NBER WORKING PAPER SERIES

FINANCE, FARMS, AND THE FED'S EARLY YEARS

Bruce Carlin
William Mann

Working Paper 23511
http://www.nber.org/papers/w23511

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2017

Finance, farms, and the Fed's early years
Bruce Carlin and William Mann
NBER Working Paper No. 23511
June 2017
JEL No. B26,G21,G28

ABSTRACT

We provide causal evidence that discount rate changes by the Federal Reserve affected economic output in the 1920s. Our identification strategy exploits county-level variation in access to the Fed's discount window, and we implement this strategy with hand-collected data on banking and agriculture in Illinois in the early 20th century. The mechanism for the Fed's effect on agriculture was a bank credit channel, operating independently of any deflationary effect on money supply. Our findings suggest that the Fed deliberately managed transitory shocks during 1920-1921, mitigating debt burdens with which farms would struggle in the years leading to the Great Depression.

Bruce Carlin
Anderson Graduate School of Management
UCLA
110 Westwood Plaza, Suite C413
Los Angeles, CA 90095-1481
and NBER
bruce.carlin@anderson.ucla.edu

William Mann
School of Management
UCLA Anderson
william.mann@anderson.ucla.edu

1 Introduction

Understanding the real effects of monetary policy is an issue of central importance in economics and finance. However, measuring those effects empirically, or assessing their mechanisms, poses an identification problem that is often insurmountable. The source of this problem is simultaneity: Most analysis focuses on aggregate series of prices and output during episodes of monetary policy change, but policy change is just as much a reaction to as a catalyst for the fluctuations in these outcomes. This always makes it challenging to disentangle the effects of policy changes from the circumstances surrounding them.

One important example of these challenges is the historical debate surrounding the deflationary depression of 1920-1921. This episode has long attracted attention as the first episode in which the Fed attempted to influence the economy, through aggressive discount rates increases during 1920. However, the depression was primarily precipitated by plummeting demand for American products following the end of World War I. Scholars have debated, inconclusively, the relative importance of demand shocks, supply frictions, and the Fed's policy – either through the money supply or through credit markets – to the depression and subsequent recovery.[1]

In this paper, we provide causal evidence that the Fed's discount rate changes in the 1920s did affect the local economy. We focus our analysis on the agricultural sector in Illinois and find that county-level agricultural output would have been significantly higher in 1920 if not for the aggressive rate increases of that year. The channel we identify for this effect is a contraction in the supply of bank lending in rural areas, which operates separately from the

[1] Friedman and Schwartz (1963) argue that rate increases worsened things by restricting the money supply. Kuehn (2012) argues that the rate increases decreased aggregate demand via government spending, not the money supply, while Soule (1947) and Romer (1988) emphasize supply instead of demand shifts as the main culprit. Sage (1983) emphasizes the removal of credit from highly-indebted farmers. Meltzer (2000) echoes all of these mechanisms. Frederico (2005) compares the "real" and "monetary" views of the episode.

deflationary channel that was the focus of Friedman and Schwartz (1963).

We further show that, when the Fed decreased the discount rate in the years following the depression, output rebounded while debt levels did not. Conventional wisdom suggests that a monetary authority should manage a credit bubble by sacrificing short-term output to achieve a lower long-term debt burden. This appears to describe our findings. Therefore, we provide an alternative view of the Fed's actions during this episode, which are typically portrayed as being naive.

To document these findings, and to address the simultaneity problem highlighted above, we introduce an identification strategy based on local variation in access to the Fed's discount window, the primary lever of monetary policy at the time. National banks were required to join the Federal Reserve upon its founding in 1913, thus gaining access to the discount window. In contrast, state banks were given the choice whether to join. Virtually none did, due to the offsetting costs of membership such as minimum reserve ratios and required ownership of Fed stock.

This gave rise to regional variation in exposure to the Fed's subsequent discount rate changes based on whether local banks had been chartered as state or national banks in the pre-Fed era. Importantly, exposure to discount rate fluctuations also affected local credit availability: While the discount window was intended only as a liquidity facility for times of stress, during its early years member banks used it much more liberally, with aggregate borrowing from the discount window exceeding $2 billion by 1920.[2] Managing this credit bubble was one of the goals of the rate increases in 1920, and of later efforts to attach "stigma" to discount-window borrowing.

To implement our strategy, we introduce hand-collected, county-level data on banking

[2] See Gorton and Metrick (2013), Figure 1, which was originally produced by Eric Tallman.

and agriculture in the early 20th century. We start with Federal Reserve call reports, which are available for member banks nationwide for the years 1916, 1920, and 1926. As mentioned above, member banks included all national banks but essentially no state banks, so to complete our picture of bank lending in these years, we augment the Fed call reports with reports published by state governments on the condition of state banks. Due to the irregular timing of these reports across states, and the intensive data collection effort required, we focus our analysis on Illinois, which was the preeminent farming state at the time, and which also published state bank reports for all three of the years mentioned above. Finally, we collect county-level statistics on crop production for the same years from separate state reports.

We first demonstrate that, as the Fed aggressively raised discount rates from 3.75% to 7% during 1916-1920, national banks decreased their lending activity in response. We demonstrate this effect *within* a given county and year, using state banks as counterfactuals for the national banks, as they were unaffected by the discount rate changes. This allows us to rule out as alternative explanations a host of aggregate shocks (such as the demand shock from the end of the war), county heterogeneity (such as regional differences in bank penetration), and even county-specific trends (such as credit conditions deteriorating in a specific county during 1916-1920). This is, to our knowledge, the first causal evidence on the effects of Fed policy in 1920-1921.

Based on this finding, we construct a county-level proxy for exposure to Fed policy: the fraction of banks in a county that were national banks, as opposed to state banks, in 1916. We show that this fraction is not correlated with observables such as population or credit conditions in 1916. Consistent with the finding described above, counties with a higher fraction of national banks in 1916 exhibited a significantly smaller volume of loans outstanding in 1920, after removing county and year fixed effects (and summing loan volumes

across member and nonmember banks). The magnitude is striking: County-level loans outstanding would have been 30% lower in 1920 if a county had 100% Fed membership compared to the same county if it had zero membership. This magnitude is consistent across specifications in levels, per-capita, and logs.

We next show that our county-level instrument predicts significantly lower agricultural output in 1920. As before, we demonstrate this effect across a range of specifications, and accounting for both county and year fixed effects. Thus, our results demonstrate that the Fed's interest rate increases affected the real economy. Combining the credit and output effects into an IV specification, we estimate that a marginal dollar of bank credit led to an additional \$0.22 to \$0.27 of annual agricultural output during 1916-1920. This large multiplier establishes that credit growth fueled the economic expansion of the war years. We conclude that the increase in interest rates during 1920 had a significant contractionary effect on the real economy.

Aside from our direct evidence on bank lending, there are at least two other reasons to interpret our findings as reflecting a bank credit channel, rather than some other mechanism such as deflation in the agricultural sector. The first reason is that factors like overproduction, expiring price controls, and shifts in the money supply would have affected all counties similarly, whereas our findings are based on variation across counties (and we show that crop prices did not fall more in counties with a higher Fed membership rate). The second reason is the sequential nature of agricultural production. The decline in agricultural prices only manifested late in 1920, after the planting season, so the 1920 rate increases would not have had time to affect 1920 crop production through the demand side. We conclude that the effects we document are driven by changes in production, not prices.

We complete our narrative by studying credit and output in 1926, the next year in which

national bank call reports are available. By this point, the Fed had lowered interest rates back to their 1916 level. We find that the output effect reversed: Counties with higher Fed membership rates saw relatively *higher* output growth from 1920-1926, with the magnitudes almost exactly equal to the negative effect fron 1916-1920, so that the net effect was to return the counties to the same relative position as where they had started in 1916. However, there was no similar reversal in loans outstanding: The relatively high debt balances that had accumulated by 1920 in counties with low Fed membership remained. As a result, the credit to output ratio was much higher in 1926 among counties less exposed to the Fed's actions.

