Low Access to Credit Decreases Asset Prices:

Evidence from a Quasi-Experiment in Agriculture

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Abstract: The impact of credit supply on asset prices is one of the central puzzles in finance, given the simultaneous causal effects of credit and asset prices. In this paper, we provide a clean identification of the causal effect of credit supply on farmland values with a difference-in-differences approach. In the past decade, farmland values skyrocketed in the U.S. Heartland due to the changing economics of agricultural production, particularly from increased demand for corn induced by ethanol policy. We compare changes in farmland values before and after the ethanol boom, between counties with low credit availability and counties with high credit availability. We find a large negative and statistically significant impact of low credit supply on farmland values during the ethanol boom.

The effect of credit supply on asset prices is one of the central puzzles in finance (Kiyotaki and Moore 1997). This puzzle derives from the simultaneous causal effects of credit on asset prices. On the one hand, easier access to credit allows firms to make investments in improved productivity, leading to higher asset prices. On the other hand, higher asset prices provide higher access to credit. In this paper, we provide empirical evidence of the effect of credit supply on asset prices using a quasi-experiment in agriculture.

The Energy Policy Act of 2005 and the subsequent Energy Independence and Security Act of 2007 mandate the use of 36 billion gallons of biofuels (including ethanol) production by 2022. These policies, together with rising crude oil prices, triggered the corn ethanol boom and shifted the demand for corn upward. In the same time period, farmland values increased sharply, especially in the U.S. Heartland[1]. However, the changes in farmland values showed a lot of spatial variation.

In this paper, we hypothesize that such spatial heterogeneity in the appreciation of farmland values can be partially explained by the spatial variation in credit supply. Specifically, using a difference-in-differences (DD) regression, we test whether the effect of credit supply on farmland values is amplified by the exogenous shift in the demand for corn. In the baseline model, we compare farmland values for counties with low and high credit supply, before and after the corn ethanol boom.

The baseline regression results show that farmland values in counties with low credit supply increased by $596 per acre less than counties with high credit supply during the corn ethanol boom, which is equivalent to a one-third reduction in the growth of farmland values in the Heartland region over this time period. The estimates are statistically significant and robust to

[1] The Heartland is a one of the nine Farm Resource Regions which are developed by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA), as shown in the appendix.

different model assumptions, specifications, and controls. To purge the potential reverse causal effect of farmland values on credit, we instrument for credit supply using a measure of interstate branching deregulation in the early sample when bank deregulation was occurring in Heartland states. We find that banking deregulation has increased credit supply and has been transmitted into higher farmland values.

Our paper is related to extensive research on whether farms/firms are financially constrained. Phimister (1995) finds that Dutch farms are not financially constrained. Beck and Demirgue-Kunt (2006) find that access to external finance is a growth constraint in small and medium-size firms. Guan et. al. (2009) explicitly measures the excess capital capacity in Dutch farms.

Our paper is also related to the vast literature on whether credit causes asset prices, productivity, and economic growth. Kiyotaki and Moore (1997) and Kiyotaki (1998) show that land prices may decline even under a negative temporary productivity shock if access to credit and land prices are dynamically simultaneously determined. Our research considers an opposite scenario in which a potential positive productivity shock may increase asset prices. Together with Butler and Cornaggia (2011), which show that access to credit causes economic growth through increasing productivity, our research may further the understanding of the effect of the corn ethanol boom on the recent gains in farmland values via credit cycles. Adelino, Schoar, and Severino (2012) and Favara and Imbs (2015) find that easy access to credit via housing deregulation (e.g., Conforming Loan Limits) and interstate bank deregulations substantially increases house prices. Ramcharan and Rodney (2015) find that counties with lower credit availability through interstate branching regulation have lower farmland values in the 1920s. Our research finds that low credit supply caused by stringent restrictions on banking deregulation reduced farmland value growth during the recent corn ethanol boom.

Lastly, our paper is connected to sizable research on whether credit availability relfects asset price changes. Gan (2007) empirically examines the effect of collateral values on debt and investment in a natural experiment. Chaney, Sraer, and Thesmar (2012) empirically test the effect of real estate values on investment via the collateral channel. Chakraborty, Goldstein, and MacKinlay (2014) suggests that a housing price boom may crowd out commercial lending and investment by firms.

The rest of the paper proceeds as follows: Section I describes the background of the current agricultural credit system. Section II develops the conceptual model of farmland values and credit supply. Section III describes the data. Section IV explains the empirical estimation strategy. Section V summarizes and interprets the main regression results. Section VI concludes.

I. Background

This section describes the current agricultural credit system, the importance of local banks on agricultural loan origination, measures of credit supply, interstate branching deregulation, and ethanol policy. These elements are essential for constructing the mechanisms of credit supply on farmland values.

A. Current Agricultural Credit System

The current agricultural credit system is comprised of five loan originators – commercial banks, the Farm Credit System (FCS), the Farm Service Agency (FSA), life insurance companies, and others – and one secondary market loan holder, the Federal Agricultural Mortgage

Corporation (Farmer Mac), according to the USDA's Economic Research Service (ERS) (Morehart 2015). Figure 1 shows the historical shares of farm debt for the major loan originators between 1970 and 2013. Commercial banks were the largest originators of farm debt from 1987 to 2009. In 2007, the largest player in farm debt origination was commercial banking[2], followed by the FCS, others, life insurance companies, and the FSA.

Commercial Banks – Commercial banks with state charters are either regulated by the Federal Deposit Insurance Corporation (FDIC) or the Federal Reserve System (FRS), while commercial banks with federal charters are regulated by the Office of the Comptroller of the Currency (OCC). The FDIC defines a commercial bank as an agricultural bank if its farm loans account for at least 25 percent of its total loans. Commercial banks engage in farm lending business by providing both real estate loans and non-real estate loans. Historically, commercial banks have dominated the FCS in total farm debt by originating a significantly larger amount of non-real estate farm loans (Robbins 2009), whereas the FCS has originated greater amounts of real estate debt (except for 2000).

FCS – The FCS was established by the Federal Farm Loan Act of 1916, with the purpose of serving farmers and ranchers with a reliable funding source. Since it was a government sponsored enterprise, it was able to obtain funding from the U.S. Treasury and lend to farmers at a lower rate than commercial banks. Beginning in 1968, it became a fully borrower-owned cooperative lending agency. Due to its debt default in 1985, the government bailed out the FCS. To provide support to the FCS, in the Agricultural Credit Act of 1987, the Congress established the Farm Credit System Insurance Corporation and Farmer Mac. The FCS is now providing

[2] During the period of 1970-1986 and after 2009, the FCS was the largest originator of farm debt.

more than 40 percent of the credit to the U.S. agricultural sector through four Farm Credit Banks with 78 local lending associations. FCS institutions are regulated independently by the Farm Credit Administration (FCA), to which institutions periodically submit primary financial data in the form of Uniform Call Reports (Farm Credit Network website).

FSA – The FSA, part of the USDA, provides loans to underrepresented farmers (e.g., farmers who are smaller in size, beginning, women, young, and minorities), who encounter trouble in obtaining loans from other sources. The FSA is often seen as a farmer's last resort for lending. The interest rates charged by the FSA tend to be lower than those charged by commercial banks.

Life Insurance Companies – Similar to the FSA, life insurance companies are not regulated by federal agencies. Their farm mortgage data are collected by the American Council of Life Insurers (ACLI) for the Life Insurers Fact Book.

Others – Other farm credit lending entities include family members, input suppliers, and equipment dealers. The data from this group are compiled from USDA's Agricultural Resource Management Survey (ARMS).

B. Local Banks Matter in Agriculture

First, a number of studies have shown that local capital markets still matter in local economic activities after the interstate branching deregulation. Petersen and Rajan (2002) document the impacts of distance to banks on small firms. Guiso, Sapienza, and Zingales (2004) show a causal effect of local financial development on firm success, especially small firms. Becker (2007) demonstrates that the geographic segmentation of capital markets has significant influence on local firm activities. Bhutta and Keys (2014) show that effective mortgage rates vary geographically due to local economic and housing conditions, though the interest rate is set at the national level. Given that the majority of U.S. farms are small, the local credit market likely matters in farm development and growth.

