 percent from 2013 to 2017 (USDA 2017). After a substantial decline in farm income, the outlook for farm finances and lending conditions deteriorated, but loan delinquencies remained relatively stable. Although stable loan delinquencies have been a bright spot in the current downturn in the agricultural economy, they may not provide complete information on the amount of stress in agricultural lending. Conversely, the decline in repayment rates seems to have been more in line with the decline in the farm economy more recently.

The third reason loan repayment rates are good indicators of stress in agricultural lending is that they are more timely indicators of increased stress than loan delinquency and default rates. One issue with measuring stress in agricultural lending with delinquency and default rates is that the full effects of stressful conditions may not be visible until the farmer's equity is exhausted. Farm loan delinquency rates, for example, have remained low partly because most agricultural loans are restructured using borrower equity before they become delinquent or default. In 2017, nearly 35 percent of agricultural bankers reported an increased use of debt restructuring compared with three to five years ago (Federal Reserve Bank of Kansas City 2017). Loan repayment rates, however, are tied to farm liquidity rather than farm equity. As a result, the point at which bankers begin reporting lower repayment rates may provide an earlier signal of stress in agricultural lending.

Indeed, farm loan repayment rates appear to be leading indicators of loan delinquency rates. Historically, repayment rates on non-real-estate farm loans have been highly and inversely correlated with the volume of subsequent national delinquent farm loans. According to Briggeman and Zakrzewicz (2009), falling repayment rates in the Tenth District were followed closely by surging national delinquencies from 1991 to 2009. Chart 4 shows repayment rates as a diffusion index, computed by subtracting the percentage of bankers who responded repayments were "lower" during the current quarter relative to the previous year from the

Chart 4

Diffusion Index for Rate of Non-real-estate Farm Loan Repayment and National Delinquent Non-real-estate Farm Loan Volumes



Notes: Bankers respond to the Ag Credit Survey by indicating whether repayment rates during the current quarter are higher than, lower than, or unchanged from the same quarter one year prior. The diffusion index is computed by subtracting the percentage of bankers who respond "lower" from the percentage who respond "higher" and adding 100.
Sources: Ag Credit Survey and Board of Governors of the Federal Reserve System.

percentage who responded repayment rates were "higher" and adding 100. Thus, a diffusion index less than 100 indicates that a majority of bankers reported lower repayment rates, while a diffusion index greater than 100 indicates that a majority of bankers reported higher repayment rates. In addition to the significant negative correlation between repayment rates and loan delinquency rates, a simple linear regression shows that District repayment rates explained more than one-third of the variation in national farm loan delinquencies from 1991 to 2009. Briggeman and Zakrzewicz (2009) also find that the diffusion index for repayment rates is a leading indicator for national delinquent farm loans. In other words, from 1991 to 2009, if the loan repayment index decreased, national delinquent farm loan volumes rose in the next quarter.

Collecting data on farm loan repayment rates

To gauge stress in agricultural lending, I use measures of farm loan repayment rates from the Ag Credit Survey. The Ag Credit Survey is a unique source of information on regional agricultural credit conditions. Each quarter, the Federal Reserve Bank of Kansas City collects data on

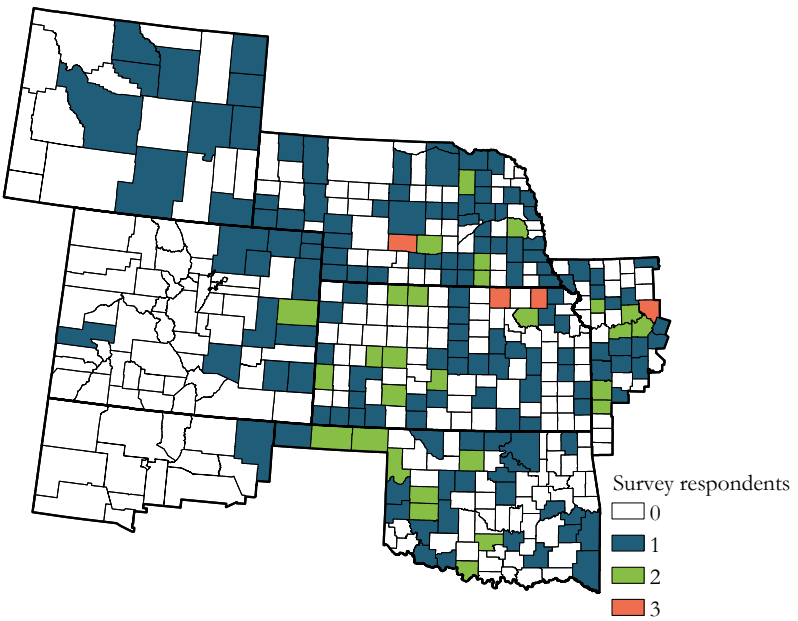
farm lending conditions from approximately 200 agricultural bankers in the Tenth District, which covers Colorado, Kansas, Nebraska, Oklahoma, Wyoming, the northern half of New Mexico, and the western third of Missouri. Although definitions vary by regulatory institution and by survey, the Kansas City Fed's Ag Credit Survey defines agricultural banks as banks that have more than 15 percent of their total loan portfolio in agricultural loans (loans for both farm production and farm real estate). Some banks may not meet the 15 percent threshold, but may still be considered agricultural banks due to their relatively large portfolio of agricultural loans.[1] Map 1 shows the number of respondents to the Ag Credit Survey in each county. Survey respondents are located in half of counties in Kansas, Nebraska, Oklahoma, western Missouri, and Wyoming, but coverage is more limited in Colorado and northern New Mexico due to fewer respondents in those areas.