This last finding provides novel evidence that the Fed deliberately managed economic shocks surrounding the end of World War I. Commentators often fault the Fed for its aggressive rate hikes in 1920, but we show that these had only a transitory effect on output (because the differential effects across counties reversed by 1926), whereas their effect on debt levels was long-lived. Sacrificing interim output spikes for lower long-term indebtedness is a commonly-stated goal of monetary policy, and it seems entirely plausible that it was also the Fed's goal in 1920. If so, our results suggest that the Fed's aggressive discount rate policy in these years was consistent with this goal.

Our paper is related to Calomiris, Jaremski, Park, and Richardson (2015), who hand-collect data on state banks in New York over a similar time period in order to understand why some state banks did not join the Federal Reserve. Their focus on New York was appropriate because New York state banks joined the Fed at an unusually high rate: By 1920, they find that 62% of state banks in New York City, and 23% outside the city, were members of the Fed. Since our goal is to understand the transmission of discount rate policy to the agricultural sector, we focus on Illinois, where few state banks joined the Fed during 1916-1926. Indeed, by 1929, only 5% of Illinois state banks were members of the Federal

Reserve, which is in line with the national average of 7.5%.[3] This is advantageous because the lack of conversion allows us to study differential exposure to discount rate policy by county, to assess its local effect on the real economy.

A broader literature studies the structure and real effect of the banking industry. Rajan and Ramcharan (2015) use nationwide data on the number of banks per county to study bank failures in the early 20th century as a function of real estate prices. Jayaratne and Strahan (1996) demonstrate that bank credit is also constrained by branching restrictions, such as Illinois's complete prohibitions on bank branching in the early 20th century. Petersen and Rajan (1995) show that small firms borrow from local lenders, even in recent history. Our paper also contributes to a growing literature on spatial heterogeneity in the impacts of monetary policy (e.g. Gabriel and Lutz (2014)).

The paper is organized as follows: Section 2 lays out the historical context of our analysis. Section 3 describes our data sources. Section 4 describes our empirical strategy and results for 1916-1920, and Section 5 extends these results to 1920-1926. Section 6 concludes. Tables and figures are in Appendix A.

2 Historical background

This section provides a brief historical background to our study, drawing on several sources, most significantly White (1983), Friedman and Schwartz (1963), and the 1922 Report of the Joint Commission of Agricultural Inquiry to Congress.

The National Banking Act of 1864 created a system of national banks, chartered by the federal government, to exist alongside state-chartered banks. By 1870, national banks had almost completely displaced state banks due to a punitive tax enacted by Congress

[3] See the Federal Reserve's *Banking and Monetary Statistics 1914-1941*, published in 1943.

on state bank notes. However, the declining importance of note issuance, and high capital requirements for national banks, led to a comeback by state banks in the 1870s-80s. The two systems continued to fluctuate in relative size thereafter, as their regulators took turns loosening requirements to attract entrants (White (1983)). By 1914, both had branches scattered throughout the country, including in Illinois, as we will show.

When the Federal Reserve system began operations in 1914, national banks were required to join. State banks could not be forced to join, and very few did. Evidently, the benefits of access to the discount window were offset by higher reserve ratios and the requirement to own stock in the Fed, so that membership in the Fed was not seen as a net benefit for the typical state bank. Thus, when the rates were later raised in 1920, the banks that had been drafted into the Fed system were ultimately left with less access to capital.[4]

Just as the Fed began operations in 1914, World War I disrupted European production, creating massive demand for US exports. This also led to inflation, initially due to gold inflows as payments for exports, and later (after the US joined the war) due to growth in Fed notes and reserves, as the government borrowed to extend credit to its allies. The Fed maintained low interest rates to accommodate this fiscal policy, delaying its intended operations until after the war.

Low interest rates also fueled growth in bank lending. Member banks used the Fed's discount window for long-term borrowing, contrary to its intentions (Gorton and Metrick (2013)). Much of this credit went to the agricultural sector, as the government encouraged farmers to expand production (Sage (1983)). Frederico (2005) shows that farms' aggregate indebtedness roughly tripled to $140 billion during 1910-1920 and was only paid down slowly thereafter (see his Figure 4), which he argues contributed to the struggles of the agricultural

[4] Supporting this view, we will show later that county-level Fed membership rates were not positively correlated with loan volumes in 1916.

sector during the Great Depression.

With the war's end, government borrowing and European demand both dropped sharply during 1919 and 1920. After some hesitation, the Fed raised discount rates sharply during 1920 (from 3.75% to 7%), partly to avoid violating gold reserve requirements, and partly to contain credit growth. Friedman and Schwartz (1963) also cite a desire to demonstrate independence from President Harding, who advocated continued low rates to aid farmers.

Immediately afterward, in the second half of 1920 and throughout 1921, the agricultural and manufacturing sectors experienced sharp declines in prices, production, and employment. To some extent, this was the inevitable result of declining demand from Europe. However, the Fed's decision to raise rates has commonly been perceived to have worsened the problem. Early analysis focused on credit conditions for bank-dependent industries, especially agriculture, as the mechanism for the Fed's effect. For example, Link (1946) says:

> A period of ruinous deflation such as the farmers experienced in 1920-1921 necessitates immediate credit if the farmers are to survive as independent farmers; and of course it was credit that they demanded [...] The insurance companies, trust companies, etc., which had normally provided this intermediate credit, had largely withdrawn from the lending market and as a consequence the chief burden of "carrying the farmers through" fell upon the commercial banks — and ultimately upon the Federal Reserve System.

The earliest proponent of this view seems to have been the 1922 Report to Congress of the Joint Commission of Agricultural Inquiry, which also highlighted the differential effects on member and non-member banks:

> Whatever restraining influence was exercised could be exercised only against member banks, and could be exercised only by restriction of credit, either through refusing loans to member banks in individual cases, or by pressure of discount rates applied to those member banks whose necessities required them to borrow from the Federal reserve banks. Restraint was exercised in both ways, and there

> were cases where restraint resulted in hardship not only upon the member banks but also upon the member banks' customers.

In contrast to this bank-credit view, Friedman and Schwartz (1963) agreed that the Fed worsened the problem, but argued that the mechanism was mainly through deflationary effects of a restricted money supply.

Commentators ever since have struggled to disentangle the separate roles of demand shocks, credit conditions, and monetary policy in this episode. A theme in much commentary has been criticism of the Fed's actions, as reflected both in the Joint Report and in Friedman and Schwartz (1963). However, these analyses are based on aggregate figures, complicating inference about the mechanism of the Fed's impact. Our study provides causal evidence, and therefore an opportunity to reevaluate the popular critique of the Fed's actions.

3 Data

We introduce several novel, hand-collected datasets on banking and agricultural output in Illinois in the early 20th century. This section describes each dataset in detail.

Federal reserve member bank call reports: Data on lending by member banks come from call reports that were filed with the Federal Reserve at irregular intervals. Specifically, before the beginning of the Great Depression, call reports were filed in June 1916, June 1921, and December 1926. From each call report for each Illinois member bank in each of these years, we obtain the name, city, county, and charter number, as well as total loans outstanding (item 1A). The top panel of Figure 1 shows an example call report from the Farmers National Bank in the city of Cambridge, Henry County.

State bank reports of condition: Data on lending by state banks come from Statements of Condition published by the State of Illinois. Each report contains a list of all state

banks, their cities and counties of location, and basic financial information including total loans outstanding and total assets, both of which we collect. These reports came out every few years throughout the 20th century. For consistency with the Fed call reports, we collect them for the years June 1916, December 1920, and December 1926. The bottom panel of Figure 1 shows an example report on the Cambridge State Bank.

County-level crop data: Data on county-level agricultural output come from Statistical Reports of the Illinois State Board of Agriculture. For a given year, these reports provide the yields of major crops by county in bushels or tons, as well as their dollar values at the prices prevailing in each county on the reporting date. We collect the yields and dollar values for corn, oats, hay, and wheat. Figure 2, reproduced from the crop report for 1926-1927, shows that these crops collectively accounted for over 90% of the gross value of Illinois crops. We sum the dollar amounts to construct a county-year measure of agricultural output. The statistics we obtain are for the years 1916, 1920, and 1926.[5]

Timing details across the datasets: Note that, in 1916, both sets of bank reports are dated in June while crops are not reported until year-end. In 1920, the state bank report and crop report are both dated to the year-end, but the Fed call reports are not published until six months later in June 1921. Figure 3 compares the timing of each dataset with the time series of Fed discount rates. We ignore these subtle timing differences in our analysis.