Second, local commercial banks are still the first resort for agricultural loans. Koo, Duncan, and Taylor (1998) find that 63 percent of farmers choose local commercial bank financing as the number one source of farm credit in a national survey of 897 farmers. Butler and Cornaggia (2011) find that the correlation between local bank deposits and agricultural loans is 0.65 in the Corn Belt during 2000-2006. FDIC (2005) finds that community banks provide 65 percent of all farm real estate loans, 61 percent of all farm operating loans, and 75 percent of small farm loans. FDIC (2012) finds that 77 percent of community banks hold positive agricultural loans in 2011. Figure 3 shows the geographic distribution of community bank headquarters and branches in 2011. As can be seen, the majority of the community banks cluster in the Heartland, where agriculture plays a central role in the rural economy. Though interstate banking deregulation makes credit transfer easier across regions, the Heartland states with a unit banking system[3] previously are the most restrictive for interstate banking deregulation (Rice and Strahan 2010).

C. The Measure of Credit

[3] Unit banking system: In some states in the United States, banks were not allowed to open branches. Unit banking was mainly in the Midwest and Southwest.

Even though loan originators can resell loans on the secondary market, due to loan size restrictions, transaction costs and asymmetric information, banks' own credit supply and cost of deposits still affect loan origination in the local credit market (Loutskina and Strahan 2009). Conceptually, we may use local agricultural loans as a measure for farm credit. However, due to data limitations, we choose an alternative measure for local credit: aggregated deposits. Becker (2007) and Butler and Cornaggia (2011) show a positive correlation between loans and deposits at the local and national levels. The Federal Reserve Bank of Chicago Land Value Survey (Oppedahl 2014) shows the average loan-to-deposits ratio to be around 0.7 in five Heartland states. We also argue that deposits are soft upper bounds of loans, which are a good proxy for credit, especially in the Heartland states where banks are relatively small.

D. Interstate Branching Deregulation Restrictions

Commercial banks in the Heartland states were forbidden from interstate branching prior to the Interstate Branching and Bank Efficiency Act of 1994 (IBBEA). The IBBEA allows states to choose to opt in or out in the interstate banking and branching deregulation between September 1994 and June 1997. Though all states opted in, states were permitted to impose out-of-state entry restrictions in the following four areas: 1) *De Novo* interstate branching; 2) acquisition of a single branch; 3) minimum age of target institution; and 4) statewide deposit caps (Johnson and Rice 2008). The IBBEA has significant influence on the banking system in the Heartland. As can be seen in figure 2, after the initial period of IBBEA in 1994-1997, seven Midwestern states erected full IBBEA barriers to out-of-state branching.

Since commercial banks originate the majority of farm loans, the IBBEA on commercial banks inevitably affects farm loans in the following ways. First, the restriction relaxation on *De Novo* interstate branching may allow banks to reach new farmers, and therefore increase the local supply of loans. Second, fewer restrictions on acquisitions and mergers increase competition among commercial banks. Due to consolidation, banks may raise interest rates. Third, fewer restrictions on a statewide deposit cap are likely to increase the deposit levels of banks. Since many local banks rely on deposit financing, farm loans are likely to be affected.

E. Ethanol Policy

As an effort to reduce dependence on foreign oil and mitigate environmental degradation, the U.S. Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 mandate 36 billion gallons of biofuels by 2022. The mandate increases the demand for corn worldwide, raising the prices of corn and other staple food crops (Roberts and Schlenker 2013; Scott 2013). In this paper, we argue that the increased crop prices are associated with an increase in farmland values in Heartland counties, especially in the states where access to credit is more readily available. Essentially, the ethanol boom amplifies the effect of access to credit on farmland values, and vice versa.

II. Theoretical Model

In this section, we set up a model of farmland values within two local markets – a local land rental market and a local credit market – to show the relationship between farmland values and credit supply.

The agricultural profit for a representative producer is modeled as the following:

(1) $$\max_{L,K} \pi = p \cdot L^{\alpha} \cdot K^{\beta} - r \cdot L - \delta \cdot K,$$

where π is the profit, L is for land, K is for capital, crop yield is $y = L^{\alpha} \cdot K^{\beta}$, p is output price, r is land rent paid to owner, δ is farm loan rate, and operating cost is $c = r \cdot L + \delta \cdot K$.

The first order conditions to solve the profit maximization by choosing optimal L and K are given by:

(2) $$\frac{\partial \pi}{\partial L} = p \cdot \alpha \cdot L_d^{\alpha-1} \cdot K_d^{\beta} - r = 0,$$

and

(3) $$\frac{\partial \pi}{\partial K} = p \cdot \beta \cdot L_d^{\alpha-1} \cdot K_d^{\beta-1} - \delta = 0.$$

where L_d and K_d are the derived demands for land and capital. We explicitly write the subscripts to emphasize the demand functions.

The inverse derived demands for land and credit are given by:

(4) $$r = p \cdot \alpha \cdot L_d^{\alpha-1} \cdot K_d^{\beta},$$

and

(5) $$\delta = p \cdot \beta \cdot L_d^{\alpha-1} \cdot K_d^{\beta-1}.$$

Given (4) and (5), we obtain the following relationship between the demand for land and capital:

(6) $$L_d = \frac{\alpha\delta}{\beta r} K_d.$$

We further assume an upward-sloping farmland supply and a constrained farm credit supply, which are given by:

(7) $$L_s = \lambda r^{\theta},$$

and

(8) $$K_s = \overline{K}.$$

where $\lambda > 0$, $\theta > 0$, and $\overline{K} > 0$.

The necessary conditions for clearing the land rental market and the farm credit market are given by:

(9) $$L_d = L_s,$$

and

(10) $$K_d = K_s.$$

Combing (4), (7), and (9), we obtain the local equilibrium land rent, which is given by:

(11) $$r^* = \left(\alpha\lambda^{\alpha-1}p\overline{K}^{\beta}\right)^{\frac{1}{1+\theta(1-\alpha)}}.$$

We conduct comparative statics of land rent with respect to credit availability. First, we take the first partial derivative of land rent with respect to credit availability, as shown in equation (12). Second, we take the second partial derivative of land rent with respect to crop price, as shown in equation (13).

(12) $$\frac{\partial r^*}{\partial \overline{K}} = \frac{\beta}{1+\theta(1-\alpha)} \cdot (\alpha\lambda^{\alpha-1}p)^{\frac{1}{1+\theta(1-\alpha)}} \cdot \overline{K}^{\frac{\beta}{1+\theta(1-\alpha)}-1} > 0.$$

(13) $$\frac{\partial^2 r^*}{\partial \overline{K}\partial p} = \frac{\beta}{[1+\theta(1-\alpha)]^2} \cdot (\alpha\lambda^{\alpha-1})^{\frac{1}{1+\theta(1-\alpha)}} \cdot \overline{K}^{\frac{\beta}{1+\theta(1-\alpha)}-1} \cdot p^{\frac{\theta(\alpha-1)}{1+\theta(1-\alpha)}} > 0.$$

Equations (12) and (13) have the following implications. First, land rent is higher where credit availability is higher. Second, land rent increases more in area with higher credit availability as crop price increases over time.

Similarly, combining equations (5), (6), (8), (10), and (11), we obtain the local equilibrium farm loan rate, which is given by:

(14) $$\delta^* = \alpha^{\frac{\alpha\theta}{1+\theta(1-\alpha)}} \cdot \beta \cdot p^{\frac{1+\theta}{1+\theta(1-\alpha)}} \cdot \lambda^{\frac{\alpha}{1+\theta(1-\alpha)}} \cdot \overline{K}^{\frac{\frac{-\alpha\beta}{1+\theta(1-\alpha)}+(\alpha+\beta-1)}{1-\alpha}}.$$

We also conduct comparative statics of farm loan rate with respect to credit availability. First, we take the first partial derivative of farm loan rate with respect to credit availability, as shown in equation (15). Second, we take the second partial derivative of farm loan rate with respect to crop price, as shown in equation (16).