One of the goals of the Ag Credit Survey is to collect qualitative data on agricultural lending conditions.[2] For example, bankers are asked if repayment rates in their lending area were higher, lower, or unchanged over the past three months compared with the same period last year. Map 2 uses raw data from the survey to show how repayment rates varied across the District in one particular quarter. Panel A shows that in the fourth quarter of 2016, a majority of bankers reported lower repayment rates on non-real-estate farm loans than one year prior. But Panel B shows that in the fourth quarter of 2017, a majority of bankers reported no change in farm loan repayment rates compared with the fourth quarter of 2016. In both years, a larger share of bankers in Kansas, Nebraska, and eastern Colorado reported lower farm loan repayment rates.

Although Map 2 offers some sense of where farm loan repayment rates were lower—and therefore, where farm financial stress may be higher—it does not show what economic factors contributed to stress in agricultural lending in the Tenth District nor does it show where stress is most likely to occur based on these contributing factors. For example, why did a smaller share of bankers in Oklahoma and Wyoming indicate lower repayment rates than bankers in other states? To answer these questions, I next use Ag Credit Survey data in an empirical model.

Map1

Number of Respondents to the Federal Reserve Bank of Kansas City's Ag Credit Survey, 2017:Q4



Source: Ag Credit Survey.

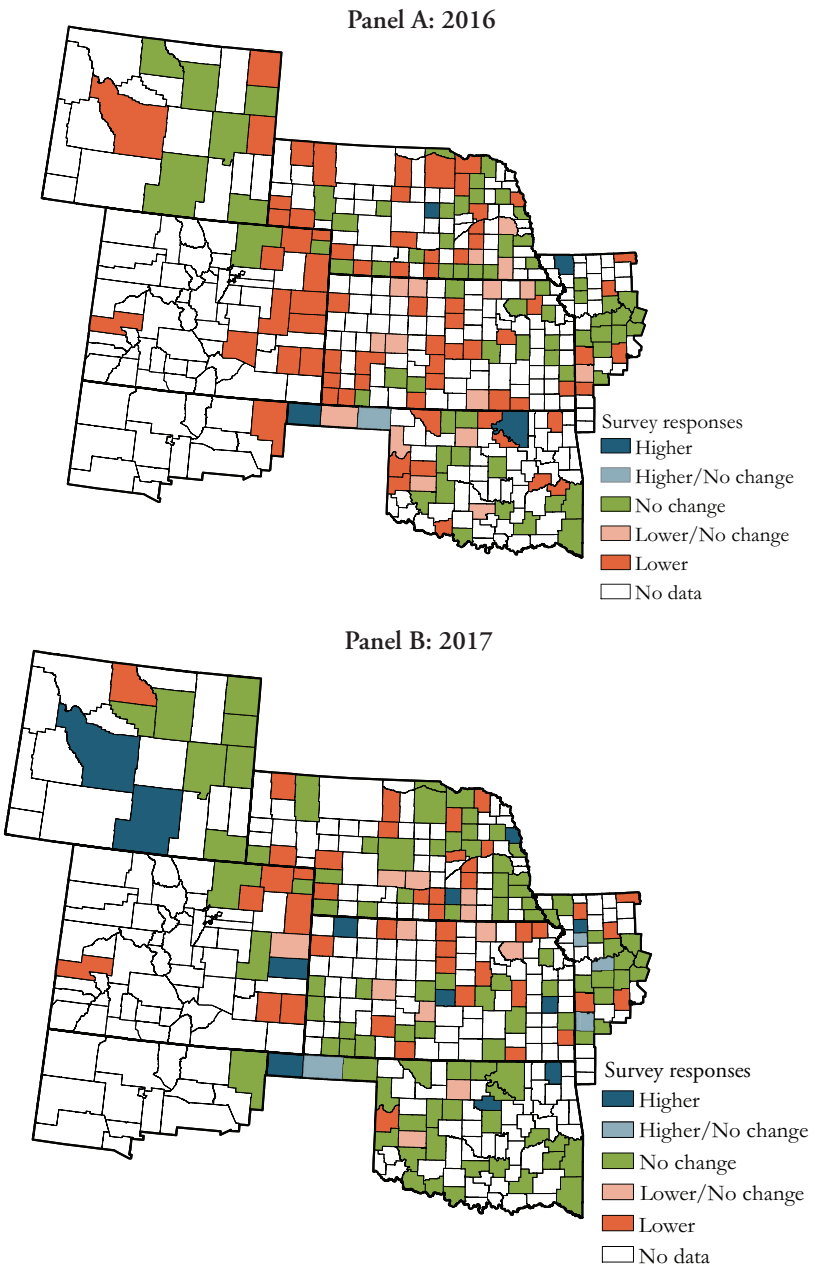
II. Modeling Stress in Agricultural Lending