Population data: We collect county-level population from census numbers for 1910, 1920, and 1930 from the US Census website (census.gov). We extrapolate these figures to 1916 and 1926 by fitting a log-linear model of population growth for each county.

In all the analysis that follows, we will exclude Cook County, which contains Chicago

[5] Many other crops and agricultural products are also recorded, but we do not bother to collect these, as each is produced in only a minority of counties, and they collectively constitute only a negligible share of aggregate agricultural output for Illinois. For 1920, the figures are actually found incorporated in the Illinois Crop Reporter, issued by the United States Department of Agriculture.

and is an extreme outlier on every dimension.

3.1 Stylized facts and motivation

Since our data are largely novel, we start by demonstrating several basic facts of interest to motivate our analysis.

Table 1 summarizes the county-level banking and agricultural data as of 1916. The median county had 4 member banks and 6 non-member banks, yielding a median membership rate of 40%. The median county had $1.4 million in bank loans outstanding as of 1916 (worth $32.7 million in 2017 dollars), and 24 thousand residents (using our interpolation between the 1910 and 1920 censuses). The mean (median) dollar value of total agricultural output was $3.4m ($3.2m). This output was dominated by corn, which accounted for 57% of total value in the median county, and for 48% even at the lower quartile.

We next use the data for 1920 and 1926 to examine trends in all these statistics over time. The years 1916–1920 were a time of explosive credit growth nationwide, and this fact is reflected in our sample: Table 2 shows that the *minimum* growth rate of outstanding bank loans across counties during this time was over 20%. Agricultural output growth was not uniformly positive, but the mean (median) growth rate over these four years was 6% (3.7%). This slightly understates the peak of output growth, as corn production and prices had already begun to fall by the end of 1920, when we measure it. However, other crop prices had not yet started to fall, as their growing seasons ended before the onset of the depression in late 1920.

Following 1920, the economic boom stopped abruptly, an aggregate pattern that is again reflected in our data: Table 3 shows that credit growth was roughly flat during 1920–1926, and agricultural output gave up much of the prior gains it had exhibited. This marked the

beginning of struggles in the agricultural sector that would persist to and through the Great Depression. All crop prices fell during this time, reflecting the broad deflation experienced throughout the economy.

4 Onset of the depression: 1916-1920

4.1 Within-county analysis

We begin by demonstrating that increases in the Fed's discount rate directly affected the volume of bank loans outstanding in a given county and year. As mentioned earlier, this poses an identification problem, in that other factors affecting bank lending may have been correlated with or even caused the Fed's actions. To address this problem, we compare the national and state (member and non-member) banks within a given county and year, exploiting our novel data of loan volumes within both subsets of banks.

We run a regression explaining loan volumes at the county-system-year level. For each county and year, we have two observations: One measuring total outstanding loan volume among member banks, and another measuring outstanding loan volume among nonmember banks. Our statistical model for end-of-year loan volume is

$$L_{cst} = \alpha_{ct} + \gamma_{cs} + \beta \times \mathbb{1}\{\text{member bank}\}_s \times \mathbb{1}\{1920\}_t + \epsilon_{cst} \tag{1}$$

where c indexes county, t indexes year, and s indexes whether the observation is for national banks (which were members of the Federal reserve) or state banks (which were not). The coefficient of interest is β, which measures the sensitivity of member banks to the rate increases of 1920. This specification makes clear that β is unaffected by heterogeneity at the

county-year or the county-system level.

Table 4 summarizes the results of this estimation. The three columns employ three different functional forms for the dependent variable in (1): Column 1 employs the level of total county loans outstanding, in thousands of dollars; Column 2, loans outstanding per 1916 population; and Column 3, the natural logarithm of loans outstanding.

Across all three specifications, we see a sharp relative drop in lending by member banks. The magnitudes are striking: The average county had $7m in loans outstanding by 1920, or about $200 per capita, and the point-estimates in Columns 1 and 2 are about a third of these respective values. In Column 3, the estimate of -1.67 corresponds to a decrease of 82% ($= e^{-1.67} - 1$), and on average member banks accounted for 42% of the loans in a given county in 1920, implying a county-level effect of $42\% \times 82\% = 34\%$.

Thus, taken at face value, our results in Table 4 suggest that bank lending would have been about one-third higher in 1920 if not for the Fed's rate increases. However, these magnitudes may overstate the county-level effect, as some borrowers could have shifted from member to non-member banks. Our county-level results on total lending in the next section will net out any such shifting, instead reflecting only the extent to which some borrowers from member banks could not find a new lender. Accordingly, the magnitudes will be smaller, although still economically large.

4.2 County-level analysis

To demonstrate that the removal of bank credit in high-membership counties decreased agricultural output in 1920, we must move to a county-year analysis, as crop statistics are only available at that level. This means we cannot include fixed effects at the level of granularity that we did in the previous subsection. However, motivated by the results in that

subsection, we can build a county-level instrument for exposure to the Fed's rate increases. Our instrument is the fraction of banks in a given county that were members of the Federal Reserve as of 1916.

In constructing this instrument, we retain only the 95 counties that had both a member and a non-member bank as of 1916, as these were already effectively dropped from the within-county-year regressions in the previous section. This means dropping Scott County, which had no banks at all in our data in 1916; Calhoun and Hardin counties, which had no member banks; and Edwards, JoDaviess, and Wayne counties, which had no non-member banks. We continue to exclude Cook County as in previous sections.

The identifying assumption behind our instrument is that systematic correlation between Fed membership rates and *relative* changes in county agricultural output can be attributed to the large 1920 discount rate increases. To address this exclusion restriction, we show that counties with high membership rates do not look systematically different from those with low membership (in the cross section as of 1916), making it plausible that they would have followed similar average trends if not for the rate increases.

Figure 4 maps out the geographic distribution of Fed membership rates as of 1916. Encouragingly, it shows no particular geographic clustering or pattern, with both high and low values scattered all across the state. In Figure 5, we further examine whether population or credit conditions are correlated with 1916 membership rates, and find that they are not. Linear trends fitted through these figures are statistically and economically insignificant.

While one cannot test the exclusion restriction, these findings are encouraging. They are consistent with the view that the relative composition of state versus national banks in a given county was mostly driven by historical trends in the late 1800s (as was described in Section 2) which were no longer relevant to relative county-level trends from 1916-1920.

Later we will also show that our results in this section are robust to a range of cross-sectional controls, and that the effects we find on agricultural output completely disappeared when the Fed lowered interest rates again.

The second reason to find our identifying assumption plausible is that our instrument is relevant. The tightly-identified evidence from the previous section already showed that member banks cut back lending relative to non-member banks by the end of 1920. We now demonstrate that we can produce the same result using our county-level membership rate instrument. We run a county-year regression of loan volumes (now summing across the two sets of banks) against the fraction of banks that were Federal Reserve members, with county and year fixed effects. Our specification is

$$L_{ct} = \alpha_c + \gamma_t + \beta \times \frac{\text{Member banks}_{c,1916}}{\text{Total banks}_{c,1916}} \times \mathbb{1}\{1920\}_t + \epsilon_{ct} \tag{2}$$

Table 5 summarizes the results of this estimation. The magnitudes reflect a counterfactual shift from zero to 100% county-level bank membership in the Fed for the average county. The best fit (as captured by R^2) is in the log specification, and it implies roughly a 50% drop in this scenario. On a more realistic scale, the lower and upper quartiles of Fed membership rates in Table 1 were 0.3 and 0.56, and a shift between these two values would be estimated to cause a 13% decline in lending for the average county due to the Fed's actions.

Our next step is to show that this credit effect extended to agricultural output, which we do in Table 6. To construct this table, we simply replace loans with agricultural production as the outcome variable in each of the regressions in Table 5. The estimated effects are significant both statistically and economically, establishing the bank credit mechanism for Fed policy during this time period: We estimate that agricultural output would have been

about 30% higher for the average county at zero as compared to 100% membership, or more realistically about 10% higher at 30% as compared to 56% membership.