(15) $$\frac{\partial\delta^*}{\partial\bar{K}} = \frac{\alpha^-}{1-\alpha}\cdot\alpha^{\frac{\alpha\theta}{1+\theta(1-\alpha)}}\cdot\beta\cdot p^{\frac{1+\theta}{1+\theta(1-\alpha)}}\cdot\lambda^{\frac{\alpha}{1+\theta(1-\alpha)}}\cdot\bar{K}^{\frac{\alpha^-}{1-\alpha}-1} < 0.$$

(16) $$\frac{\partial^2\delta^*}{\partial\bar{K}\partial p} = \frac{\alpha^-}{1-\alpha}\cdot\frac{1+\theta}{1+\theta(1-\alpha)}\cdot\alpha^{\frac{\alpha\theta}{1+\theta(1-\alpha)}}\cdot\beta\cdot p^{\frac{1+\theta}{1+\theta(1-\alpha)}-1}\cdot\lambda^{\frac{\alpha}{1+\theta(1-\alpha)}}\cdot\bar{K}^{\frac{\alpha^-}{1-\alpha}-1} < 0.$$

where $\alpha^- = \frac{-\alpha\beta}{1+\theta(1-\alpha)} + (\alpha+\beta-1) < 0$ give the assumption of diminishing returns to scale, i.e., $\alpha+\beta<1$.

Now let us turn to the capitalization channel of farmland values. we assume no growth in land rents, so farmland values equal to the perpetuity of land rents, i.e.,

(17) $$v = \frac{r^*}{\delta^*}.$$ [4]

where v is farmland values.

Take the partial derivative of farmland values with respect to credit supply, we obtain the following:

(18) $$\frac{\partial v}{\partial\bar{K}} = \frac{\partial r^*}{\partial\bar{K}}\cdot\frac{1}{\delta^*} - r^*\cdot\frac{\partial\delta^*}{\partial\bar{K}}.$$

[4] We assume that the cap rate equals the farm loan rate.

Since $\frac{\partial r^*}{\partial \bar{K}} > 0$ and $\frac{\partial \delta^*}{\partial \bar{K}} < 0$, the first derivative of farmland values with respect to credit supply is given by:

(19) $$\frac{\partial v}{\partial \bar{K}} > 0.$$

This simply suggests that farmland values increase with credit supply, via at least two channels: the numerator channel – productivity and the denominator channel – capitalization.

Since $\frac{\partial^2 r}{\partial \bar{K} \partial p} > 0$ and $\frac{\partial^2 \delta^*}{\partial \bar{K} \partial p} < 0$, the second derivative of farmland values with respect to credit supply and crop price is given by:

(20) $$\frac{\partial^2 v}{\partial \bar{K} \partial p} > 0.$$

Equations (19) and (20) drive our empirical tests. First, farmland values are positively affected by credit supply. Second, the changes in farmland values by credit supply are amplified by the increase in crop prices.

III. County-Level Data

We collect six datasets to construct county-level variables. First, we obtain county-average farmland values in four consecutive census years 1997, 2002, 2007, and 2012 from the USDA Census of Agriculture.

Second, we obtain branch level deposits during 1995-2012 from the Federal Deposit Insurance Corporation (FDIC) and aggregate the deposits to county-level. We simultaneously construct the number of banks in each county using the same FDIC data. We only use the data from 1997, 2002, 2007, and 2012 in order to match the farmland value data. As described earlier, deposits are positively but nonlinearly correlated with farm loans and a good proxy for credit supply. Therefore, we define an indicator variable for whether counties are low in deposits – the LOWDEP dummy, which equals 1 if the county-aggregated deposits rank in the lowest quartile within all county-aggregated deposits pooled over all counties and all years in the sample and 0 otherwise.

Third, we obtain county population and land areas during 1978-2012 from the U.S. Census Bureau to construct a variable for population density. We also obtain per capita income from the same source. We only keep the data from 1997, 2002, 2007, and 2012 in order to match the farmland value data.

Fourth, we obtain weather data from Parameter Elevation Regression on Independent Slopes Model (PRISM) via Schlenker and Roberts (2009). The original PRISM data include monthly average maximum temperature, minimum temperature, and daily precipitation on a 4 km-by-4 km grid. Schlenker and Roberts (2009) interpolate the monthly weather data to daily data. We then construct our own measures of climate using their interpolated daily weather data. The county-level climate data, which include extreme cold index, extreme heat index, rainfall deficiency index, and rainfall surplus index are constructed as follows: First, we calculate daily Degree Days<0ºC (extreme cold index), Degree Days>34ºC (extreme heat index), precipitation<0.2cm (rainfall deficiency index), and precipitation>1.7cm (rainfall surplus index) at each grid. Second, we sum these measures during April-September in each day at each grid.

Third, we average the above cumulative measures over the 56-year periods from 1950 to 2005 at county-level.

Fifth, we obtain sub-county level soil data from the gridded Soil Survey Geographic Database (gSSURGO) and weight the soil properties by the areas of the sub-counties to obtain county-level data. The soil data include available water capacity (AWC)—(a measure of soil moisture), pH, and organic matter (OM). Note that neither the soil nor the climate variables vary across years.

Lastly, we obtain the state level interstate branching restriction indexes during 1994-2005 from Rice and Strahan (2010). Rice and Strahan (2010) assign a score of 1 if a state has restrictions on any of the following interstate banking deregulation: (1) *de novo* interstate branching; (2) acquisition of a single out-of-state branch; (3) minimum age on the banks to be acquired; and (4) statewide caps on deposits that a single bank holds. The Rice-Strahan Index is the total score of the above four elements, with 0 representing the least restrictive bank regulation and 4 representing the most restrictive bank regulation. The corresponding variables used in this paper are labeled as: *De Novo*, *Single*, *Age*, and *Cap*.

Table 1 shows the descriptive statistics. Average farmland values increased steadily from 1997 to 2007 and jumps in 2012. Average LOWDEP dummy decreased over the years, suggesting more counties are low in deposits in the early years of the sample. Average population and per capita income both increased at steady rates. Soil and climate variables were measured as the 56-year average from 1950-2005, which does not vary over time.

Figure 4 shows the geographic distribution of county-average farmland values in the Heartland, which covers nine states (i.e., Iowa, Indiana, Illinois, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota) and 542 counties over four census years. In 1997 and 2002, average farmland values are the highest in Indiana, Illinois, and Ohio and lowest in Minnesota, South Dakota, Nebraska, and Missouri. From 2007 to 2012, average farmland values increased fastest in Iowa, while increasing more slowly in Indiana and Ohio. During the same period, average farmland values remained lowest in Minnesota, South Dakota, Nebraska, and Missouri.

Figure 5 shows the geographic distribution of county-level deposits in the Heartland over four census years. As can be seen, low levels of deposits coincide with low farmland values in Minnesota, South Dakota, Nebraska, and Missouri, especially in 1997 and 2002. From 1997 to 2012, higher levels of deposits coincide with higher farmland values in Iowa.

IV. Econometric Model

A. Cross-Sectional Model

Following naturally from equation (19), we first test the cross-sectional relationship between farmland values and credit supply. The measure of credit supply is the $LOWDEP$ dummy, which equals 1 if county aggregate deposits in a given year rank in the lower quartile of all county aggregate deposits pooled over the sample years, and 0 otherwise. The use of the $LOWDEP$ dummy is consistent with the conceptual model in that deposits are good proxies for farm loans and have nonlinear impacts on farmland values. We specify the cross-sectional model as the following:

$$V_c = \alpha_o + \beta_o LOWDEP_c + X_c' \gamma_o + \epsilon_c, \qquad (21)$$

where V is farmland values, X is a vector of control variables, and ϵ is the idiosyncratic error term. Subscript c stands for county.