Several factors may affect farm loan repayment rates. Previous studies have shown that economic conditions at the regional and farm level can affect farm loan repayment rates (Oladeebo and Oladeebo 2008; Quaye, Nadolnyak, and Hatarska 2017; Singh 2017). Both farm income and nonfarm income significantly affect farmers' ability to repay loans. Other factors that have been shown to influence farm loan repayment include farmers' age, education, and years of experience with credit use and farm size; however, these other factors do not vary considerably from year to year.

To determine which factors are most likely to contribute to stress in agricultural lending, I construct a model to determine the probability of bankers reporting lower repayment rates based on a set of regional and farm financial characteristics that vary over time and space. Because stress in agricultural lending can vary across the region and build over

Map 2

Changes in Non-real-estate Farm Loan Repayment Rates in the Fourth Quarter



Notes: Counties with "Higher/No change" and "Lower/No change" designations contain multiple bankers that provided differing responses on farm loan repayment rates in the fourth quarters of 2016 and 2017. For example, bankers in "Higher/No change" counties reported that farm loan repayment rates were either higher or unchanged in the fourth quarter compared with the same quarter in the previous year.
Source: Ag Credit Survey.

time, I include explanatory variables in the model describing regional and farm financial conditions across the Tenth District over multiple years. In particular, I employ a panel dataset, where the unit of observation is a bank. In the panel dataset, survey data from agricultural banks in the Tenth District are matched to county-level data on farm financial and regional economic characteristics based on the county in which the bank is located. The key county-level factors used to help explain variation across the region are annual changes in crop and livestock revenues, lagged changes in farm production expenses relative to total revenues, percent income from non-farm sources, concentration of farm earnings in the county relative to the national average, concentration of earnings from mining relative to the national average, annual percent change in "good-quality" farmland values, and interest rates on farm operating loans.

The econometric model is a fixed effects binary logit model determining the likelihood that banker i in county j in year t will report lower repayment rates ($y_{ijt} = 1$). The model can be written as:

$$prob(y_{ijt}=1)=\Lambda(\alpha_i+ x'_{jt}\beta),$$

where y_{ijt} is the dependent variable, which equals 1 if banker i in county j in year t reports lower repayment rates and 0 otherwise; α_i is the fixed effect, which in this case is banker i; x'_{jt} is the set of explanatory variables for county j in year t; and β is a vector of parameters to be estimated.[3] More information on variables, including descriptions, sources, and descriptive statistics, is available in the appendix.

The regression results provide information on how regional and farm financial conditions affect the likelihood that a banker will observe lower repayment rates, indicating elevated levels of stress in agricultural lending. The results in Table 1 suggest that annual declines in crop revenues, lower farm expenses relative to revenues, a lower share of off-farm income relative to total income, a lower concentration of farm earnings, and lower farmland values are the strongest predictors of an increased likelihood that a banker will report lower farm loan repayment rates. Similarly, a higher concentration of mining earnings and higher interest rates in county j increase the likelihood that a banker in that county will report lower repayment rates.

