The Real Effects of Fed Intervention: Revisiting the 1920-1921 Depression*

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Abstract

To study how monetary policy affects the real economy, we re-evaluate the events surrounding the 1920-1921 U.S. depression. We provide causal evidence that discount rate changes by the Federal Reserve significantly 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 output shocks during 1920-1921 and lowered debt-to-output ratios in the years leading to the Great Depression. As such, our findings call into question the conventional narrative that Fed policy was misguided in its early years and during this depression.

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1 Introduction

Understanding the real effects of monetary policy is a central issue in economics and finance. However, measuring those effects empirically, or assessing their mechanisms, poses identification problems that are often insurmountable. The primary stumbling block is simultaneity. Analyzing the aggregate time series of prices and output during episodes of monetary policy change is confounded by the fact that policy change is just as much a reaction to as a catalyst for the fluctuations in these outcomes. This makes it challenging to disentangle the effects of policy changes from the circumstances surrounding them.

For this reason, historical natural experiments are an attractive way to study how Federal Reserve policy affects lending and real economic activity. But such opportunities are scarce. One well-known example in which historical study shed light on this issue is Richardson and Troost (2009). The authors identify the effect of monetary policy on bank failures during the 1930's by comparing banks located in Mississippi at the boundary of more- and less-interventionalist Fed districts. They find that banks in the 6th district (Atlanta) survived at higher rates and had faster recoveries than those in the 8th district (St. Louis) due to the monetary activism extended by the Atlanta Fed.

In this paper, we study a novel natural experiment around the deflationary depression of 1920-1921. This episode has long attracted attention and historical debate as to whether the Fed made poor decisions in its early years. Following the end of World War I, global demand for American products plummeted, especially in the agricultural sector. During this contraction, and contrary to what modern conventional wisdom would prescribe, Federal Reserve Banks actually *raised* discount rates aggressively. Many economists and historians have asserted that this policy exacerbated the depression and hurt subsequent economic activity. But, this remains inconclusive even to this day because of the empirical challenges

noted above.[1]

Our findings support some aspects of conventional wisdom, but contradict others. We find that the Fed's discount rate increases in 1920 did indeed have a large contractionary impact on the real economy, reducing both bank lending and agricultural output. But when the Fed subsequently lowered rates back to their original levels a few years later, the effect on output reversed, while lower levels of indebtedness persisted. The resulting lower debt-to-output ratios lasted through 1929, into the beginning of the Great Depression. Lower indebtedness has been shown to be an important predictor of farms' survival and recovery during the Great Depression. We thus challenge the view that the Fed's actions during this episode were naive: it appears plausible that the Fed successfully managed a credit bubble that arose during World War I.

To establish these findings, we focus on lending activity and agricultural output during 1916-1929 in Illinois, which was the preeminent farming state at the time. Our identification strategy to address simultaneity concerns is based on variation in the county-level composition of national versus state banks within Illinois. Upon the Federal Reserve's founding in 1913, national banks were required to join, whereas state banks were given the choice. Virtually none did in Illinois, due to the offsetting costs of membership such as minimum reserve ratios and required ownership of Fed stock.[2] This gave rise to regional variation in credit availability and exposure to the Fed's discount rate changes, based on whether local banks had been chartered as state or national banks in the pre-Fed era.[3]

[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.

[2] Even by 1929, only 5% of Illinois state banks were members of the Federal Reserve. See page 26 of the Federal Reserve's *Banking and Monetary Statistics 1914–1941*, published in 1943.

[3] While the discount window was intended only as a liquidity facility for times of stress, during its early

We hand-collect county-level data from several sources on banking and agriculture in Illinois. Statistics on lending by Federal Reserve member banks come from Fed call reports, which are available for member banks nationwide for the years 1916, 1920, 1926, and 1929. Since member banks included all national banks but essentially no state banks, we augment the Fed call reports with reports published by Illinois on the condition of state banks. Finally, we collect county-level statistics on crop production for the same years from Illinois agriculture reports.

We first show that, as the Fed aggressively raised discount rates during 1919-1920, national banks decreased their lending activity in response.[4] We demonstrate this effect *within* a given county and year, using state banks as counterfactuals for the national banks, as they were less affected 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, we use the fraction of national banks in each county in 1916 as a proxy for county-level exposure to Fed policy. Importantly, we confirm that this fraction is not correlated with observables such as population, credit conditions, or agricultural output in 1916. We show that 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. The magnitude is striking: County-level loans outstanding would have been

years member banks used it much more liberally, with aggregate borrowing from the discount window exceeding $2 billion by 1920. See Gorton and Metrick (2013), Figure 1, which was provided by Ellis Tallman.

[4]Counties in Illinois were covered by the districts of either the the Chicago or the St. Louis branches of the Federal Reserve. As we show in the paper, both of these Reserve banks contemporaneously raised their rates during this period.

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 provide causal evidence that the Fed's discount rate changes in the 1920s did affect the real economy. The county-level fraction of national banks predicts significantly lower agricultural output in 1920. We demonstrate this effect across a range of specifications, and accounting for both county and year fixed effects. 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. However, the subsequent increase in interest rates by the Fed during 1920 had a significant contractionary effect on the real economy. While this has been generally believed to be true, to our knowledge it has not been previously shown.

We complete our narrative by studying credit and output in 1926 and 1929, the next years in which national bank call reports were available. By 1926, the Fed had lowered interest rates back to their 1916 level. We find that the effect on agricultural output 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, the net effect was to return the counties to their same relative position where they started in 1916.

However, there was no similar reversal in loans outstanding. As a result, the ratio of bank loans outstanding to agricultural output was much lower in 1926 among counties with more exposure to the Fed's actions. We show that these lower loan-to-output ratio persisted through 1929, up to the eve of the Great Depression. Counties with low Fed membership did

not experience this same trend. Ostensibly, agricultural regions that were more exposed to the Fed's actions in 1920 were better prepared for the long-term and the coming traumas of the Great Depression, at the cost of a transitory drop in agricultural output. Commentators have often faulted the Fed for its aggressive rate hikes in 1920, but our identification strategy exploiting the cross-section of counties in Illinois suggests an interpretation that is more positive. The Fed may deserve credit for successfully managing the credit expansion brought on by World War I.