We control for the factors that may be correlated with $LOWDEP$ by 1) limiting the sample to 542 Heartland counties, which are exposed to similar economic conditions, as well as similar weather and soil conditions and 2) explicitly controlling for per capita income, population density, weather, and soil, which may be correlated with $LOWDEP$.

B. DD

Following naturally from equation (20), we then test the time series relationship between farmland values and credit supply. We set up a DD framework as follows:

(22) $$V_{ct} = \alpha + \beta POST_t \times LOWDEP_{ct} + \delta POST_t + \theta LOWDEP_{ct} + X'_{ct}\gamma + \epsilon_{ct},$$

where $POST$ is a dummy variable that equals 1 if year t is after 2007 and 0 otherwise. The $POST$ dummy captures the ethanol boom, which includes the increase in crop prices and expansion in crop acreage.

C. Identification via Bank Deregulation Restriction

Lastly, we want to purge the reverse causal effect of farmland values on credit, which may cause upward bias in the estimate of $LOWDEP$. We instrument for the $LOWDEP$ dummy with the interstate branching deregulation restriction index in Rice and Strahan (2010). The index is comprised of four restrictions: (1) *de novo* interstate branching; (2) acquisition of a single out-of-state branch; (3) minimum age on the banks to be acquired; and (4) statewide cap on deposits that a single bank holds. The first three elements are related to the number of branches. The relaxation of the first restriction is likely to increase the number of branches, while the relaxation of the second and third restrictions is likely to decrease the number of branches via consolidation, making the effect of the index on the number of branches ambiguous. The fourth restriction affects deposits. According to the interstate banking and branching efficiency act of 1994, a state was allowed to put a deposit cap on banks, such that a bank holding company cannot exceed a statewide deposit concentration limitation, for example, 20 percent. This cap probably will deincentivize banks to raise deposits locally. Given many local banks rely on deposit financing, the deposit cap lowers the local credit supply.

Since the data measuring credit supply starts in 1995 and the data for farmland values starts in 1997, we cannot capture the temporal effects on farmland values by credit supply via banking deregulation. Nevertheless, the interstate branching is almost complete before 1997 within the Heartland states. Therefore, we rely on the spatial variation in the banking deregulation restriction to study the effects of credit supply on farmland values. We propose that banking deregulation increases credit supply in fully deregulated states relative to restrictive states, driving up farmland values in fully deregulated states.

V. Empirical Results

A. Cross-Sectional Regression Results

Table 2 shows the cross-sectional regression results. Columns we to IV correspond to the effect of the LOWDEP dummy on farmland values in each of 1997, 2002, 2007, and 2012, controlling for socioeconomic factors, climate, and soil conditions. Being low in bank deposits leads to a reduction in farmland values by $264 per acre in 1997, $211 per acre in 2002, $287 per acre in 2007, and $911 per acre in 2012.

B. DD Regression Results

Table 3 shows the DD regression results. Column I shows the results of a simple DD. Column II is the simple DD with random effect. Column III is the simple DD with county fixed effect. Column IV is DD with socioeconomic variables and county fixed effect. Column V is DD with interaction terms of $POST$ and the cross-sectional climate and soil variables as well as county fixed effect. Column VI is DD with socioeconomic variables, interaction terms of $POST$ and cross-sectional climate and soil variables, as well as county fixed effect.

The effects of LOWDEP on farmland values range from -$434 to -$804 per acre during the ethanol boom. The preferred specification in column VI shows that counties with low aggregated deposits suffer from a reduction in average farmland values by $596 per acre during the ethanol boom.

We are also interested in the role of federal regulation agencies in the determination of farmland values. Table 4 shows the percentage of banks specializing in agricultural lending in the Heartland by regulation agency. FDIC banks account for 70 percent of banks in agricultural lending activities among all commercial banks. We argue that given the same amount of deposits, farmers are more exposed to FDIC banks. The easier access to credit by the FDIC banks is then transmitted to higher farmland values, while the credit provided by other regulation agencies is relatively harder to access, making them natural placebo counterparts. We report the DD regression results by regulation agency in table 5. Columns I – III correspond to the samples aggregating deposits by FDIC, FRS, and OCC. As expected, the coefficient on the LOWDEP dummy is higher in the FDIC sample than those in the FRS and OCC samples[5].

C. Bank Deregulation Restriction as Instrument for Credit Supply

In an effort to confirm the causal effect of credit supply on farmland values, we formally study 1) the impact of banking deregulation on credit supply and 2) the effect of the induced credit supply on farmland values. We employ an instrumental variable approach using 1997 and 2002 pooled data. We choose the data before the ethanol boom for two reasons. First, this is the period that captures the immediate effects of banking deregulation on credit supply and farmland values. Second, the bank deregulation restriction index developed by Rice and Strahan (2010) is only available for the period 1994-2005[6].

Table 6 shows the two stage least square results. Column I shows the first stage results of bank deregulation restriction indices on credit supply. As expected, the deposit cap has the most significant impact on county aggregated deposits. If a state restricts the amount of deposits that a bank can hold, then the probability that a county is low in deposits is increased by almost 12 percent. Column II shows the second stage results of induced credit supply on farmland values. As expected, having low levels of deposits decreases county-average farmland values by $529 per acre.

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[5] Cross sectional regression results by regulation agencies show that the impact of FRS banks on farmland values is increasing from 1997 to 2012 as more FRS banks engage in agricultural lending.

[6] Tara Rice has agreed to share the updated index in 2006-2014 when the updating is complete.

VI. Conclusion

We study the effect of credit supply on asset prices. Our contribution to the literature is to provide a clean identification of the effect of credit supply on asset prices by exploiting the impacts of an exogenous increase in the demand for corn on farmland values under different levels of access to credit. We find that a low level of access to credit has a large and statistically significant negative effect on farmland values, especially during the ethanol boom. Additional banking deregulation could potentially increase credit supply, which could lead to increases in farmland values.

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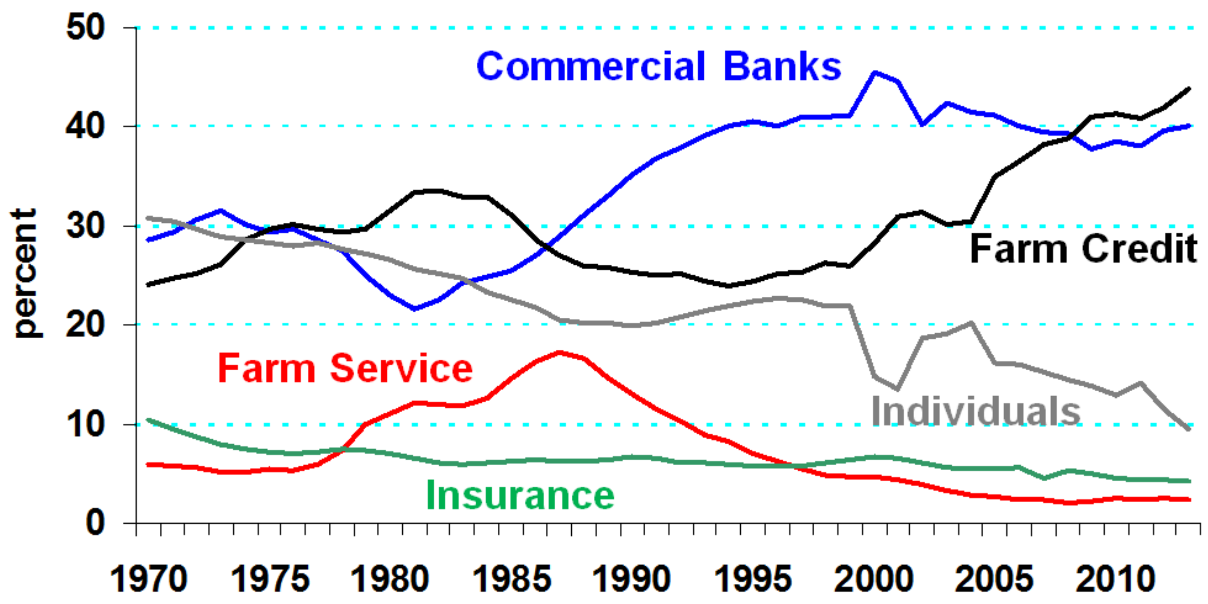


Figure 1. Shares of Farm Debt by Loan Origination

Note: This figure shows the shares of farm debt held by each type of loan originator.