Table 1

Effects of Regional Farm Characteristics on Farm Loan Repayment Rates—Regression Results

Independent variables	Dependent variable: lower farm loan repayment rates		
	Coefficients	Standard errors	Marginal effects
Annual change in crop revenues	−0.0110***	0.0037	−0.0011
Annual change in livestock revenues	0.0002	0.0076	0.00002
Lagged ratio of expenses to receipts	−6.0771***	1.6040	−0.5827
Off-farm income (percent of total income)	−0.0186*	0.0124	−0.0018
Farm location quotient	−0.0189*	0.0091	−0.0037
Mining location quotient	0.0384*	0.0334	0.0109
Annual change in farmland values	−0.0062***	0.0024	−0.0006
Fixed interest rates on operating loans	0.2836**	0.1297	0.0272
Year			
2003	−1.4415***	0.3523	−0.1732
2004	−2.4082***	0.3800	−0.2401
2005	−2.1849***	0.3814	−0.2279
2006	−2.5874 ***	0.4119	−0.2487
2007	−3.3175***	0.5275	−0.2739
2008	−1.0726***	0.3601	−0.1372
2009	−0.4718	0.3811	−0.0659
2010	−1.8626***	0.4752	−0.2070
2011	−1.2444***	0.4460	−0.1547
2012	−1.2208***	0.4667	−0.1524
2013	−0.6399	0.4525	−0.0874
2014	−0.5356	0.4552	−0.0742
2015	0.5845	0.4117	0.0907
2016	1.3390***	0.4501	0.2148
Observations	1,729		
Pseudo R^2	0.74		

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level
Sources: Ag Credit Survey, BEA, and author's calculations.

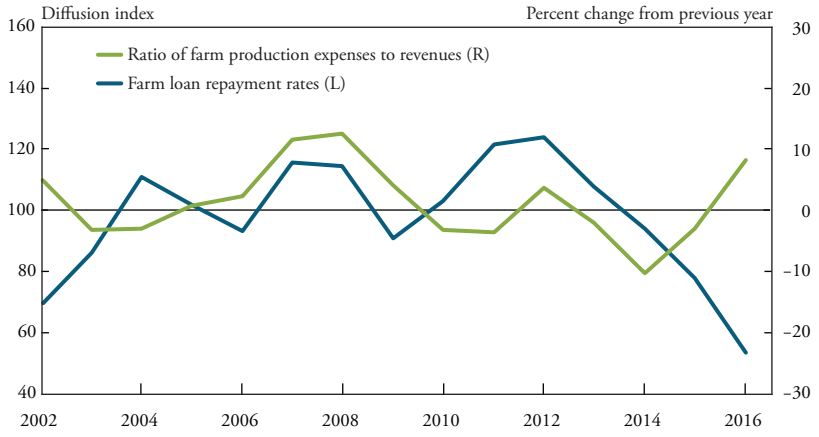
Although the coefficients on logit models give some indication of the direction and significance of the relationship between dependent and explanatory variables, they are not directly interpretable. Therefore, I calculate marginal effects to determine the magnitude of a 1 percent change in each dependent variable on the likelihood that a banker would report lower repayment rates. For example, the marginal effect of the annual change in crop revenues is –0.0011, suggesting that a 1 percent decrease in crop revenue would lead to a 0.11 percent increase in the probability that a banker would report lower repayment rates. These results are consistent with previous studies: for example, Escalante, Song, and Dodson (2016) show that declining commodity prices and increasing severity of drought adversely affect farmers' ability to repay loans.

Similarly, Table 1 shows that the ratio of farm production expenses to receipts, or revenues, is a significant predictor of stress in agricultural lending. The marginal effect of lagged annual changes in the ratio of farm expenses to receipts is relatively large, and the coefficient is highly significant. The negative sign implies, surprisingly, that lagged growth in expenses relative to receipts reduces the likelihood that bankers will report lower repayment rates. In other words, when expenses are higher, relative to receipts, bankers are more likely to report that repayment rates are either higher or unchanged. In most years in the study period, larger growth in the ratio of farm production expenses to revenues was correlated with higher farm loan repayment rates (Chart 5). While this result may seem unintuitive, farm production expenses tend to rise in years of stability or growth, as demand for production inputs increases. In addition, bankers may be more likely to report higher farm loan repayment rates because of correspondingly higher commodity prices and farm incomes.

Lower levels of off-farm income may also help predict lower rates of farm loan repayment. Some farmers may be able to use off-farm income to meet loan obligations if expenses increase. Using new seed technologies and maintaining plant and soil health can help farmers achieve higher yields, but these management practices incur high costs. Off-farm income can help farmers maintain optimal production practices when farm income is low. For many farms, off-farm employment provides a stable source of income for household and farm operation expenses (Brown

Chart 5

Farm Expense Ratios and Loan Repayment Rates



Sources: Ag Credit Survey and BEA.

and Weber 2013). During the recent downturn in the agricultural economy, some bankers reported that farmers were seeking off-farm employment or that spouses were going back to work off the farm to maintain living standards or assist with farm or household expenses. In addition, other studies have shown that off-farm income can significantly reduce financial stress for both borrowers and lenders (Brooks and others 2018; Dinterman, Katchova, and Harris Forthcoming).