Related Literature

As mentioned above, the most similar paper to ours is Richardson and Troost (2009). We share the goal of using cross-sectional variation to identify the effect of policy in the early 20th century, but we exploit different, within-county variation. Also, their focus is on how emergency lending impacted bank survival, whereas we abstract from the individual bank and focus on how discount rates affected county-level credit provision.

Our paper is also 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%.[5] This is advantageous because the lower membership rate allows us to study differential exposure to discount rate policy

[5] See page 26 of the Federal Reserve's *Banking and Monetary Statistics 1914–1941*, published in 1943.

by county and 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).

2 Historical background

This section provides a brief historical background for 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 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 types were scattered throughout the country.

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 in Illinois, especially outside of Chicago. 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 often not a net benefit for a state bank. Thus, when discount rates were later raised in 1920, the banks in rural Illinois that had been drafted into the Fed system were ultimately left with less access to capital.[6]

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 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 sector during the Great Depression.

With the war's end, government borrowing and European demand dropped sharply during 1919 and 1920. After some consideration, Federal Reserve banks across the country raised discount rates sharply during 1920, partly to avoid violating gold reserve requirements, and partly to contain credit growth. Figure 3 shows this to be the case for the Chicago Fed

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

and the St. Louis Fed, whose districts included rural counties in Illinois. 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 exhibited 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 re-evaluate the popular critique of the Fed's actions.

3 Data

3.1 Sources

We exploit several 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. Selected dates of these reports were microfilmed in 1946 and, more recently, scanned into PDF format and posted on the website of the FRASER library at the Federal Reserve Bank of St. Louis. The remaining dates were lost or destroyed after 1946. These details are discussed in Mason (1998) and Calomiris and Mason (2003), who coded the microfilmed call reports for 1930–1933. For our window of interest, the call report dates that survived are June 1916, June 1921, December 1926, and December 1929. From each call report for each Illinois member bank at each of these dates, we hand-collect the name, city, county, and charter number, as well as total

loans outstanding (item 1A in the report). 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 dates June 1916, December 1920, December 1926, and December 1929. 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, 1926, and 1929.[7]

Timing details across the datasets: Figure 3 compares the timing of each dataset with the time series of Fed discount rates for Chicago and St. Louis, the two reserve districts covering Illinois. 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

[7] Many other crops and agricultural products were also recorded, but we do not bother to collect these, as each was 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.

June 1921. We ignore these minor timing differences in our analysis.

Population data: We collect the county-level population from census numbers for 1910, 1920, and 1930 from the US Census website (census.gov). We interpolate these figures to 1916, 1926, and 1929 by fitting a log-linear model of population growth for each county.

In all the analysis that follows, we exclude Cook County, which contains Chicago and is an extreme outlier on every dimension in our data.

3.2 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 state banks, and the median county-level fraction of national banks was 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.

Tables 2-4 examine trends in all of 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% and the median growth rate approached 100%. However, during the time periods 1920-1926 and 1926-1929, there was little change in the amount of aggregate indebtedness. The mean change in bank loans was zero during 1920-1926, and was a decline of approximately 4% during 1926-1929.

During 1916-1920, 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, however, the economic boom stopped abruptly and agricultural output gave up much of the prior gains it had exhibited. All crop prices fell during this time, reflecting the broad deflation experienced throughout the economy. During 1926-1929, leading up to the Great Depression, agricultural output did rebound (mean increase of 13.8%) as did prices.

In the aggregate trends in Tables 2-4, changes in discount rates are negatively associated with agricultural output, but not bank loans, which might seem to support the view that the Fed affected the local economy through channels other than through bank lending (for example, through a deflationary channel, as emphasized in Friedman and Schwartz, 1963). However, as we show in the remainder of the paper, this is not the whole story. Using state banks as counterfactuals for Fed member banks, we will provide novel evidence that there was indeed a strong lending channel for the impact of Fed policy on the local 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

member banks and state banks within a given county and year, exploiting our novel data of loan volumes within both subsets of banks.

We first 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 non-member 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. Intuitively, β can be thought of as a weighted-average of the coefficients from county-specific difference-in-difference models, in which each model compares the member to nonmember systems in a given county from 1916 to 1920.

Table 5 summarizes the results of this estimation. The three columns employ three different functional forms for the dependent variable in (1): Column 1 is 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 magnitude is approximately one-third of outstanding loans. According to Tables 1 and 2, by 1920 the average county had \$6.7m in loans, or about \$204 per capita. So, the point estimates in Columns 1 and 2 are about 31.6% and 34.6% of these respective values. In Column

3, the estimate of -1.67 corresponds to a drop of 82% ($= e^{-1.67} - 1$). Since member banks accounted for 42% of the loans in a given county in 1920, this implies a county-level effect of $42\% \times 82\% = 34\%$.

Thus, taken at face value, our results in Table 5 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. As such, 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 proxy for exposure to the Fed's rate increases. Our proxy is the fraction of banks in a given county as of 1916 that were national banks, and therefore had been forced to join the Federal Reserve.

In constructing this proxy, we retain only the 95 counties that had both a state and national 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 national banks; and Edwards, JoDaviess, and Wayne counties, which had no state banks. We continue to

exclude Cook County, as in previous sections.

The key identifying assumption behind using this proxy 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 a high fraction of national banks do not look systematically different from those with a low fraction (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 the county-level fraction of national banks as of 1916. Encouragingly, it shows no particular geographic clustering or pattern, with both high and low values scattered all across the state. In Figures 5 and 6, we further demonstrate that population, credit conditions, and agricultural output are not very different for counties with higher or lower values of this 1916 fraction: When we regress these observables on the membership fraction, the slope coefficients are statistically insignificant,[8] and the magnitudes of these coefficients are economically small.