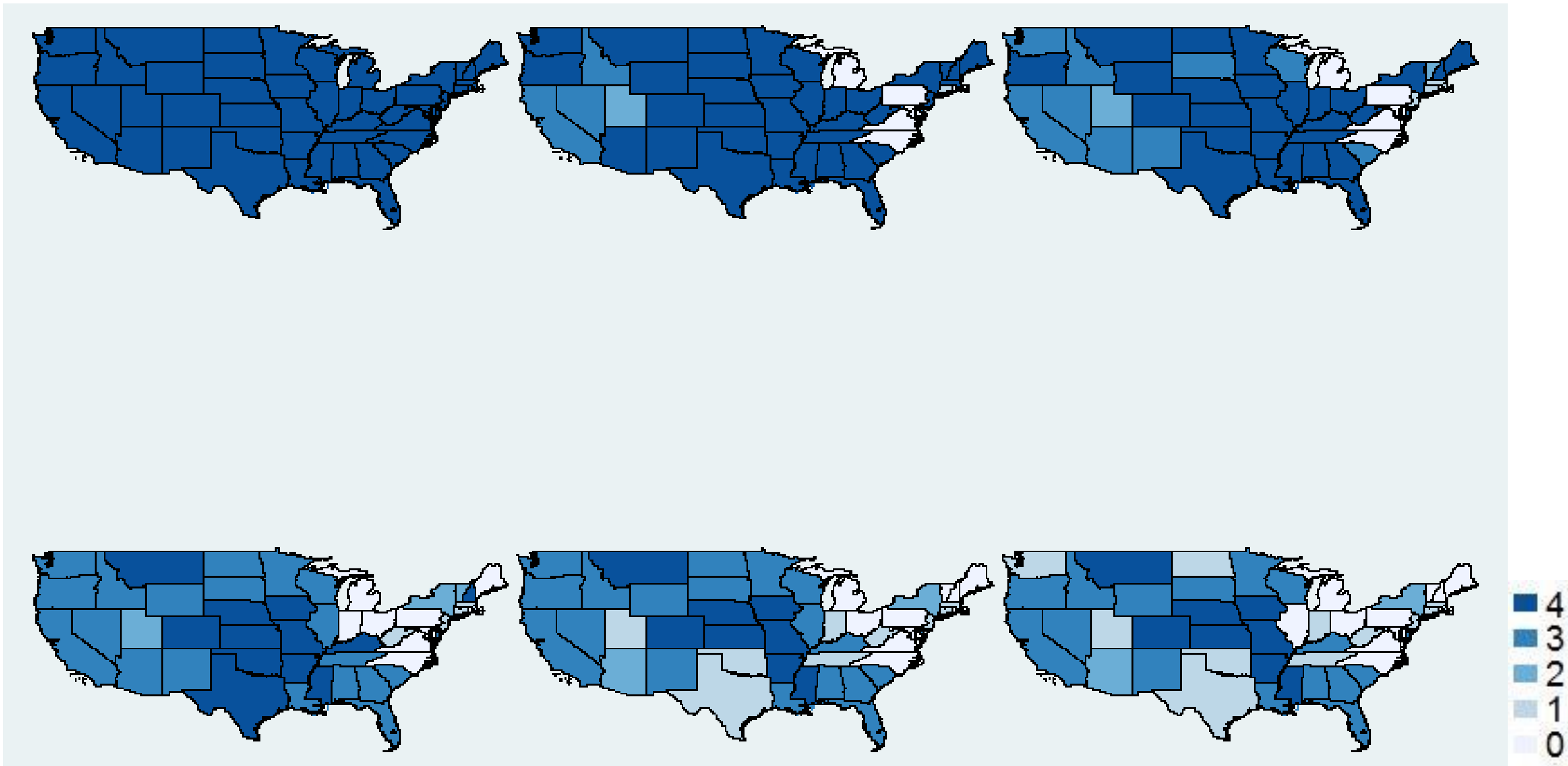


Figure 2. Rice-Strahan Index of the Interstate Branching Deregulation

Note: This figure shows the Rice-Strahan Index of the Interstate Branching Deregulation in 1994-1997, 2002, and 2005. Rice and Strahan (2010) assigns 1 score if the state has restrictions on any of the following interstate banking deregulation: (1) *de novo* interstate branching; (2) merger of a single out-of-state branch instead of the whole bank; (3) minimum age on the banks to be acquired; and (4) cap on deposits that a single bank holds. The Rice-Strahan Index is the total score of the above four elements, with 0 representing the least restrictive in bank regulation and 4 representing the most restrictive in bank regulation.

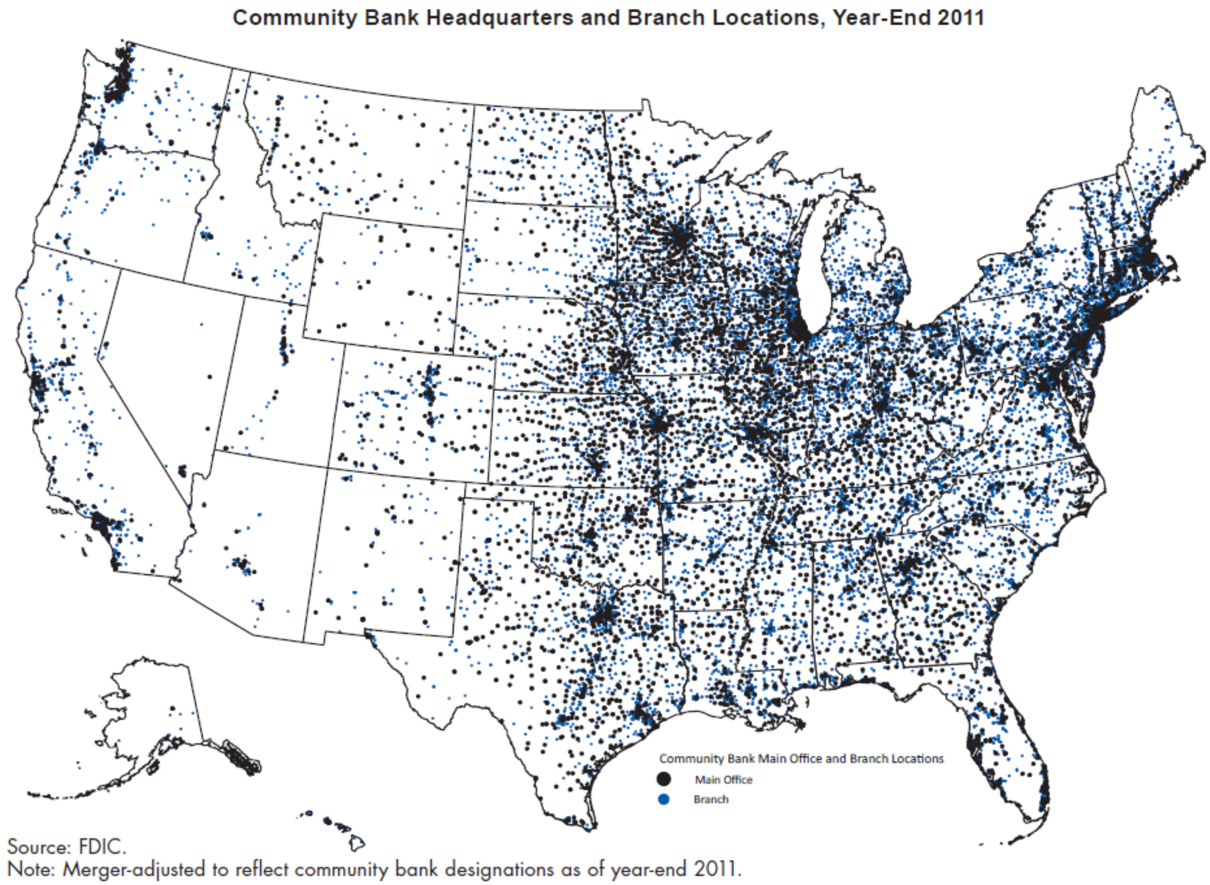


Figure 3. Geographic Distribution of Community Banks in the United States

Note: This figure shows the geographic distribution of community banks in the United States in 2011.