Industry concentration is also correlated with stress in agricultural lending, but results differ by industry. One measure of this concentration is the location quotient, a ratio that quantifies how concentrated a particular industry is in a region compared with the nation. Location quotients are calculated for this study based on earnings. A farm location quotient of 1 means that a county has the same share of earnings from farming as the nation. A farm location quotient greater than 1 means the county has a greater share of earnings compared with the nation and is therefore more concentrated in farming. The coefficient for farm location quotient in Table 1 is negative and significant, suggesting bankers in counties less concentrated in farming activities are more likely to report lower farm loan repayment rates. Bankers in areas less concentrated in farming typically have less knowledge and experience with agricultural producers and loans. This experience may make bankers in these areas more cautious about lending when the

agricultural economy is in a downturn. They may also be less prepared to work with agricultural borrowers to identify ways to avoid or address repayment issues.

The mining location quotient is significant and positive, suggesting bankers in counties more concentrated in mining are more likely to report lower farm loan repayment rates. Compared with other areas of the United States, the Tenth District is relatively more concentrated in oil and gas production. Energy production is most prevalent in Oklahoma, the Mountain States, and western Kansas, where the productivity of grain, oilseed, and forage crops is lower than in other areas of the District. Several studies have highlighted the important relationship between energy and agricultural markets (Cowley 2016; Weber, Brown, and Pender 2013; Farm Credit Canada 2015). Lease and royalty payments from oil and gas companies can generate income for farm households, but oil and gas prices are also relatively volatile (Davig and others 2015). Bankers in counties with a higher concentration of earnings from mining may be more at risk when oil and gas prices fall. Therefore, a higher concentration of mining activity could contribute to a higher likelihood of stress in agricultural lending.

Lower farmland values also help predict lower repayment rates, but the marginal effect is small. The coefficient for annual percent change in farmland values is negative, suggesting that as farmland values decrease, bankers are more likely to report lower farm loan repayment rates. This result is not surprising. Farmland values vary widely throughout the Tenth District, make up a large share of the farm balance sheet, and are an important source of collateral in agricultural lending; they would be expected to have an effect on measures of stress in agricultural lending. However, the marginal effect is smaller than expected. For example, the results in Table 1 suggest that if farmland values were to decline by 10 percent in a banker's lending area, the banker's probability of reporting lower farm loan repayments rates would increase by just 0.6 percent. Although the effect is statistically significant, the magnitude of the effect is not as large as variables more directly related to farmers' loan repayment capacity, such as farm revenues, expenses, and income.

Interest rates have a positive and significant effect on the likelihood that a banker will report lower repayment rates. When interest rates increase, interest expenses rise for farm borrowers (Cowley and McCoy

2017). Especially during times of relatively low farm incomes, higher interest rates can make repaying farm loans more difficult for borrowers. Therefore, if interest rates are increasing or have increased, bankers are more likely to report lower loan repayment rates.

Finally, the coefficients for the year indicator variables in Table 1 show that stress in agricultural lending can vary significantly by year. In years with positive and significant coefficients, bankers were more likely to report lower repayment rates compared with the base year of 2002. In years with negative signs on the coefficients, bankers were less likely to report lower repayment rates compared with the base year. Notably, 2015 and 2016 are the only years with positive coefficients. The last year in the sample period, 2016, has the largest positive coefficient, indicating that the largest increase in stress over the 15-year period occurred in 2016. In addition, the coefficient for 2016 is statistically different from the coefficient for 2015, suggesting stress was significantly higher in agricultural lending in 2016 compared with just one year earlier.