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 the county-level fraction of national banks is relevant to predicting changes in credit and output over the

[8] One exception is the slope for per-capita agricultural output, which is marginally significant at $p = 0.10$.

following years. 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 proxy. We run a county-year regression of loan volumes (now summing across the two sets of banks) against the fraction of county banks that were national banks, 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 6 summarizes the results of this estimation. The magnitudes reflect a counterfactual shift from zero to 100% membership by county banks 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 loans, going from zero to 100% membership in the Fed (calculated as $e^{-0.685} - 1 = -0.50$). A more salient way to assess this magnitude is to compare the upper and lower quartiles of national-bank fractions in Table 1 (0.56 and 0.30, respectively). The Fed's actions would then be expected to cause lending to decline by 13% more for a county at the upper as compared to the lower quartile (calculated as $0.50 \times [0.56 - 0.30] = 0.13$).

Our next step is to show that this credit effect extended to agricultural output, which we address in Table 7. To construct this table, we simply replace loans with agricultural production as the outcome variable in each of the regressions in Table 6. The estimated effects are statistically and economically significant, establishing the bank credit mechanism for Fed policy during this time period. Agricultural output would have been about 31% lower ($e^{-0.371} - 1 = -0.31$) for a hypothetical county with 100% membership rate in the Fed, compared to one with zero membership. Again, comparing the upper and lower quartiles,

there is an 8% drop with higher membership.

Figure 7 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 6.

These figures demonstrate that the variation driving those regressions is spread out across the state, and importantly, is not driven by any small subset of observations, nor by any outlier counties. The figures show that 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 7 also clarifies that the effects in Table 6 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. According to Table 2, 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 potential 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 whether its price decline is driving the results of Table 7. Table 8 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 8 thus confirms that our instrument captures features of production, not demand.

We next use the results so far to construct an instrumental-variables estimate of the effect of credit on output. Here, the idea is to write an underlying model in which credit supply L_{ct} directly affects agricultural output Y_{ct}:

$$Y_{ct} \;=\; \eta_c \;+\; \delta_t \;+\; \theta \times L_{ct} \;+\; \nu_{ct} \tag{3}$$

OLS estimation of specification (3) would face a simultaneity problem, in that observed loans L_{ct} reflect both demand and supply. However, we can use our previous specification (2) as a first-stage regression to predict loans, relying on the identifying assumption from that specification, that changes in county loans from 1916-1920 should not correlate with 1916 membership rate except due to changes in the Fed's policy. When we substitute the predicted

loan values from specification (2) into the model (3), we obtain a consistent estimate of θ.[9]

Table 9 implements this approach. The IV estimate of the effect of a marginal dollar of credit in 1920 is \$0.22 in additional agricultural output in the level specification (Column 1), or \$0.25 in the per-capita specification (Column 2). The log specification also yields results that are consistent with these magnitudes (Column 3). 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 approximately 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 several cross-sectional 1916 controls to the log specification, 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 Effects on indebtedness in 1926 and 1929

So far, we have documented that counties with higher bank membership rates in the Federal Reserve exhibited lower growth in both agricultural output and bank lending during 1916-1920, due to the restraining influence of the Fed's rate increases during 1920. In this section, we study the aftermath during which the Fed lowered rates in 1922, back to 1916 levels. We show that the disparity in relative output across counties disappeared by 1927,

[9] A different route to the same estimate would be to take the ratios of the key coefficients in Tables 7 and 6, reinterpreting these respectively as the reduced-form and first-stage coefficients behind the IV estimation of specification (3).

while the gap in bank lending persisted as late as the end of 1929, months before the passage of the Smoot-Hawley Tariff (in June 1930). Based on this, we conclude that the Fed's actions reduced farm indebtedness through the end of the 1920's, which may have protected them from the looming pressures of the Great Depression.

In Tables 10 and 11, we repeat our prior regressions in (2) with agricultural output and bank loans as the dependent variables, but the time period covered is 1920 to 1926.[10] By 1926, the Fed had reduced the discount rate back to 4%. Table 10 shows a positive trend in agricultural output for counties with higher Fed membership. Interestingly, the magnitudes are almost exactly the same as those in Table 7, with the opposite sign. As such, the disparity in agricultural output that arose by 1920 completely disappeared. This reversal implies a remarkably tight connection between discount rate changes and agricultural output.

In contrast, Table 11 shows no impact at all on bank credit. This is consistent with Frederico (2005) who shows that farms underwent a rapid increase in indebtedness up to 1920, followed by a slow deleveraging during the 1920s. Our findings imply that the disparity in borrowing between counties with higher and lower exposure to the Fed persisted following subsequent interest rate decreases. Overall, thids suggests that Fed intervention was associated with lower debt-to-output ratios.

In Table 12, we address this interpretation directly. We repeat our difference-in-difference specification (2) simultaneously for the years 1916, 1920, 1926, and 1929. Column 1 shows that the negative effect of the Fed's actions on agricultural output were only transitory: The first interaction term (in the fourth row of the table) recovers the coefficient of -0.371 that was reported in Column 3 of Table 7. As before, the interpretation of this effect is that areas

[10] 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.

with high Fed membership rates exhibited a decline in agricultural output from 1916-1920, even as a hypothetical county with no member banks exhibited an increase (as captured by the main effect on Year = 1920). But, the analogous interaction terms for 1926 and 1929 are much smaller and statistically insignificant. Thus, while we can tightly identify an effect of the Fed's actions on the real economy in 1920 via a bank-lending channel, we find that real effect was only transitory and disappeared by 1926.

In contrast, Column 2 shows that the Fed's effect on county-level bank indebtedness was persistent. Again, the first interaction term in the table recovers the coefficient of -0.685 from Column 3 of Table 6. This magnitude shows that areas with relatively more exposure to the Fed's actions experienced relatively less growth in bank lending from 1916-1920, which was the mechanism behind the Fed's effect on agricultural output. Unlike the output effect, this negative effect is statistically significant all the way through 1929, and its magnitude only decays slightly to -0.530. These findings demonstrate that the Fed's negative effect on bank indebtedness in rural regions of Illinois lasted all the way through 1929, just before the beginning of the Great Depression.