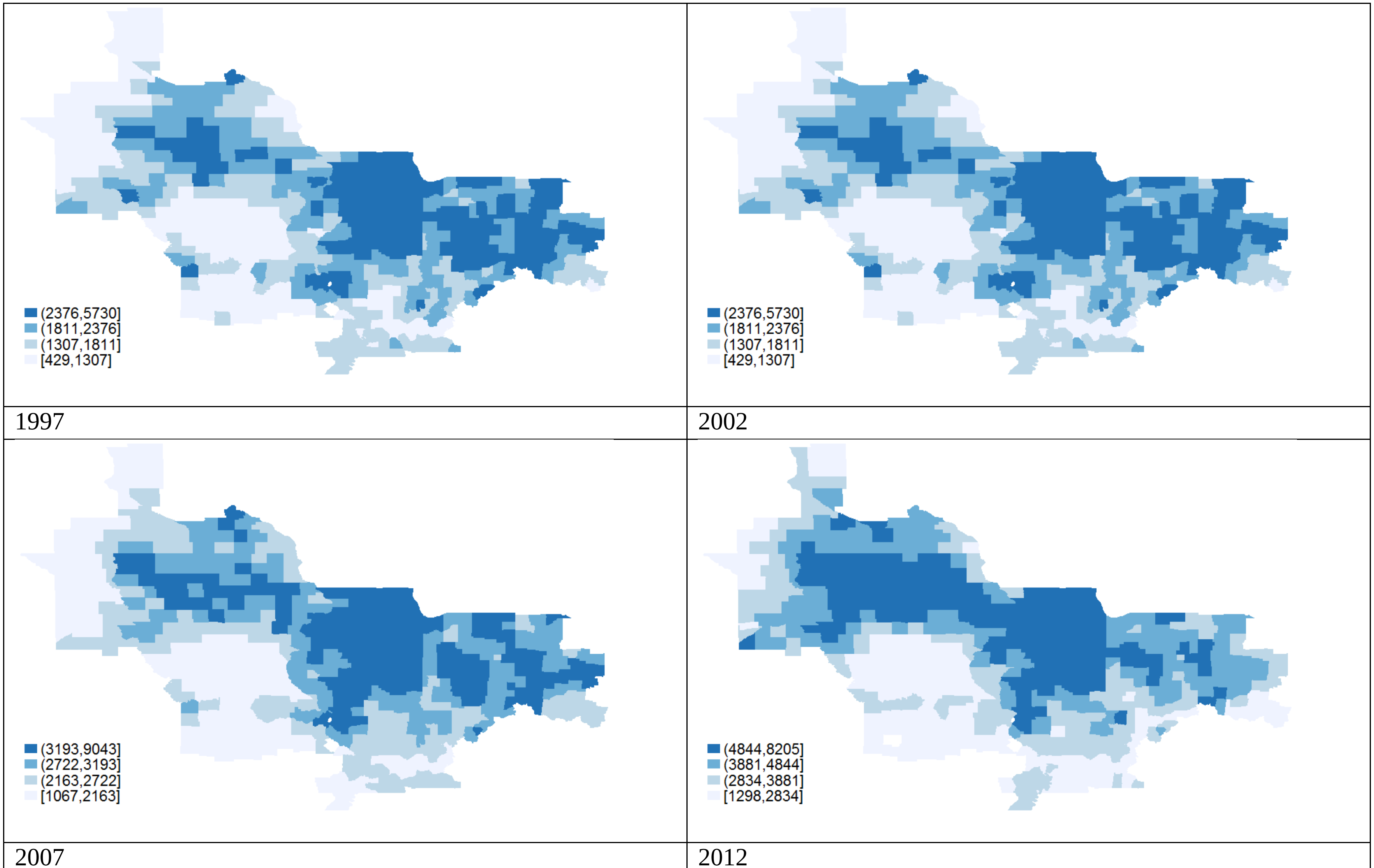
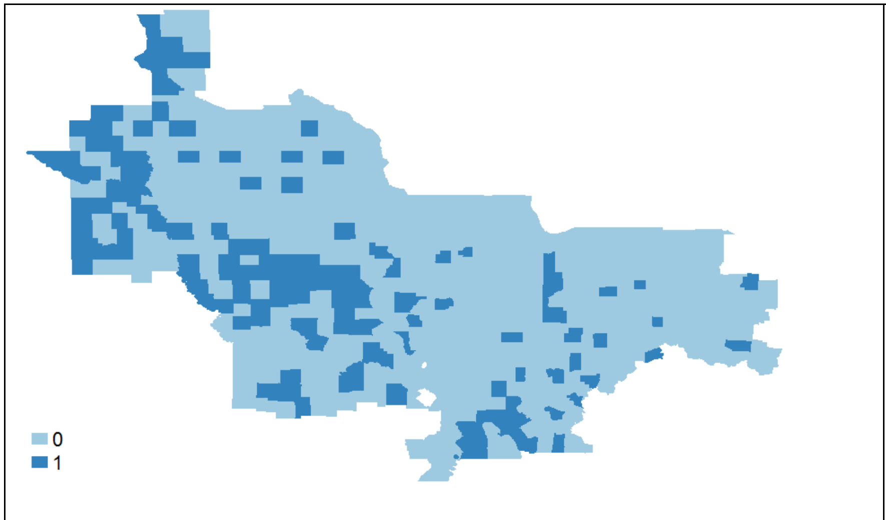
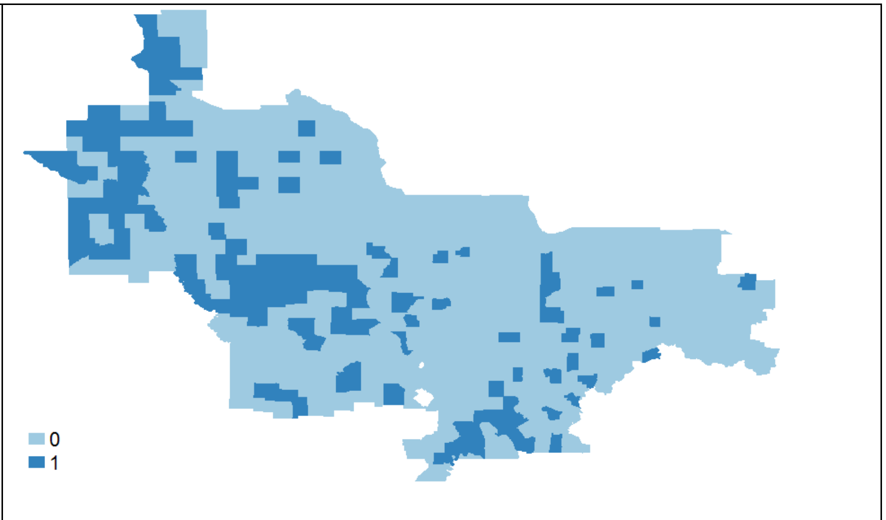