Figure 6 depicts the underlying variation behind our credit and output results. To understand these figures, note that our specification (2) can be reformulated in differences, removing the county fixed effect and allowing the intercept to pick up the aggregate time trend. Following this intuition, the figures plot county-level growth rates of the outcome variables in the regressions from 1916-1920 against the 1916 Fed membership rate of county banks. The slopes of the fitted lines in the figures are the effects captured by the county-level regressions in Table 5.

These figures demonstrate that the variation driving those regressions is spread out across the state, not driven by a few extreme counties. In other words, there was a smooth connection between exposure to the Fed's discount rate changes (measured by 1916 membership rate) and county-level responses to those changes. This helps address identification concerns: Any confounding variable would have to vary quite smoothly with both Fed membership rates in 1916 and with credit and output growth during 1916–1920.

Figure 6 also clarifies that the effects in Table 5 are largely due to high credit growth in counties with low Fed membership rates. This suggests a specific interpretation of our findings: The Fed's discount rate increases constrained credit growth among member banks at a time of rapid expansion, the latter years of World War I. In the next section, we will build on this interpretation by showing that the Fed's actions led to lower long-run credit/income ratios, which arguably reflected the exact tradeoff that the Fed was trying to make.

To bolster the interpretation of our findings as a credit channel, we next demonstrate that price deflation during 1920 is not driving our findings. The first observation to make is that most prices in our data actually had not fallen by 1920. Table 2 showed that, of the

various crops that we consider, only corn had a lower average price in 1920 than 1916. The reason is the timing of the growing season, which is different for different crops. The crops in our data other than corn were harvested in August, and their values were calculated using prices prevailing in that month, when most of the yield was sold. In August 1920, there had not yet been significant deflation. Thus, the only price deflation that could be driving our results is in the price of corn, which is harvested, sold, and reported at the end of the year.

For corn specifically, we check how important its price decline is in driving the results of Table 6. Table 7 repeats our difference-in-difference specification, but uses the county-level corn price and its log as outcome variables. The insignificant coefficient estimates (both economically and statistically) indicate that the price deflation was no worse among counties with greater Fed membership. Of course, this could have been expected, as corn was traded nationwide, not in local markets. The null result in Table 7 thus confirms that our instrument captures features of production, not demand.

As a different way of thinking about the magnitudes, Table 8 reinterprets the credit and output regressions as the first stage and reduced form of an instrumental-variables effect of credit on output. The IV estimate of the effect of a dollar of credit in 1920 is \$0.22 and \$0.25 in additional agricultural output for the level and per-capita specifications, respectively (Columns 1 and 2). Again, the log specification in Column 3 yields consistent results: The coefficient of 0.541 implies that a 1% increase in credit led to a 0.54% increase in output. The average county-level loan-to-output ratio in 1920 was 2, so dividing the 0.54% estimate by 2 suggests a dollar multiplier of \$0.27, which is in line with the other specifications.

Column 4 adds to the log specification several cross-sectional controls as of 1916, interacted with time trends. While some of them have meaningful effects (e.g. counties with larger 1916 populations saw larger output growth during 1916-1920), the IV coefficient of

interest on the volume of 1920 credit does not change and only becomes more statistically significant. This is what we expect if the membership-rate instrument satisfies the exclusion restriction: Adding controls does not affect the consistency of the key coefficient but does increase its precision.

5 Recovery from the depression: 1920-1926

Our results so far have documented that credit and output grew less among counties with more Federal Reserve member banks. To flesh out the interpretation of our findings, we add one further time period: 1926, the next year in which the call reports for Fed member banks are available.

In Tables 9 and 10, we repeat our prior regressions of bank loans and agricultural output respectively, but the time period covered is 1920 to 1926.[6] By this time, the Fed had reduced the discount rate back to 4% from its peak in 1920. Table 9 shows that the disparity in agricultural output, documented before, completely disappears: The magnitudes are almost exactly the same, with the opposite sign, as those in Table 6. This reversal implies a remarkably tight connection between discount rate changes and agricultural output.

However, Table 10 shows no impact at all on bank credit. For context, Frederico (2005) shows that farms underwent a rapid increase in indebtedness up to 1920, followed by a slow deleveraging during the 1920s. Our findings then suggest that the Fed's rate increase during 1920 constrained counties with a high number of member banks from the excessive credit and output growth of the first interval, while subsequent rate decreases allowed these counties to maintain their original output levels, while other counties slumped back to the same relative

[6]For consistency, these tables continue to use the 1916 membership rate as the explanatory variable. However, we obtain essentially the same results if we recalculate membership rates as of 1920, which takes into account bank openings and closures during 1916–1920.

output levels by 1926, but were left with higher debt burdens.

Table 11 addresses this interpretation directly. The outcome variable in this table is the county-level ratio of credit to agricultural output from 1916 to 1926. The key finding is that the 1926 ratio was much higher among counties with low exposure to the Fed's actions.

Our results thus call into question a popular view that the Fed did not understand the impact of its actions in 1920. Slow and painful deleveraging has been cited as a source of distress in the agricultural sector during the 1920s, and as an eventual contributor to the Great Depression. While we cannot assess the optimality of the Fed's actions, they at least seem consistent with its having anticipated, and mitigated, this outcome of the credit boom.

6 Conclusion

In this paper, we find that Fed policy during 1920-1921 affected both credit and agricultural output in rural areas. We study farming because it was a major part of the U.S. economy at the time, and we focus on the state of Illinois due to its central role in farming, and due to the availability of novel county-level data on bank lending and agricultural output. We use the divide between state and national banks, which pre-dated the Fed, to study the effect of Fed policy on member and non-member banks and their local economies.

We find that the Fed's increase in discount rates in 1920 caused counties with greater proportions of member banks to suffer a relative drop in credit and agricultural output. Our findings provide evidence of a bank credit channel by which Fed policy affected local economies. Further, we show that the subsequent lowering of interest rates restored counties' relative output levels, but led to lower debt levels among counties with high membership. These events resemble the conventional idea of policymakers attempting to stabilize the

economy during a volatile period.

More broadly, it is always a challenge to document clear evidence of the effects of monetary policy, due to the simultaneity of policy, output, and prices. In this paper we are able to address this challenge, shedding light on the early history of the Federal Reserve.

References

Calomiris, Charles, Matthew Jaremski, Haelim Park, and Gary Richardson, 2015, Liquidity Risk, Bank Networks, and the Value of Joining the Fed, Working paper.

Frederico, Giovanni, 2005, Not Guilty? Agriculture in the 1920s and the Great Depression, *Journal of Economic History* 65, 949–976.

Friedman, Milton, and Anna Schwartz, 1963, *A Monetary History of the United States* (Princeton University Press).

Gabriel, Stuart, and Chandler Lutz, 2014, The Impact of Unconventional Monetary Policy on Real Estaet Markets, UCLA working paer.

Gorton, Gary, and Andrew Metrick, 2013, The federal reserve and financial regulation: The first hundred years, NBER Working paper.

Jayaratne, Jith, and Philip Strahan, 1996, The Finance-Growth Nexus: Evidence from Bank Branch Deregulation, *The Quarterly Journal of Economics* 111, 639–670.

Kuehn, Daniel, 2012, A note on America's 1920-21 depression as an argument for austerity, *Cambridge Journal of Economics* 36, 155–160.

Link, Arthur S., 1946, The Federal Reserve Policy and the Agricultural Depression of 1920-1921, *Agricultural History* 20, 166–175.

Meltzer, Allan H., 2000, Lessons from the Early History of the Federal Reserve, Presidential Address to the International Atlantic Economic Society.

Petersen, Mitchell, and Raghuram Rajan, 1995, The Effect of Credit Market Competition on Lending Relationships, *Quarterly Journal of Economics* 110, 407–443.

Rajan, Raghuram, and Rodney Ramcharan, 2015, The Anatomy of a Credit Crisis: The Boom and Bust in Farm Land Prices in the United States in the 1920s, *The American Economic Review* 105, 1439–1477.