The final column of the table summarizes these findings by examining the *ratio* of loans to output. This value can be thought of as a (bank) credit to (agricultural) output ratio for Illinois counties during our sample period. This ratio serves as a useful economic indicator of the debt burden facing rural regions in Illinois in the years leading to the Great Depression. As expected, the first interaction term in Column 3 of Table 12, which captures the effect as of 1920, is not significantly different across counties with different Fed membership rates. This is because even though there were large differences in output growth across Illinois counties from 1916-1920, they were largely accounted for by similar differences in credit growth. As the Fed constrained credit growth during this period, it came at the cost of

output growth.

However, moving on to the interaction terms for 1926 and 1929, we find that in these years, the credit-to-output ratio was significantly lower for counties with greater exposure to the Fed's actions. Based on the findings in the first two columns of the table, this is driven by the fact that the relative output effect in 1920 disappeared by 1926, but differences in county-level indebtedness persisted. Thus, this column shows that the Fed's actions led to lower debt burdens per dollar of output in counties that were more exposed to the Fed's actions, and these lower burdens persisted through 1929, just before the beginning of the Great Depression. While we do not perform welfare analysis or take a stand on whether this appears optimal, we do conclude that on a very important dimension, the counties more exposed to the Fed's actions in 1916 seemed to be in better financial shape through the end of the 1920s.

Our earlier summary statistics and figures demonstrated that the rural counties in our sample feature very different populations and scales of economic activity. We showed that this is not necessarily a concern for our identification strategy, since these observables do not correlate with our proxy for the intensity of treatment. However, one might still wonder if the findings in the tables up to this point are mainly driven by the smallest and most rural regions in the sample, which would limit their external validity in terms of drawing aggregate conclusions. To check that any such heterogeneity does not substantially affect our findings, in Table 13 we repeat the final specification above, but weight the regressions by the 1916 values of (respectively across the columns) population, loans outstanding, and agricultural output. Across all three approaches, the conclusion is the same: Membership in the Fed as of 1916 predicts a sustained, lower level of indebtedness per dollar of agricultural output, with the effect remaining significant through 1929.

Our results thus call into question a popular view that the Fed did not understand the impact of its actions in 1920. Counties that were more exposed to the Fed's aggressive interest rate policy during 1920 saw a transitory drop in agicultural output that recovered by 1926, and a long-term decrease in bank indebtedness that lasted until the beginning of the Great Depression. Slow and painful deleveraging has been cited as a source of farm distress during the 1920s, and as an eventual contributor to the Depression. Thus, while we cannot assess the optimality of the Fed's actions, they at least seem consistent with its having anticipated, and mitigated, the effects of a temporary 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

Board of Governors of the Federal Reserve System, 1943, Banking and Monetary Statistics, 1914–1941, Technical report.

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

Calomiris, Charles, and Joseph R. Mason, 2003, Fundamentals, Panics, and Bank Distress During the Depression, *The American Economic Review* 93, 1615–1647.

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.

Mason, Joseph R., 1998, American Banks During the Great Depression: A New Research Agenda, *Federal Reserve Bank of St. Louis Review* 80, 151–152.

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.

Richardson, Gary, and William Troost, 2009, Monetary Intervention Mitigated Banking Panics during the Great Depression: Quasi-Experimental Evidence from a Federal Reserve District Border, 1929–1933, *Journal of Political Economy* 117, 1031–1073.

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

Enter Charter Number of Bank Here.

No. 8572

At CAMBRIDGE, in the State of ILLINOIS

at the close of business on JUNE 30th., 1916.

PLEASE FOLD THIS SIDE UP.

DR.

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.