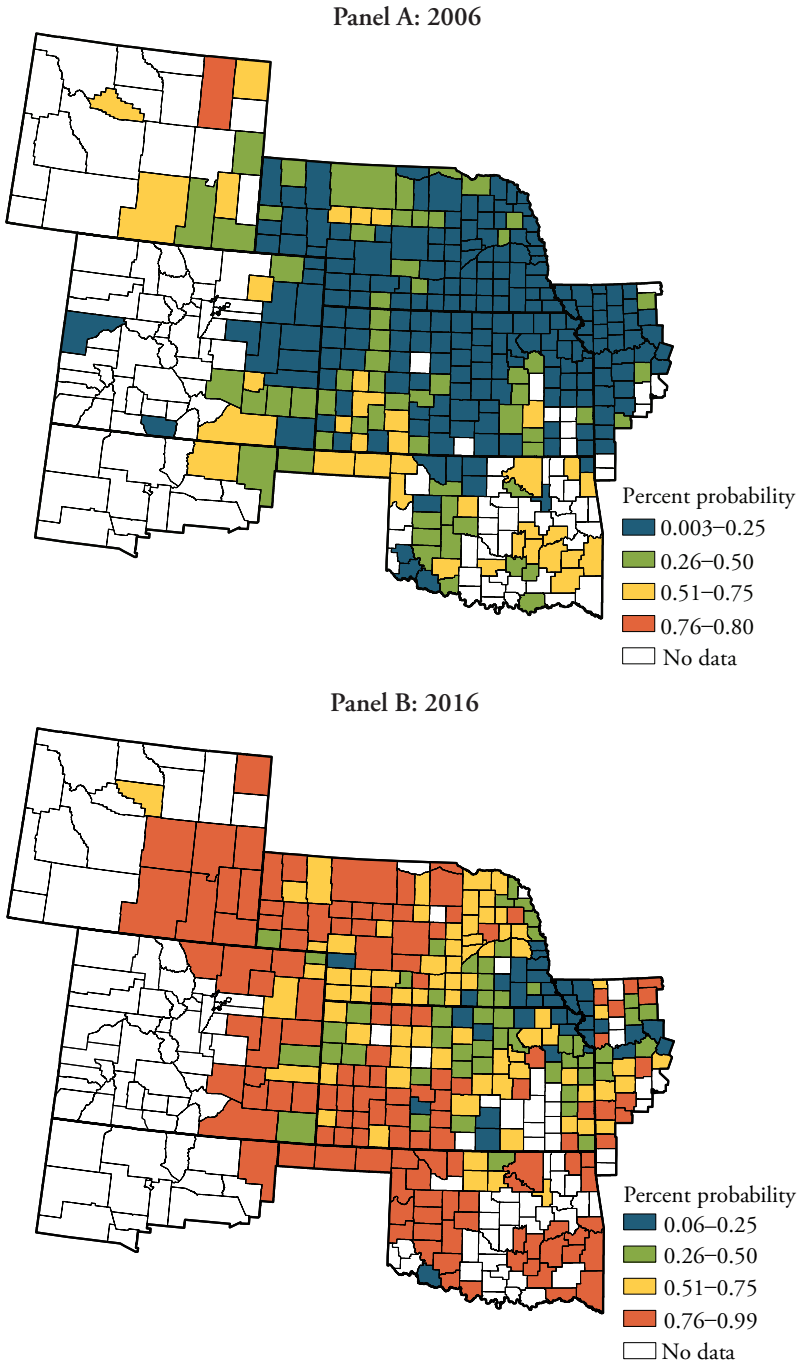
III. Mapping Stress in Agricultural Lending

In addition to identifying potential factors driving stress in agricultural lending, the model described in Section II can be used to map areas with the highest predicted probability of loan repayment problems. Using county-level data with the model, I calculate predicted probabilities of agricultural stress for the Tenth District.

Map 3 shows where stress in agricultural lending was more probable in the Tenth District. Panels A and B of Map 3 show snapshots of the District in 2006 and 2016, respectively. In 2006, stress in agricultural lending was less probable than in the previous year across most of the District, although Wyoming, Oklahoma, and a few other parts of the District showed some signs of elevated stress. On average, only 15 percent of bankers in the Tenth District reported lower farm loan repayment rates in each quarter of 2006 compared with one year prior. Most bankers in Oklahoma, Wyoming, and other areas experiencing greater stress in 2006 commented on the adverse effects of a severe drought on cattle pastures and wheat crops. Agricultural conditions in other parts of the District seemed more stable.