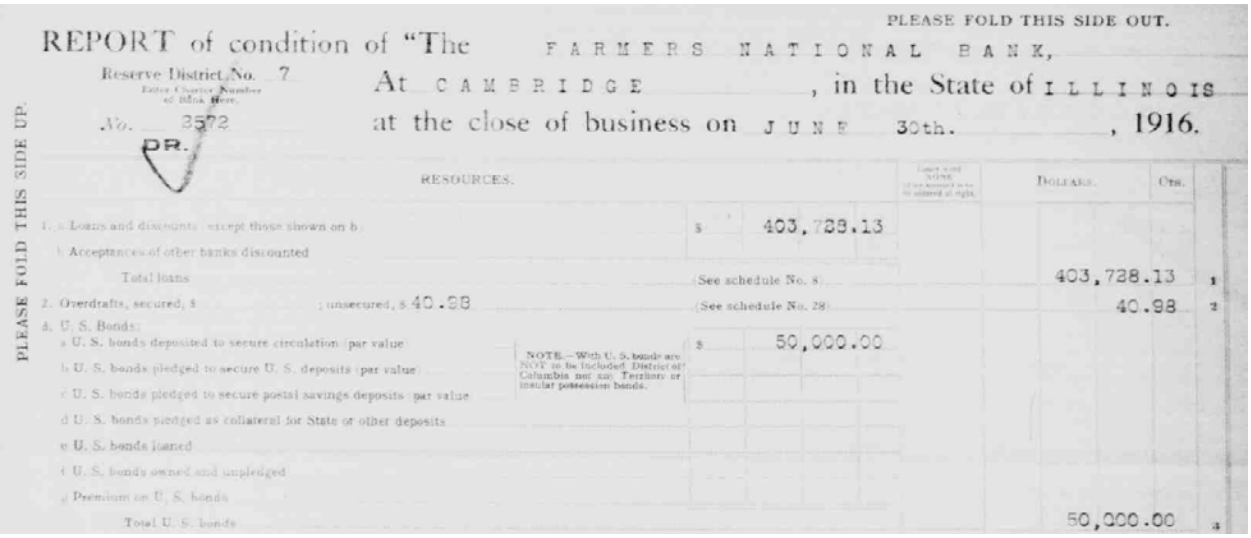
Romer, Christina, 1988, World War I and the Postwar Depression: A Reinterpretation Based on Alternative Measures of GNP, *Journal of Monetary Economics* 22, 91–115.

Sage, Leland L., 1983, Rural Iowa in the 1920s and 1930s, *The Annals of Iowa* 47, 91–103.

Soule, George, 1947, *The Prosperity Decade: From War to Depression, 1917-29* (Routledge).

White, Eugene Nelson, 1983, *The Regulation and Reform of American Banking, 1900–1929* (Princeton University Press).

A Tables and figures



PLEASE FOLD THIS SIDE OUT.

REPORT of condition of "The FARMERS NATIONAL BANK,
Reserve District No. 7
At CAMBRIDGE, in the State of ILLINOIS
No. 3572
at the close of business on JUNE 30th., 1916.

PLEASE FOLD THIS SIDE UP.

RESOURCES.

			Dollars.	Cts.	
1. a Loans and discounts, except those shown on b	$	403,728.13			
b Acceptances of other banks discounted					
Total loans (See schedule No. 8)			403,728.13		1
2. Overdrafts, secured, $; unsecured, $ 40.98 (See schedule No. 28)			40.98		2
3. U. S. Bonds:					
a U. S. bonds deposited to secure circulation (par value	$	50,000.00			
b U. S. bonds pledged to secure U. S. deposits (par value)					
c U. S. bonds pledged to secure postal savings deposits (par value					
d U. S. bonds pledged as collateral for State or other deposits					
e U. S. bonds loaned					
f U. S. bonds owned and unpledged					
g Premium on U. S. bonds					
Total U. S. bonds			50,000.00		3

NOTE.—With U. S. bonds are NOT to be included District of Columbia nor any Territory or insular possession bonds.

CAMBRIDGE STATE BANK—Cambridge.

(Organized September 26, 1903.)

James Pollock, President. **F. L. Brodd, Cashier.**

Resources.	Amount.	Liabilities.	Amount.
Loans on real estate	$ 8,750 00	Capital stock paid in	$ 25,000 00
Loans on collateral security	2,325 51	Surplus fund	15,000 00
Other loans and discounts	235,420 72	Undivided profits, net	1,447 03
State, county and municipal bonds	1,000 00	Deposits—	
Banking house	25,000 00	Time certificates	154,013 60
Real estate other than bkg. house	2,400 00	Savings subject to notice	50,771 37
Due from banks—		Demand subject to check	51,311 29
State	5,777 77	Demand certificates	3,528 75
National	14,461 27	Dividends unpaid	1,000 00
Cash on hand—			
Currency	2,958 00		
Gold coin	2,560 00		
Silver coin	588 10		
Minor coin	61 53		
Checks and other cash items	769 14		
Total resources	$302,072 04	Total liabilities	$302,072 04

Figure 1: Example call report for a member national bank (top) and statement of condition for a nonmember state bank (bottom) from Cambridge, Illinois, 1916.

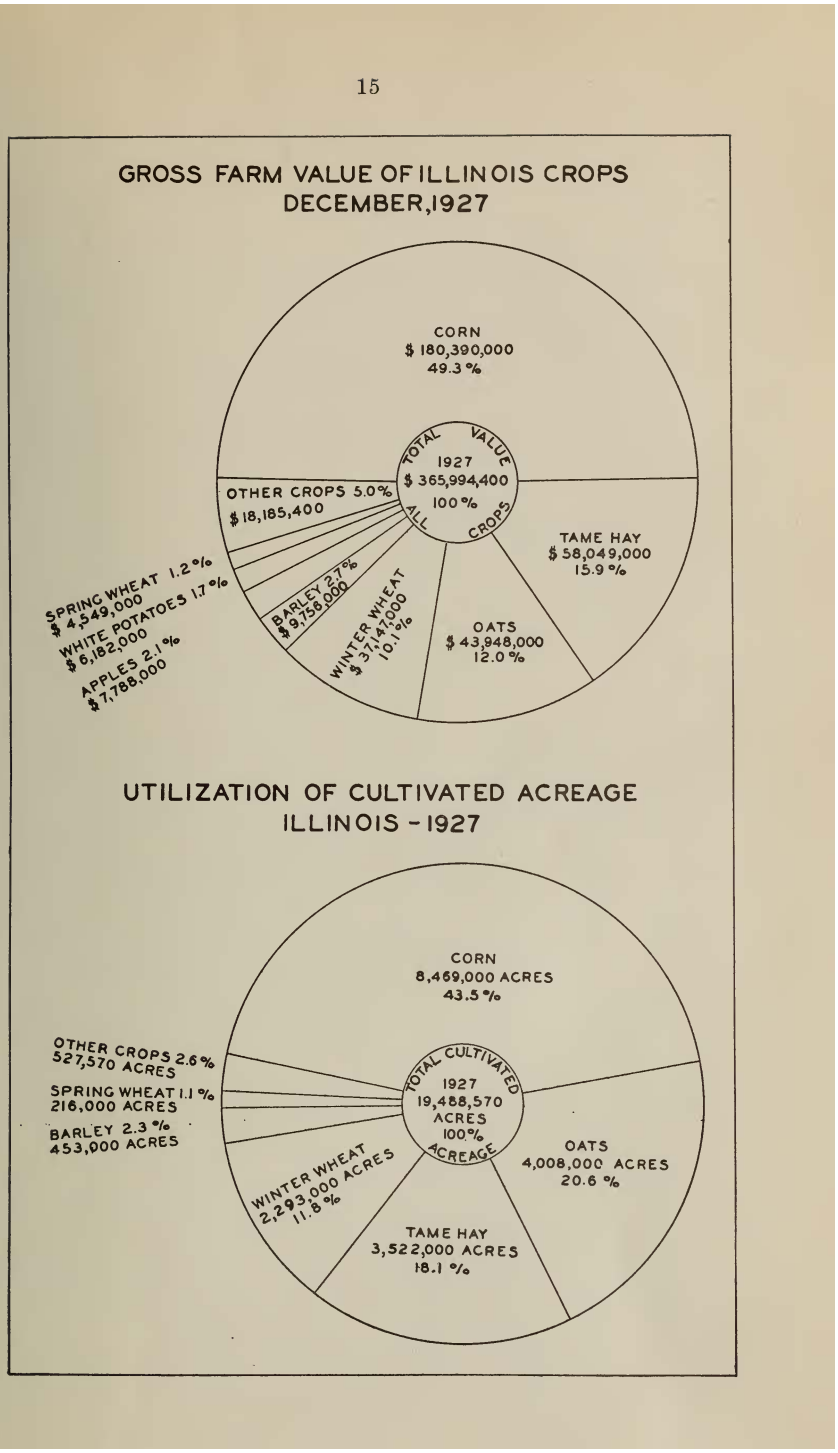


Figure 2: Page 15 of the 1926-1927 Illinois crop report.