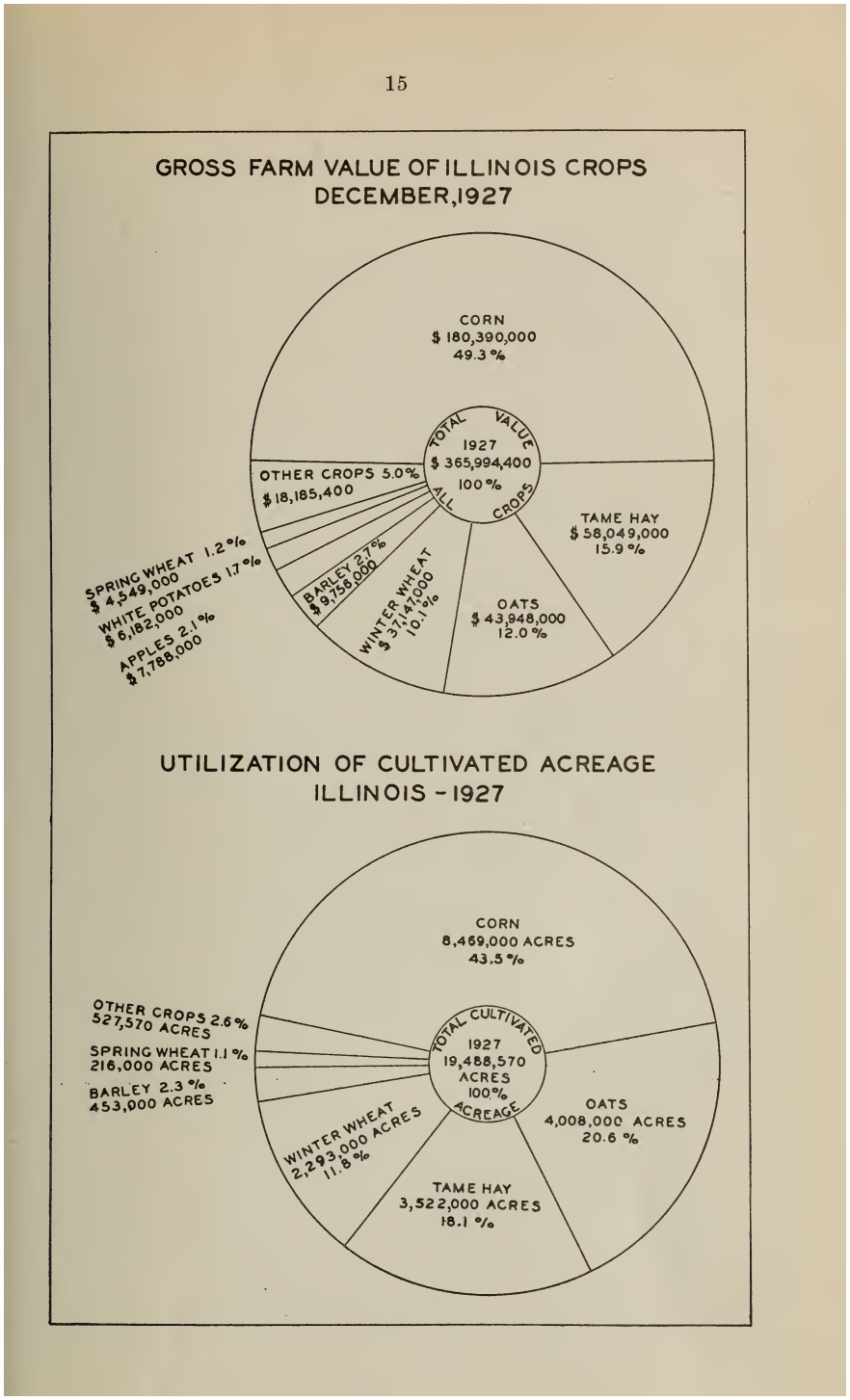

Figure 2: Page 15 of the 1926-1927 Illinois crop report.

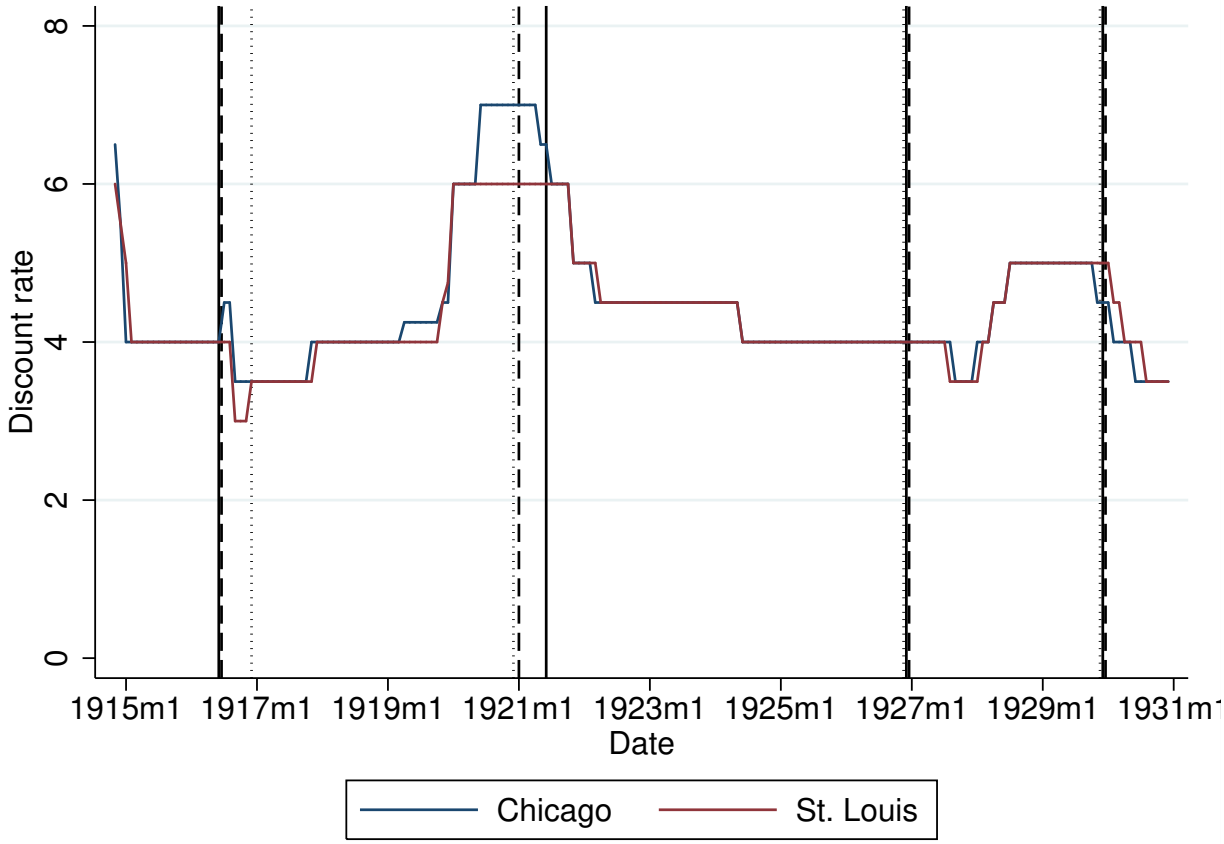

Figure 3: Discount rates at Federal Reserve Banks of Chicago and St. Louis, 1915-1928. Solid lines are dates of national bank call reports. Dashed lines are dates of state bank reports. Dotted lines are dates of crop reports.

	(1)					
	mean	min	p25	p50	p75	max
National banks	4.238	0	2	4	6	15
State banks	6.248	0	3	6	9	23
Fraction national banks	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 Oats price per bushel	-0.0936	-0.240	-0.140	-0.0900	-0.0400	0.110
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)					
	mean	min	p25	p50	p75	max
Change in county loans	-162.4	-7085.1	-827.7	-174.2	389.8	8133.7
Change in Bank loans / 1916 pop.	-7.510	-192.2	-31.01	-8.502	16.66	180.5
Change in Ln(Bank loans)	-0.0429	-1.108	-0.184	-0.0400	0.0935	0.985
Change in ag. output	543.1	-544.2	109.7	446.1	790.1	2989.9
Change in Ag. output / 1916 pop.	18.65	-23.30	5.172	15.31	29.95	87.78
Change in Ln(Ag. output)	0.138	-0.169	0.0620	0.139	0.216	0.517
Change in Corn price per bushel	0.168	0.1000	0.150	0.160	0.200	0.210
Change in Oats price per bushel	0.0388	-0.00172	0.0200	0.0400	0.0600	0.174
Change in Wheat price per bushel	-0.111	-0.142	-0.120	-0.109	-0.100	-0.0978
Observations	101					

Table 4: County-level changes in key statistics, 1926—1929. Sample is as in Table 1.