Figure 4. County Average Farmland Values within the Heartland States

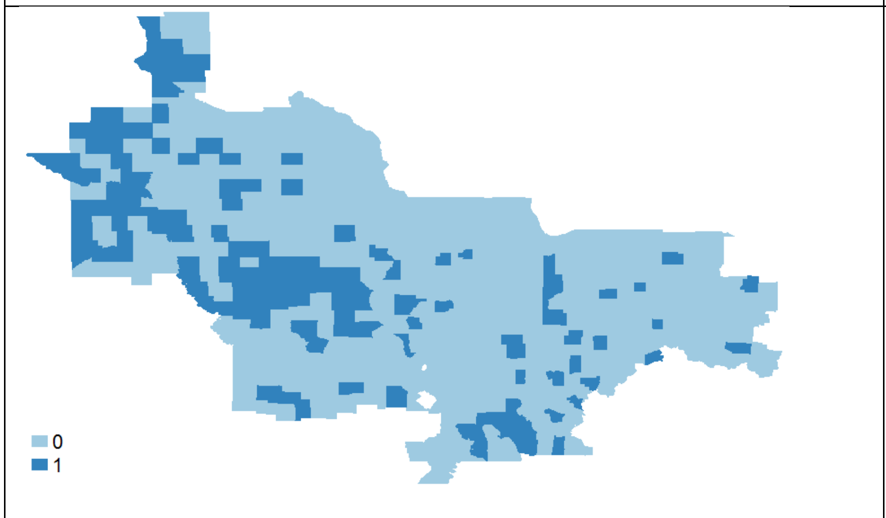
Note: This figure shows the geographic distribution of county average farmland values within the Heartland states in 1997-2012. Farmland values are labeled by quartile in each year instead of common dollar value ranges in all years.



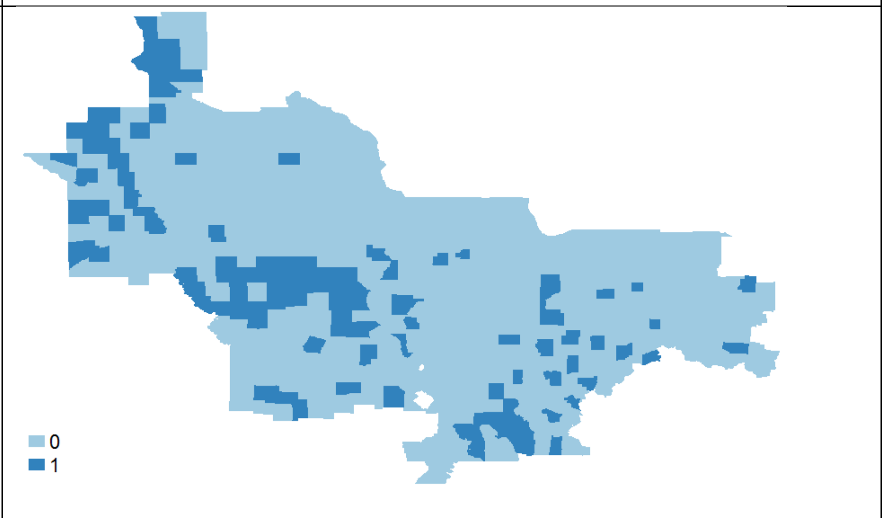
1997



2002



2007



2012

Figure 5. County Bank Deposit Status within the Heartland States

Note: This figure shows the county aggregated Bank Deposits within the Heartland states in 1997, 2002, 2007, and 2012. Legend 1 means if county aggregated bank deposits are in the lowest quartile among all counties in the Heartland over all sample years, and 0 otherwise.

Table 1. Descriptive Statistics

	Year	Observations	Mean	SD	MIN	MAX
Farmland Values	1997	542	1897.72	796.28	429.29	5729.9
	2002	542	2094.35	799.16	487	6286
	2007	542	2727.23	782.41	1067.21	9042.63
	2012	542	4989.77	1675.05	1656	10471
LOWDEP	1997	542	0.32	0.47	0	1
	2002	542	0.27	0.44	0	1
	2007	542	0.2	0.4	0	1
	2012	542	0.17	0.38	0	1
Per Capita Income ($)	1997	542	24791	3557.5	17075.4	44521.05
	2002	542	26042.4	4043.49	14733	46748
	2007	542	28297	4316.99	18043.6	49309.34
	2012	542	30993.6	6052.46	19430.7	61665.94
Population Density	1997	542	122.91	348.24	4.85	5627.29
	2002	542	126.69	353.96	4.46	5634.33
	2007	542	130.37	352.54	4.21	5449.78
	2012	542	133.17	360.68	4.06	5527.77
AWC (%)	-	542	0.16	0.02	0.1	0.21
OM (%)	-	542	1.35	0.88	0.4	10.17
PH	-	542	6.54	0.66	5.05	7.78
Rainfall Deficiency (cm)	-	542	21.6	1.17	17.01	25.2
Rainfall Surplus (cm)	-	542	9.5	2.68	3.73	18.03
Cold Index (ºC)	-	542	4.6	3.87	0.06	22.14
Heat Index (ºC)	-	542	2.04	1.73	0.16	9.7

Note: This table shows the summary statistics of the dependent variable and explanatory variables in 1997, 2002, 2007, and 2012 within the Heartland counties. Soil and climate variables are the 56-year average in 1950-2005, which do not vary across years.

Table 2. Cross-Sectional Regression Results

	(I) 1997	(II) 2002	(III) 2007	(IV) 2012
LOWDEP	-263.991***	-211.065***	-286.511***	-911.135***
	(43.546)	(46.180)	(46.279)	(118.446)
Income Per Capita	0.087***	0.066***	0.036***	0.074***
	(0.007)	(0.006)	(0.005)	(0.010)
Population Density	0.383***	0.679***	0.869***	0.502***
	(0.061)	(0.062)	(0.059)	(0.129)
AWC	551.836	-1,458.073	3,641.201***	19,969.911***
	(901.526)	(906.041)	(872.976)	(2,157.230)
OM	48.815*	32.492	69.840***	293.843***
	(26.360)	(26.583)	(25.124)	(61.375)
PH	280.948***	258.217***	185.408***	906.685***
	(49.196)	(48.577)	(45.978)	(112.098)
Rainfall Deficiency	-56.561**	-71.964***	-50.826**	-45.145
	(22.405)	(22.473)	(21.292)	(52.252)
Rainfall Surplus	-9.620	13.526	7.470	22.276
	(9.762)	(9.770)	(9.260)	(22.590)
Cold Index	-99.777***	-88.218***	-83.801***	-173.881***
	(7.698)	(7.699)	(7.322)	(18.510)
Heat Index	-158.060***	-161.794***	-235.879***	-460.896***
	(16.357)	(16.268)	(15.322)	(37.324)
Constant	-128.024	1,024.405**	1,643.522***	-4,307.760***
	(473.626)	(477.749)	(448.124)	(1,098.504)
Observations	542	542	542	542
R-squared	0.711	0.712	0.731	0.649

Note: This table represents the cross-sectional regression results of access to credit on farmland value. Column (I)-(IV) uses farmland values in 1997, 2002, 2007, and 2012 respectively.