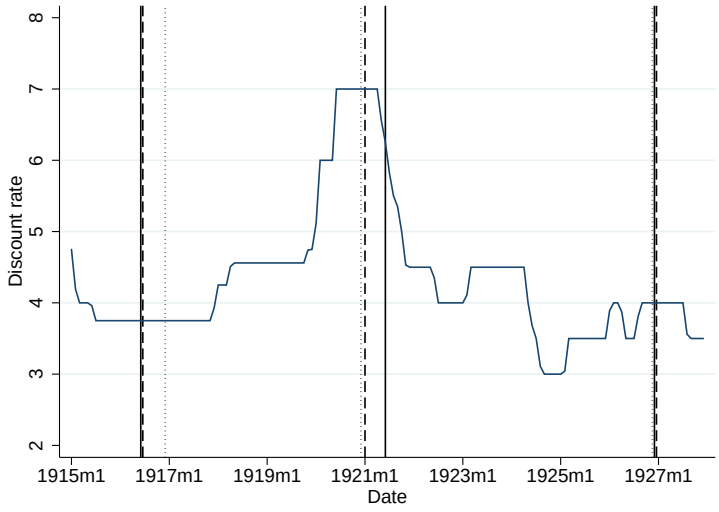


Figure 3: Discount rates at Federal Reserve Bank of New York, 1915-1928. Solid lines are dates of national bank call reports. Dashed lines are dates of state bank reports. Dotted lines are dates of crop reports.

	(1)					
	mean	min	p25	p50	p75	max
Member banks	4.238	0	2	4	6	15
Non-member banks	6.248	0	3	6	9	23
Fed membership rate	0.432	0	0.293	0.400	0.563	1
Bank loans, $1,000	2657.6	0	793.5	1409.6	3034.9	18159.4
1916 Population	33100.2	7321.4	16449.3	23899.8	38402.4	129599.1
Bank loans / 1916 pop.	67.08	0	38.30	61.98	86.16	169.7
Corn output (bushels, 1k)	2383.7	222.5	935.9	2050.3	3417.8	8131.6
Hay output (tons, 1k)	62.43	5.635	29.41	50.68	83.28	189.6
Oats output (bushels, 1k)	1773.3	31.25	615.8	1303.4	2365	9124.9
Wheat output (bushels, 1k)	109.4	0.171	31.58	72.96	161.3	742.5
Barley output (bushels, 1k)	13.23	0	0	0	5.220	307.9
Corn price per bushel	0.844	0.750	0.810	0.840	0.860	1
Hay price per ton	9.911	6	8.250	10	11	15
Oats price per bushel	0.370	0.300	0.350	0.360	0.380	0.500
Wheat price per bushel	1.116	1	1.080	1.120	1.150	1.300
Corn value (dollars)	2008678.7	178024	792667.2	1742661	2909130.4	6505315.2
Hay value (dollars)	618214.8	56350	303000	506780	771903	2843400
Oats value (dollars)	648605.6	11562.5	227269.8	515230	893025	3193722
Wheat value (dollars)	123823.2	186.4	35683.1	77699.4	185529.5	891000
Barley value (dollars)	8361.1	0	0	0	3393	184752
Corn value / ag. output	0.563	0.200	0.483	0.569	0.654	0.814
Hay value / ag. output	0.210	0.0310	0.126	0.197	0.277	0.527
Oats value / ag. output	0.175	0.0255	0.113	0.163	0.218	0.382
Wheat value / ag. output	0.0497	0.0000795	0.00932	0.0336	0.0673	0.246
Barley value / ag. output	0.00231	0	0	0	0.00110	0.0418
Ag. output, $1,000	3407.7	445.2	1669.0	3148.9	4644.9	10846.3
Observations	101					

Table 1: County-level summary statistics as of 1916. The sample is the 102 counties in Illinois, excluding Cook County. The observation count for "Fed membership rate" is only 100, due to a missing value for Scott County, which had no banks in our data as of 1916.

	(1)					
	mean	min	p25	p50	p75	max
Change in county loans	4104.6	298.1	1326.1	3217.2	5676.1	16383.7
Change in Bank loans / 1916 pop.	123.8	13.42	77.38	109.8	166.0	360.4
Change in Ln(Bank loans)	1.071	0.217	0.804	0.994	1.329	2.343
Change in ag. output	285.2	-3466.7	-309.9	130.1	784.3	3981.7
Change in Ag. output / 1916 pop.	4.444	-99.42	-17.58	6.582	27.99	102.4
Change in Ln(Ag. output)	0.0609	-0.902	-0.185	0.0371	0.303	0.744
Change in Corn price per bushel	-0.228	-0.450	-0.310	-0.240	-0.170	0.120
Change in Hay price per ton	5.656	-13	4.418	9.650	11.87	17.73
Change in Oats price per bushel	0.0980	-0.140	0.0400	0.0800	0.160	0.310
Change in Wheat price per bushel	0.501	0.110	0.415	0.509	0.577	0.890
Observations	101					

Table 2: County-level changes in key statistics, 1916—1920. Sample is as in Table 1. The observation count for "Change in Ln(Bank loans)" is only 100, due to a missing value for Scott County, which had no banks in our data as of 1916.

	(1)					
	mean	min	p25	p50	p75	max
Change in county loans	235.8	-2460.3	-386.4	11.57	377.5	6963.8
Change in Bank loans / 1916 pop.	-1.074	-187.4	-16.15	0.319	15.53	140.5
Change in Ln(Bank loans)	-0.00402	-0.813	-0.108	0.00351	0.0887	0.643
Change in ag. output	-397.8	-2856.8	-962.0	-136.8	190.2	2085.3
Change in Ag. output / 1916 pop.	-10.28	-97.92	-24.96	-7.367	8.506	44.37
Change in Ln(Ag. output)	-0.0739	-0.578	-0.242	-0.0832	0.0955	0.700
Change in Corn price per bushel	-0.0612	-0.430	-0.140	-0.0400	0.0300	0.100
Change in Hay price per ton	-15.57	-25.73	-22.08	-19.20	-13.38	0
Change in Oats price per bushel	-0.468	-0.660	-0.520	-0.450	-0.410	-0.210
Change in Wheat price per bushel	-0.397	-0.789	-0.471	-0.391	-0.318	-0.0394
Observations	101					

Table 3: County-level changes in key statistics, 1920—1926. Sample is as in Table 1.

	(1) Loans	(2) Loans/1916 population	(3) Ln(Loans)
Member bank × 1920	-2138.7	-70.78	-1.668
	(435.0)	(9.497)	(0.135)
Fixed effect	County-year, County-system	County-year, County-system	County-year, County-system
Obs.	202	202	193
R^2	0.643	0.670	0.825

Standard errors in parentheses

Table 4: Within-county effect of the Fed raising interest rates. Each regression includes two observations for each county and year: The specification is given by (1) in the paper, includes fixed effects for both county-year and county-system, and is estimated in first-differences. Loans in column 1 are in thousands of dollars. Standard errors are clustered by county.