	(1) Loans	(2) Loans/1916 population	(3) Ln(Loans)
National 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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: 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.

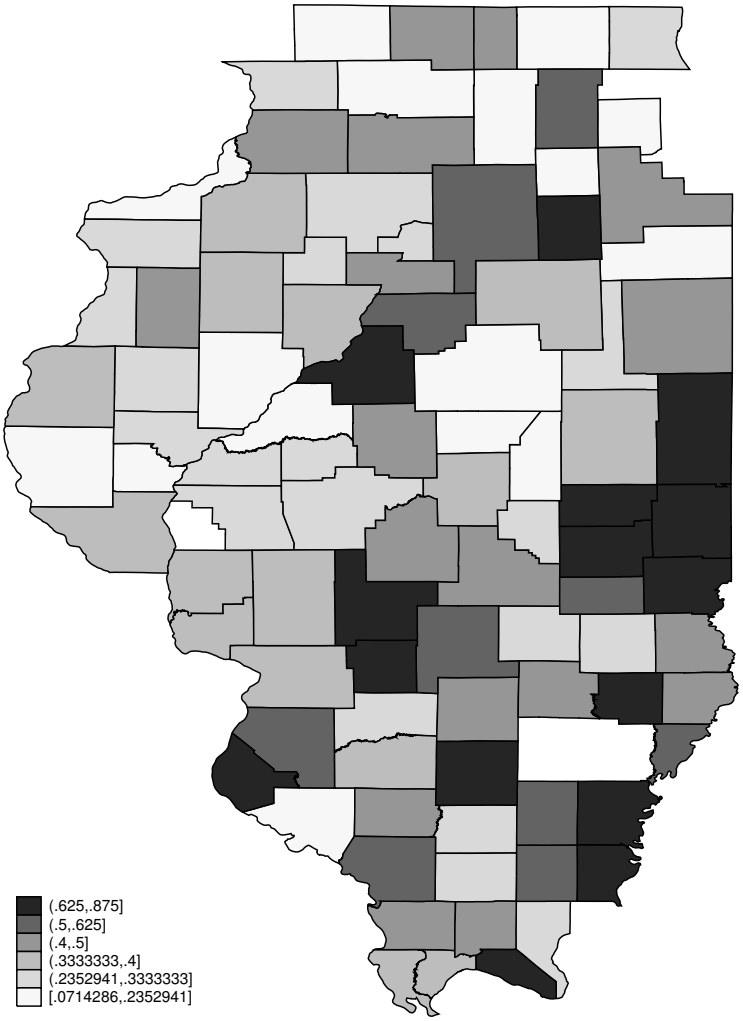

Figure 4: Fraction of county banks that were national banks (and therefore required to be members of the Federal Reserve) as of July 1, 1916. National banks are compiled from call reports filed with the Federal Reserve. State banks are compiled from statements of condition published by the Illinois state government.