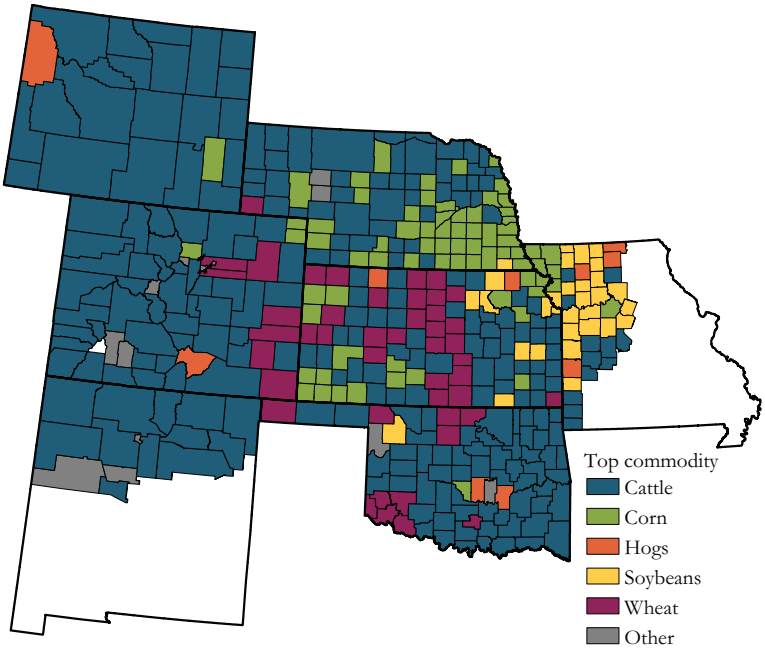
In 2016, however, stress in agricultural lending was more probable than in the previous year across most of the District. In each quarter of

Map 3
Probability of Stress in Agricultural Lending



Sources: Ag Credit Survey, BEA, and author's calculations.

Map 4
Top Commodity by Sales



Sources: USDA and author's calculations.

2016, more than half of bankers reported lower farm loan repayment rates relative to one year earlier, and a large majority reported lower farm income. Panel B of Map 3 shows that almost all counties in Oklahoma and the Mountain States with survey coverage were in the highest quartile of percent probability of agricultural stress. In 2016, markets for cattle, wheat, and energy seemed to contribute to more widespread stress in these areas. However, bankers covering counties along the borders of southeast Nebraska, northeast Kansas, and northwest Missouri were less likely to report lower farm loan repayment rates.

Lower probabilities of stress in these areas were likely due to the relatively larger concentration of corn and soybean production (Map 4). Soybeans in particular benefited from strong export demand in 2016. In fact, an unexpected surge in soybean exports in the third quarter of 2016 was so large that it boosted total U.S. gross domestic product growth by around 0.6 percentage point. The strong export demand supported relatively stronger soybean prices, boosted revenues for

soybean farmers, and lowered the probability that bankers in areas with a higher concentration of soybean production and sales would report lower farm loan repayment rates. Corn markets also received some support from exports in 2016, which were well above historical averages through most of the year (Cowley and Clark 2016). Although the increase in corn prices was not as large as the increase in soybean prices, strong export demand contributed to reduced probabilities of stress in agricultural lending in the northeastern part of the District, where corn and soybeans are the top commodity in most counties. Conversely, many counties in the rest of the District have a larger share of sales from cattle, wheat, or hogs. In 2016, prices for each of these commodities declined significantly. Consequently, a majority of counties in Oklahoma, the Mountain States, and western Nebraska and Kansas had higher probabilities of stress in agricultural lending—that is, higher probabilities that bankers in those counties would report lower repayment rates on farm loans.

IV. Conclusions

Farm loan repayment rates, as reported by bankers in the Tenth Federal Reserve District, provide a useful measure of how regional and agricultural economic conditions have contributed to stress in agricultural lending over space and time. Results from a regression model using data from the Ag Credit Survey show that a decline in crop revenues and, to a lesser extent, farmland values can significantly increase the likelihood of stress in agricultural lending. The results for expense ratios seem to be more nuanced and related to the current tendency of some agricultural producers to choose to operate at a loss in the short run while commodity prices are low. These results suggest that rising interest rates or further declines in farmland values could increase the prevalence and persistence of stress in agricultural lending.

The regression results also show that stress in agricultural lending has increased more recently. From 2003 to 2015, conditions in the agricultural sector were better than or not statistically different from the reference year of 2002. Although signs of deterioration began in 2014, conditions became significantly worse in 2016 after three consecutive years of lower commodity prices and declining farm incomes.

Maps of predicted probabilities show that stress has been more likely in areas with a greater share of wheat and cattle production and may be compounded in areas with high concentrations of oil and gas activity due to oil price volatility. Even in a year such as 2006, which was statistically better than the reference year, signs of stress were still evident in Oklahoma and Wyoming, areas more commonly associated with wheat, cattle, and energy production. In contrast, areas associated with soybean production have fared better more recently. In 2016, most of the Tenth District experienced significantly higher stress in agricultural lending. However, soybean exports were so high in the summer of 2016 that they supported a small bump in U.S. GDP. Consequently, the probability of financial stress was lower in areas with a higher share of soybean production.