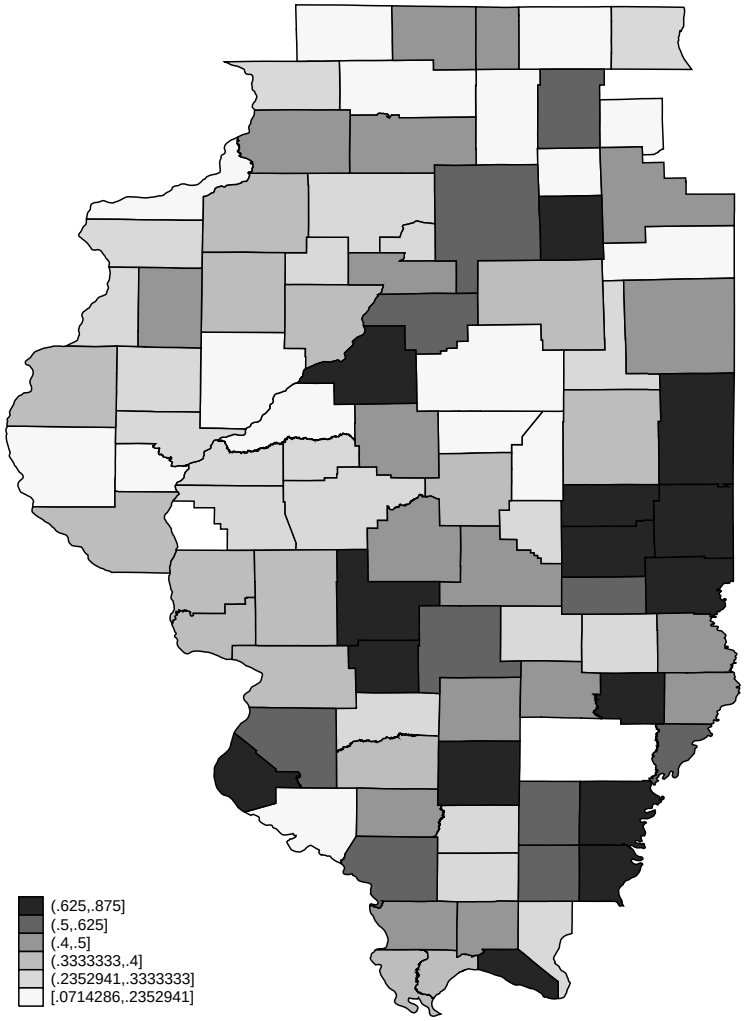


Figure 4: Fraction of county banks that were Federal Reserve member banks as of July 1, 1916. Member banks are compiled from call reports filed with the Federal Reserve. State banks are compiled from statements of condition published by the Illinois state government.

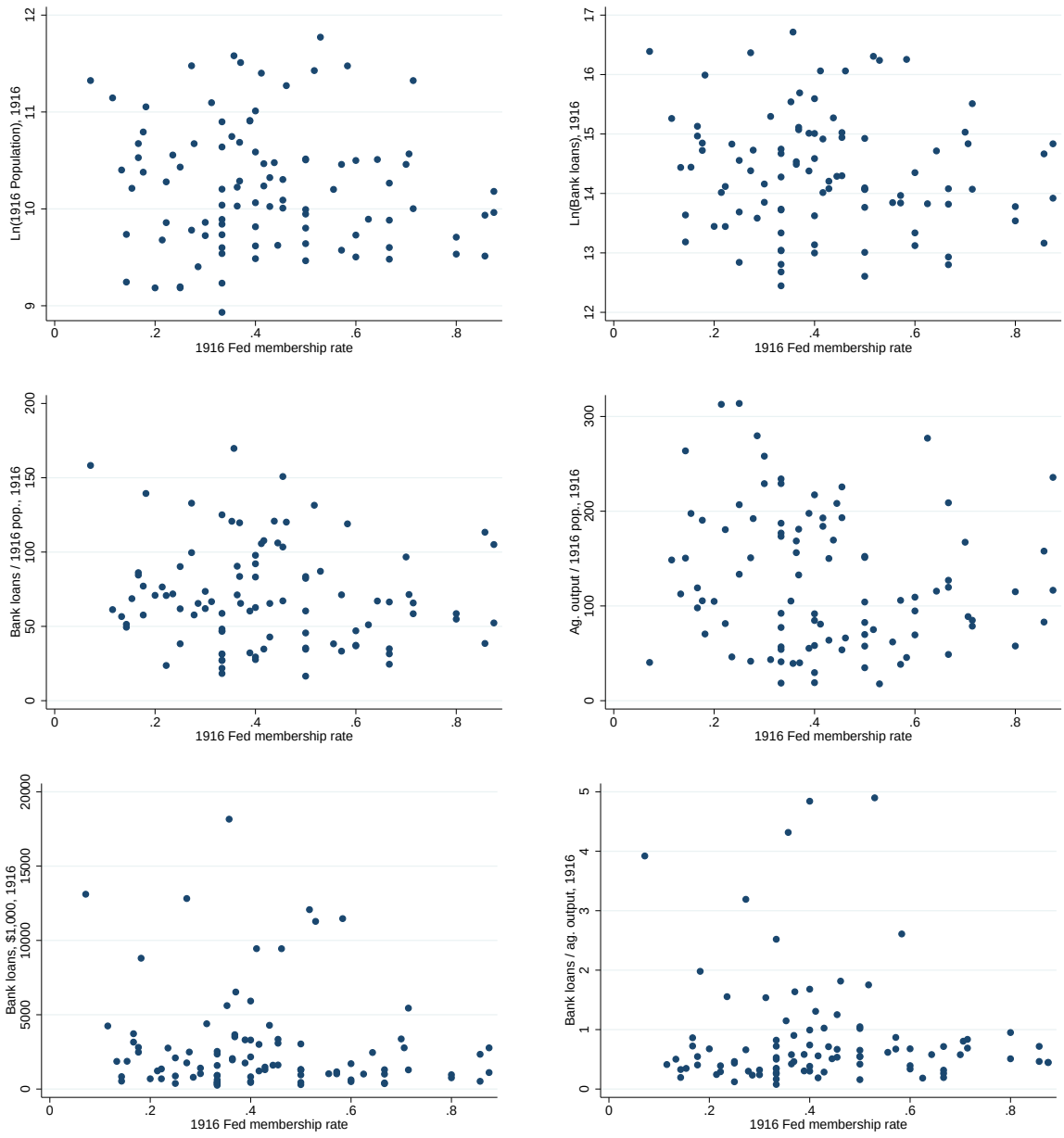


Figure 5: Pre-treatment covariate balance checks for various observables.

	(1) Loans	(2) Loans/1916 pop.	(3) Ln(Loans)
Year = 1920 × 1916 Fed membership rate	-6412.3	-160.2	-0.685
	(1824.2)	(25.26)	(0.157)
Year = 1920	7022.0	194.3	1.356
	(971.6)	(13.56)	(0.0810)
Fixed effect	County	County	County
Obs	190	190	190
R^2	0.646	0.844	0.909

Standard errors in parentheses

Table 5: County-level regressions of bank loans outstanding as a function of Fed membership. The sample includes one observation from 1916 and one from 1920 for each of the 95 Illinois counties included in Table 1. The specification is given by (2) in the paper, and includes fixed effects for year and county. "1916 membership rate" is the fraction of sample banks for the county as of 1916 that appear in the Fed call reports for national member banks. Column 1 is in thousands of dollars. Standard errors are clustered by county.

	(1) Ag. output	(2) Output/1916 pop.	(3) Ln(Output)
Year = 1920 × 1916 Fed membership rate	-1419.8	-39.81	-0.371
	(608.5)	(21.95)	(0.172)
Year = 1920	879.2	19.88	0.209
	(279.7)	(9.935)	(0.0729)
Fixed effect	County	County	County
Obs	190	190	190
R^2	0.0971	0.0457	0.0750

Standard errors in parentheses

Table 6: County-level regressions of agricultural output as a function of Fed membership. All information is as in Table 5.