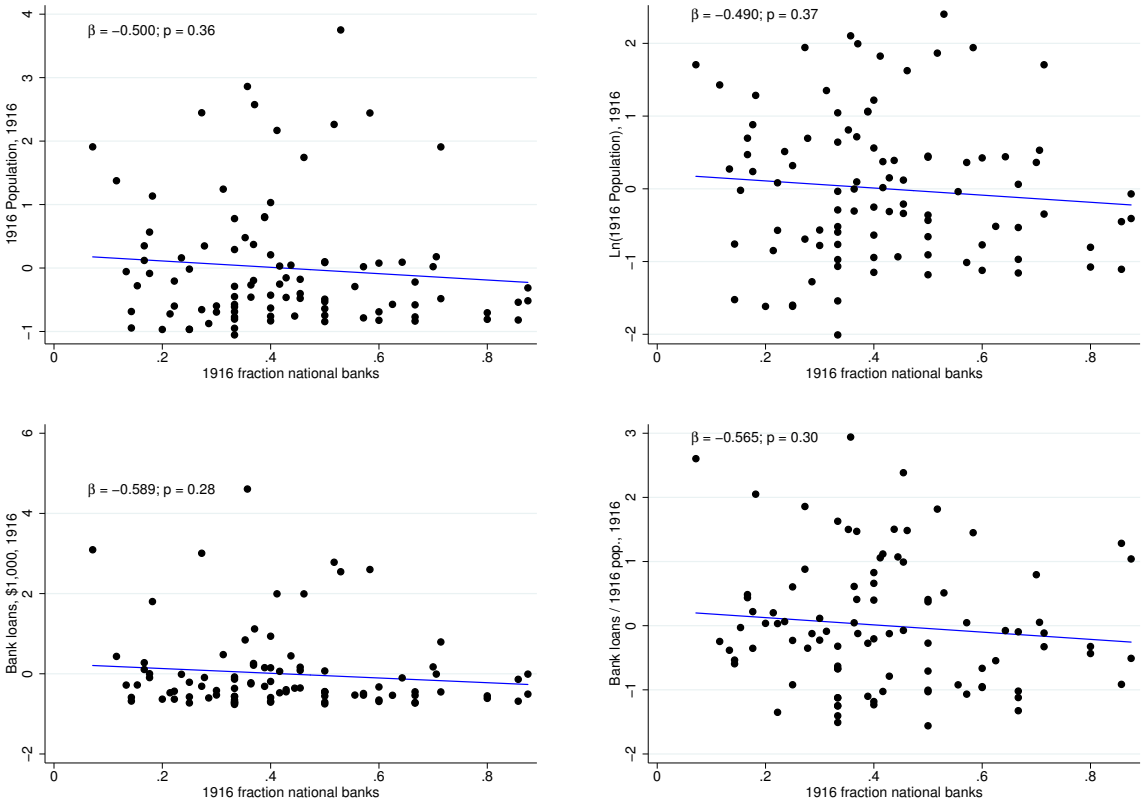

Figure 5: Pre-treatment covariate balance checks: Each dot corresponds with a county in Illinois, and the horizontal axis in each figure plots the fraction of sample banks that were member banks in the Federal Reserve as of 1916. As discussed in Section 4.2, we exclude six counties for which this fraction is zero or 100%, as well as Cook County, which contains Chicago. In the top-left panel, the vertical axis plots 1916 population (interpolated between the 1910 and 1920 Censuses as discussed in Section 3); in the top-right panel, the log of 1916 population; in the bottom-left panel, total loans outstanding at all sample banks as of 1916; and in the bottom-right panel, the ratio of bank loans to population as of 1916. Each figure plots a best-fit line in blue, and also reports a slope and p-value from a regression of the dependent variable on the membership fraction. In this regression, the outcome variable is standardized by its sample standard deviation, so that β in each figure is the effect of a 100% increase in membership on *standard deviations* of the outcome variable.

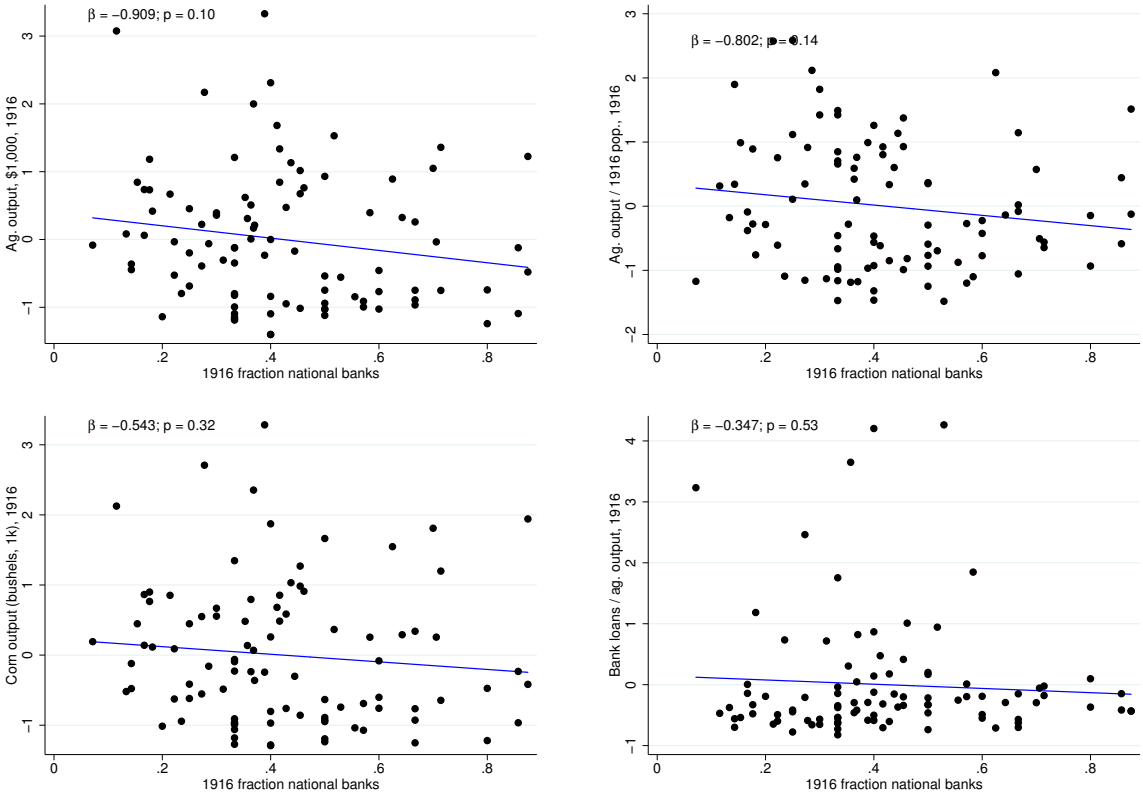

Figure 6: Pre-treatment covariate balance checks for agricultural output. Other than the values on the vertical axis, these figures are constructed as in Figure 5.

	(1) Loans	(2) Loans/1916 pop.	(3) Ln(Loans)
Year = 1920 × 1916 fraction national banks	-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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: County-level regressions of bank loans outstanding as a function of the fraction of national banks in a county. 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 fraction national banks" 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 fraction national banks	-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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: County-level regressions of agricultural output as a function of the fraction of national banks in a county. The outcome variables measure agricultural output, defined as the total dollar production of corn, oats, hay, and wheat, for each county and year in the sample. All other information is as in Table 6.