These results may help inform agricultural lenders on regional and agricultural economic conditions that could indicate growing stress in agricultural lending. The maps of where stress is highest may also help agricultural lenders benchmark their own outlook for conditions in agricultural lending. If bankers see stress growing in their lending areas, they may be more prepared to identify and address the causes of stress with their lenders.

Appendix
Additional Tables

Table A-1
Variable Descriptions and Sources

Dependent variable	Description	Source
Farm loan repayment rates 1 = Lower 0 = Otherwise	Banker responses to the question: "What changes occurred in non-real-estate farm loans at your bank in the previous three months compared with the same months one year ago?" Response options include higher, lower, or no change.	Ag Credit Survey
Independent variables	**Description**	**Source**
Annual change in crop revenues	Revenues obtained from the sale of crops as a percent change from the previous year	BEA
Annual change in livestock revenues	Revenues obtained from the sale of livestock as a percent change from the previous year	BEA
Lagged ratio of expenses to receipts	Ratio of total farm expenses to total farm revenues, lagged one year	BEA and staff calculations
Off-farm income	Income obtained from off-farm sources as a percent of total farm income	BEA and staff calculations
Farm location quotient	Farm sector share of county earnings divided by the farm sector's share of total earnings in the United States.	BEA and staff calculations
Mining location quotient	Mining sector share of county earnings divided by the sector's share of total earnings in the United States	BEA and staff calculations
Annual change in farmland values	Values for "good quality," non-irrigated cropland, as a percent change from the previous year	Ag Credit Survey
Fixed interest rates on operating loans	The average effective rate applied to farm operating loans	Ag Credit Survey

Table A-2

Descriptive Statistics of Explanatory Variables by Year

Year	N	Annual change in crop revenues (percent)	Annual change in livestock revenues (percent)	Ratio of expenses to receipts	Off-farm income (percent of total income)	Farm location quotient	Mining location quotient	Annual change in farmland values (percent)	Fixed interest rates on operating loans (percent)
2002	309	7.89	–1.76	0.36	16.66	13.49	2.67	10.79	7.57
2003	305	13.66	16.52	0.35	17.77	19.52	2.27	19.33	7.11
2004	292	7.36	10.71	0.34	15.62	17.02	2.56	12.67	7.54
2005	287	6.80	1.84	0.34	20.37	19.48	2.47	17.87	8.49
2006	281	4.23	–0.28	0.35	17.24	16.77	2.80	10.31	9.15
2007	276	43.51	5.77	0.40	14.53	18.93	3.02	31.41	8.61
2008	261	32.85	–2.07	0.46	12.58	20.76	2.52	16.15	7.03
2009	254	1.36	–10.43	0.47	13.11	18.82	2.79	8.75	6.89
2010	263	10.28	15.16	0.46	10.16	20.77	2.60	20.52	6.64
2011	258	13.42	18.08	0.44	13.81	22.20	2.46	22.91	6.28
2012	236	21.24	1.89	0.46	17.90	18.60	2.73	23.94	5.91
2013	230	–7.08	0.16	0.44	17.56	17.94	2.53	16.78	5.82
2014	219	–6.90	19.21	0.39	19.18	21.03	2.17	7.86	5.69
2015	204	–10.97	–4.57	0.38	13.59	19.62	2.36	5.51	5.68
2016	200	2.42	–14.56	0.40	12.12	23.01	3.10	–2.39	5.74

Sources: Ag Credit Survey, BEA, and author's calculations.

Endnotes

[1]Approximately 20 banks, or 10 percent of Ag Credit Survey respondents, do not meet the 15 percent threshold but are still included in the survey due to their large presence in agricultural lending. For example, representatives from Wells Fargo Bank, First National Bank of Omaha, BMO Harris Bank, UMB Bank, and Bancfirst respond to the survey. Although these banks do not have a total agricultural loan ratio of 15 percent, they are included because their volume of agricultural loans exceeds that of many dedicated agricultural banks in the District.

[2]Previous studies have shown that the Ag Credit Survey provides reliable information on agricultural lending conditions (Briggeman and Zakrzewicz 2009).

[3]I also try using a multinomial logit model with fixed effects. In the multinomial logit model, the dependent variable is a discrete variable, farm loan repayment rates, with three alternatives: higher, lower, or unchanged relative to the previous year. However, after comparing results from both models, I use the binomial logit model instead of the multinomial logit model. It is easier to distinguish between higher and lower repayment rates (the binomial logit model) than it is to distinguish between higher, lower, and no change in repayment rates (the multinomial model). Furthermore, the model already has limited variability, so splitting the data for three different responses reduces the variability even more and could lead to less optimal results.

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