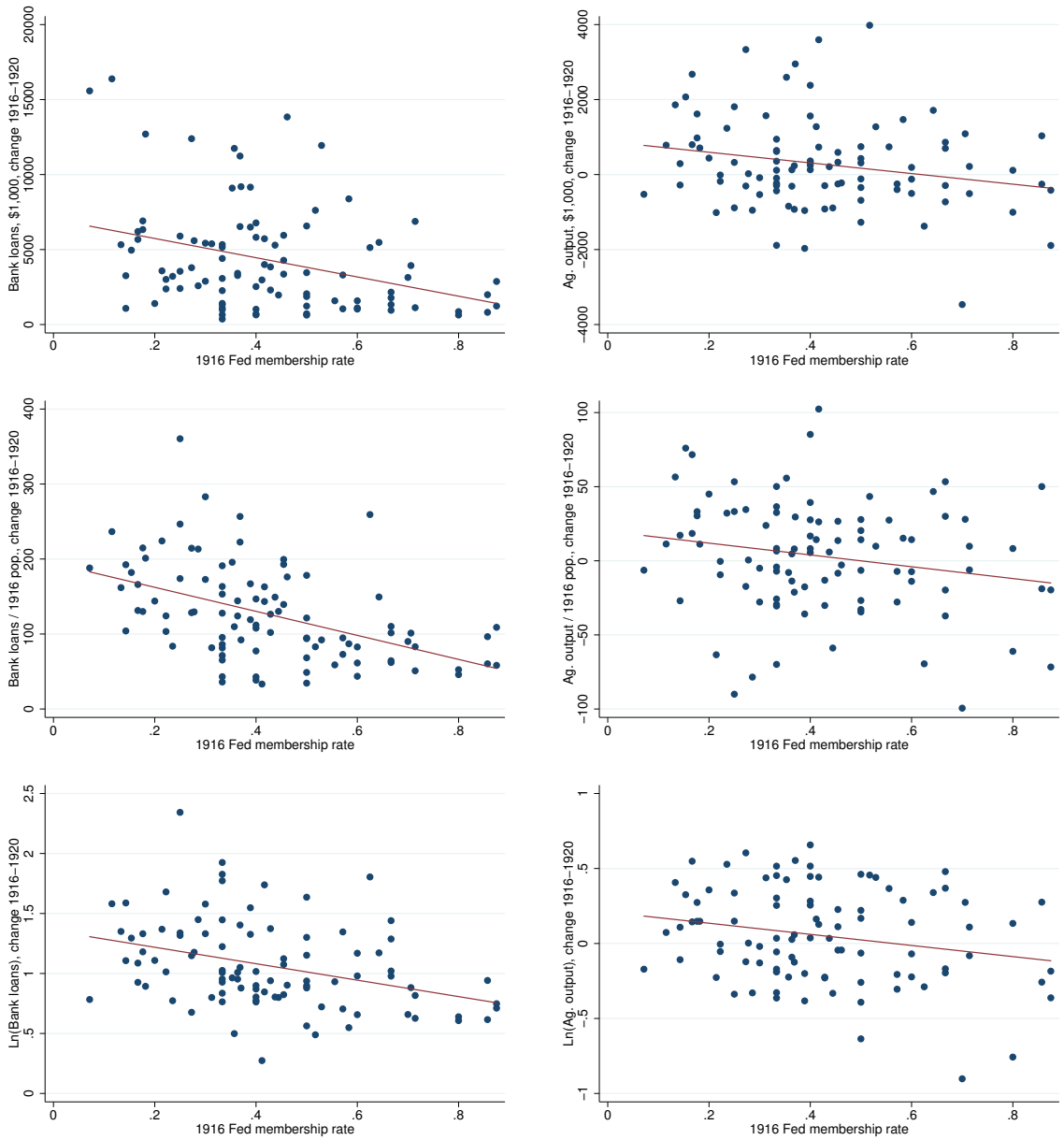


Figure 6: Left panels depict the regressions from Table 5, which compares the county-level growth in bank lending, 1916-1920, with the 1916 membership rate of county banks in the Federal Reserve system. Right panels depict the regressions from Table 6, which compares the county-level growth in agricultural output, 1916-1920, with the 1916 membership rate of county banks in the Federal Reserve system.

	(1)	(2)
	Corn price	Ln(corn price)
Year = 1920 × 1916 Fed membership rate	-0.0138	-0.0322
	(0.0501)	(0.0852)
Year = 1920	-0.226	-0.319
	(0.0227)	(0.0379)
Fixed effect	County	County
Obs	190	190
R^2	0.820	0.798

Standard errors in parentheses

Table 7: Corn prices as a function of Fed membership rate. The specification is as in Tables 5 and 6. The outcome variables are the price of corn, and the natural logarithm of this price.

	(1) Ag. output	(2) Output/1916 pop.	(3) Ln(Output)	(4) Ln(Output)
County bank loans	0.221			
	(0.113)			
Bank loans / 1916 pop.		0.248		
		(0.149)		
Ln(Bank loans)			0.541	0.541
			(0.280)	(0.250)
Year = 1920 × 1916 population				0.248
				(0.139)
Year = 1920 × 1916 ag. output				-0.170
				(0.112)
Year = 1920 × 1916 credit/output				0.0650
				(0.0729)
Year = 1920 × 1916 corn value/output				-0.368
				(0.305)
Year = 1920	-675.6	-28.41	-0.524	-0.384
	(492.8)	(19.10)	(0.300)	(0.666)
Fixed effect	County	County	County	County
Obs	190	190	190	190

Standard errors in parentheses

Table 8: Instrumental-variables regressions for the marginal effect of bank credit on agricultural output during 1920. The sample is the same as in Tables 5 and 6: one observation from 1916 and one from 1920 for each of the 95 Illinois counties included in Table 1. In column 1, the outcome variable is the county-level bushels of corn produced in the year. In the remaining columns, the outcomes are based on the total dollar value of crops produced: In thousands of dollars in Column 2; scaled by (interpolated) 1916 population in Column 3; and in natural logarithms in Column 4. The first three explanatory variables are treated as endogenous, and each is instrumented with the interaction between the 1920 dummy and the 1916 county-level membership rate of banks in the Federal Reserve system. The other explanatory variables are treated as exogenous. See Section 4 for discussion of the magnitudes of the coefficients. Standard errors are clustered by county.

	(1) Ag. output	(2) Output/1916 pop.	(3) Ln(Output)
Year=1926 × 1916 Fed membership rate	1449.4	39.86	0.384
	(451.7)	(16.71)	(0.135)
Year=1926	-1005.1	-25.79	-0.224
	(226.0)	(7.802)	(0.0589)
Fixed effect	County	County	County
Obs	190	190	190
R^2	0.217	0.153	0.129

Standard errors in parentheses

Table 9: This table repeats the analysis of Table 6, but considers the years 1920 and 1926 instead of 1916 and 1920.

	(1) Loans	(2) Loans/1916 pop.	(3) Ln(Loans)
Year=1926 × 1916 Fed membership rate	-263.4	1.372	0.0114
	(625.6)	(18.01)	(0.0873)
Year=1926	361.6	-1.827	-0.00770
	(329.0)	(10.42)	(0.0481)
Fixed effect	County	County	County
Obs	190	190	190
R^2	0.0307	0.00124	0.000424

Standard errors in parentheses

Table 10: This table repeats the analysis of Table 5, but considers the years 1920 and 1926 instead of 1916 and 1920.

	(1) Bank loans / ag. output	(2) At 1916 prices
Year=1920	1.456	1.549
	(0.317)	(0.317)
Year=1926	2.259	2.053
	(0.501)	(0.428)
Year=1920 × 1916 Fed membership rate	-0.742	-0.896
	(0.597)	(0.589)
Year=1926 × 1916 Fed membership rate	-1.939	-1.536
	(0.910)	(0.762)
Fixed effect	County	County
Obs	285	285
R^2	0.455	0.426

Standard errors in parentheses

Table 11: County level analysis of the credit-to-output ratio. The sample includes one observation for each of the 95 Illinois sample counties for each of the years 1916, 1920, and 1926. In Column 1, the outcome variable is the ratio of bank loans outstanding to dollar agricultural output in a given year. Column 2 recalculates the denominator of this outcome using 1916 crop prices, in order to separate the effect of production from changes in the prices level during this time. The specification includes fixed effects for county and year. The interaction terms show that counties with higher Fed membership rates in 1916 had lower credit-to-output ratios in 1926. Standard errors are clustered by county.