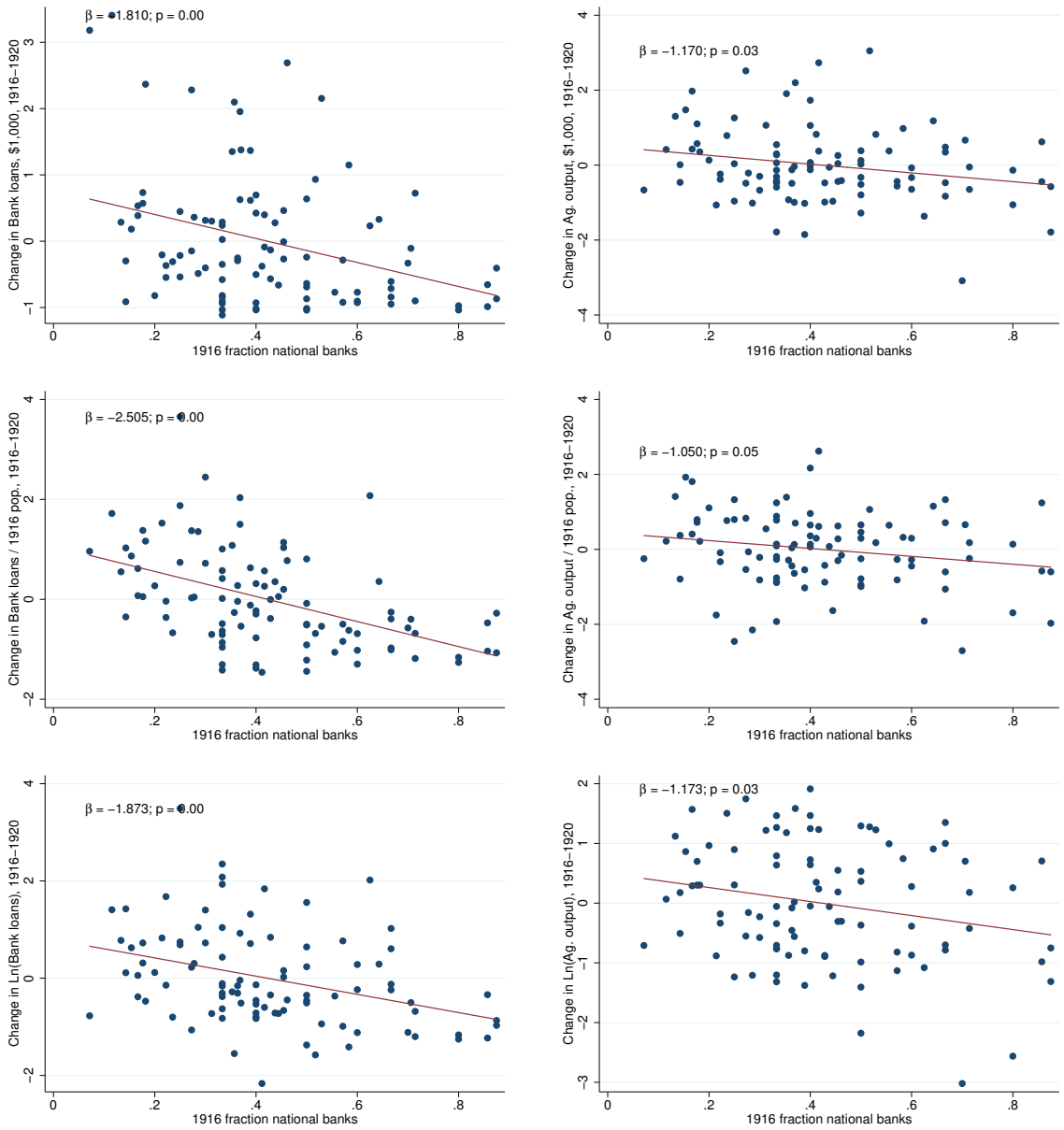

Figure 7: Left panels depict the regressions from Table 6, which compares the county-level growth in bank lending, 1916-1920, with the 1916 fraction of county banks that were national banks. Right panels depict the regressions from Table 7, which examines the county-level growth in agricultural output from 1916-1920 against the same fraction.

	(1) Corn price	(2) Ln(corn price)
Year = 1920 × 1916 fraction national banks	-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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Corn prices as a function of the fraction of national banks in a county. The specification is as in Tables 6 and 7. 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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Instrumental-variables regressions for the marginal effect of bank credit on agricultural output during 1920. The sample is the same as in Tables 6 and 7: 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 fraction of banks in a county that were national banks. 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 fraction national banks	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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: This table repeats the analysis of Table 7, but considers the years 1920 and 1926 instead of 1916 and 1920.

	(1) Loans	(2) Loans/1916 pop.	(3) Ln(Loans)
Year=1926 × 1916 fraction national banks	-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

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: This table repeats the analysis of Table 6, but considers the years 1920 and 1926 instead of 1916 and 1920.

	(1) Ln(Ag. output)	(2) Ln(Bank loans)	(3) Bank loans / ag. output
Year=1920	0.209***	1.356***	1.456***
	(0.0731)	(0.0812)	(0.317)
Year=1926	-0.0144	1.348***	2.259***
	(0.0631)	(0.0796)	(0.502)
Year=1929	0.179***	1.234***	1.486***
	(0.0573)	(0.0970)	(0.291)
Year=1920 × 1916 frac. nat'l banks	-0.371**	-0.685***	-0.742
	(0.173)	(0.157)	(0.598)
Year=1926 × 1916 frac. nat'l banks	0.0127	-0.674***	-1.939**
	(0.132)	(0.154)	(0.911)
Year=1929 × 1916 frac. nat'l banks	-0.120	-0.530***	-0.988*
	(0.129)	(0.182)	(0.521)
Fixed effect	County	County	County
Obs	380	380	380
R^2	0.138	0.843	0.406

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: 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 more national banks in 1916 had lower credit-to-output ratios in 1926. Standard errors are clustered by county.

	(1) Loans/output	(2) Loans/output	(3) Loans/output
Year=1920	1.502***	1.508***	1.451***
	(0.344)	(0.350)	(0.317)
Year=1926	2.365***	2.371***	2.255***
	(0.541)	(0.549)	(0.500)
Year=1929	1.550***	1.546***	1.479***
	(0.308)	(0.311)	(0.290)
Year=1920 × 1916 frac. nat'l banks	-0.810	-0.823	-0.737
	(0.649)	(0.660)	(0.599)
Year=1926 × 1916 frac. nat'l banks	-2.078**	-2.089**	-1.926**
	(0.989)	(1.006)	(0.912)
Year=1929 × 1916 frac. nat'l banks	-1.061*	-1.063*	-0.980*
	(0.552)	(0.559)	(0.521)
Fixed effect	County	County	County
Weight	Ln(1916 pop.)	Ln(1916 loans)	Ln(1916 output)
Obs	380	380	380
R^2	0.407	0.408	0.407

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: This table repeats the analysis of Table 12, Column 3, but weights the counties in the regression by various observables: In the first column, the regression weight is the log of 1916 population. In the second columnm, the weight is the log of 1916 county-level bank loans outstanding. Finally, in the third column, the weight is the log of 1916 county-level agricultural output.