Table 3. Difference-in-Differences Regression Results

	(I)	(II)	(III)	(IV)	(V)	(VI)
POST	1,864.186***	1,883.405***	1,919.507***	1,050.210***	-2,787.112**	81.767
	(253.604)	(56.042)	(246.514)	(175.927)	(1,060.996)	(1,391.609)
LOWDEP	-746.417***	-654.003***	-314.710**	387.240***	-239.827**	265.323**
	(98.322)	(90.181)	(126.916)	(98.791)	(76.235)	(85.875)
POST×LOWDEP	-439.392**	-488.758***	-485.983***	-804.052***	-434.240***	-595.972***
	(163.136)	(118.685)	(121.674)	(142.446)	(55.038)	(90.573)
POST×AWC					133.670***	69.047**
					(26.382)	(27.467)
POST×OM					1.307	1.619**
					(0.723)	(0.553)
POST×PH					2.531*	1.768
					(1.270)	(1.439)
POST×Rainfall Deficiency					46.100	-43.709
					(52.126)	(53.002)
POST×Rainfall Surplus					4.697	19.214
					(42.240)	(32.973)
POST×Cold Index					-5.393	-98.818***
					(34.858)	(29.218)
POST×Heat Index					-162.156***	-206.410***
					(25.770)	(32.531)
Income Per Capita				0.233***		0.246***
				(0.038)		(0.035)
Population Density				2.568**		2.244*
				(0.783)		(0.979)
Constant	2,216.382***	2,189.102***	2,088.941***	-4,369.757***	2,066.836***	-4,603.137***
	(154.271)	(50.928)	(116.037)	(1,075.924)	(70.453)	(989.443)
County FE	N	N	Y	Y	Y	Y
Observations	2,168	2,168	2,168	2,168	2,168	2,168
R-squared	0.385		0.484	0.632	0.519	0.653
Number of Counties		542	542	542	542	542

Note: This table shows the difference-in-differences regression results. Column I shows the baseline simple DD results. Column II shows the DD results with random effect. Column III shows the simple DD with county fixed effect. Column IV includes socioeconomic variables with county fixed effect. Column V includes the POST dummy interacted with cross-sectional climate and soil variables with county fixed effect. Column VI includes both socioeconomic variables and the POST dummy interacted with cross-sectional climate and soil variables with county fixed effect. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 4. Percentage of Banks Specializing in Agricultural Lending by Regulation Agency

Year	1997	2002	2007	2012
FDIC	72.0%	69.8%	70.7%	68.6%
FRS	9.1%	10.3%	12.7%	16.7%
OCC	19.0%	19.9%	16.6%	14.7%
OTS	0.0%	0.0%	0.0%	0.0%

Note: This table shows the percentage of banks specializing in agricultural lending by regulation agency types in 1997, 2002, 2007, and 2012.

Table 5. Difference-in-Differences Regression Results (by Regulation Agency)

Explanatory Variables	I FDIC	II FRS	III OCC
POST	222.044	-653.092	-129.028
	(1,474.615)	(1,730.696)	(1,578.389)
LOWDEP	92.110	86.019	124.614
	(81.496)	(85.585)	(114.665)
POST×LOWDEP	-697.169***	-322.253***	-479.426***
	(102.067)	(93.837)	(93.929)
POST×AWC	58.336**	83.773*	64.346*
	(24.528)	(36.349)	(32.673)
POST×OM	2.378***	1.262*	1.680**
	(0.485)	(0.599)	(0.586)
POST×PH	1.467	2.609	2.191
	(1.412)	(1.533)	(1.238)
POST×Rainfall Deficiency	-26.919	-46.288	-39.005
	(51.073)	(83.997)	(71.517)
POST×Rainfall Surplus	14.250	39.039	3.393
	(34.981)	(33.461)	(32.265)
POST×Cold Index	-119.097***	-117.480**	-108.448***
	(29.567)	(43.555)	(29.108)
POST×Heat Index	-246.599***	-280.219***	-197.679***
	(45.235)	(48.094)	(33.026)
Income Per Capita	0.243***	0.262***	0.267***
	(0.034)	(0.052)	(0.031)
Population Density	2.250*	2.780*	2.292**
	(1.108)	(1.286)	(0.991)
Constant	-4,495.995***	-5,148.870***	-5,142.669***
	(935.117)	(1,466.049)	(901.824)
County FE	Y	Y	Y
Observations	2,094	1,363	1,880
R-squared	0.658	0.596	0.639
Number of Counties	538	437	517

Note: This table shows the difference-in-differences regression results by bank regulation agency. Columns (I) – (III) use bank deposits aggregated at the county level by regulation agency FDIC, FRS, and OCC respectively. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

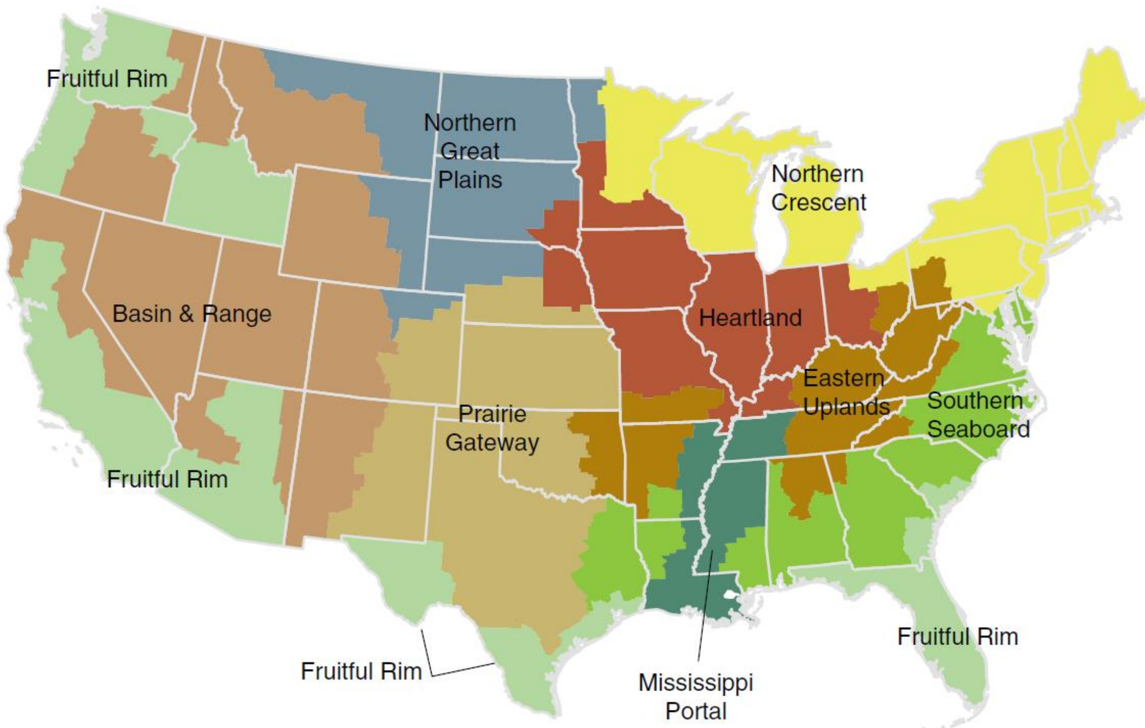
Table 6. Effects of Credit Supply on Farmland Values with 1997 and 2002 Pooled Data

	First Stage	Second Stage
LOWDEP		-529.319*
		(310.454)
Cap	0.117***	
	(0.036)	
Age	0.068	
	(0.046)	
Single	-0.029	
	(0.055)	
Per Capita Income	-0.000***	0.067***
	(0.000)	(0.013)
Population Density	-0.000	0.517***
	(0.000)	(0.045)
AWC	1.013	-76.280
	(0.706)	(807.463)
OM	-0.043**	31.268
	(0.018)	(22.223)
PH	0.066**	286.006***
	(0.034)	(40.721)
Rainfall Deficiency	0.030*	-56.845***
	(0.015)	(17.840)
Rainfall Surplus	-0.016**	0.480
	(0.007)	(7.330)
Cold Index	0.017***	-88.429***
	(0.006)	(8.604)
Heat Index	0.023*	-148.291***
	(0.013)	(17.033)
Constant	0.026	411.569
	(0.325)	(348.399)
Observations	1,084	1,084
R-squared	0.180	0.692

Note: This table shows the effects of credit supply on farmland values using the bank deregulation index as instrument for LOWDEP dummy. Column I shows the first stage results and column II shows the second stage results.

Appendix. U.S. Farm Resource Regions

U.S. Farm Resource Regions



Source: USDA, Economic Research Service.