The U.S. Farm-Credit System and Economic Expansion in Agriculture: Evidence from U.S. Counties, 1930-1940

Brent Hueth and Jared Hutchins

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*Department of Agricultural and Applied Economics, University of Wisconsin–Madison, hueth@wisc.edu and jhutchins@wisc.edu. Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington, D.C., August 5-August 7. Copyright 2018 by [authors]. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Introduction

The U.S. Congress initiated policy in 1916 to create what would eventually become a national Farm Credit System (FCS) that continues in operation to this day. The FCS was the first of several "government sponsored entities" (GSEs), as these institutions would later come to be known, created for the purpose of increasing access to credit in targeted economic sectors. Historical and political events leading to creation of each GSE are different in particulars, but all were organized to operate as quasi-private entities. The U.S. government provided seed capital, technical assistance, and an *implicit backing* to repay creditors to the system in the event of insolvency. However, each GSE was expected to operate in an economically sustainable manner, and to treat initial federal seed capital as debt to be repaid. Unlike other GSEs, the FCS was established under a structure that assigned autonomy, and considerable obligation for equity finance, to local cooperative organizations of farmers.

Farmers in many countries, both developing and developed, lack access to affordable credit and experience "credit rationing" from commercial banks. Due to information asymmetry and the riskiness of agriculture, farmers often find that their ability to access the funds for needed for successful commercial operation depend on their assets, or their affiliation with a group, rather than on the interest rate they are willing to pay (e.g., Stiglitz and Weiss, 1981; Hoff and Stiglitz, 1990; Carter, 1988). This kind of credit rationing can be detrimental to rural welfare and economic growth, but attempts to reduce credit rationing are often ineffective. A common policy is direct financing, or public subsidy for commercial lenders. Such policies are expensive, and do not directly address the informational and contracting frictions that are the root source of credit-market dysfunction (Binswanger and Khandker, 1995; Khandker and Faruqee, 2003).

There are several theoretical arguments that suggest how a cooperative or mutual firm structure can expand possibilities for private market development in settings where informational frictions limit entry by firms operating under a traditional investor-owned structure (e.g., Smith and Stutzer, 1990; Bencivenga and Smith, 1991a; Hueth and Marcoul, 2015). The FCS seems to be an example for this type of outcome. The system has been mostly successful in expanding access to credit for U.S. farmers, and with little financial cost to taxpayers. The specific evidence on whether or how the FCS has done this, however, has largely been anecdotal. If and how the FCS has aided the development of U.S. agriculture is interesting in itself, and of particular interest to understanding how this policy instrument can be applied in other contexts.

In this paper, we present empirical evidence of the effect of the FCS on agricultural yields, crop value, and use of inputs. We focus on lending by Production Credit Associations (PCAs) that were created to provide short-term production credit, a type of loan that, at the time, was provided almost exclusively by informal "merchant lenders" that charged high rates of interest. Using distances to PCAs as a proxy for credit access, we use a difference-in-difference approach to examine the effects credit expansion on several county-level outcome measures. Specifically, we examine variation in county-level outcomes in relation to proximity to PCA location, before and after establishment of the FCS. We use a variety of historical data sources to control for other policies that ran parallel to the PCAs at the time. We find that areas closer to PCAs were less productive than areas farther away before program implementation, but then become *more* productive in years after. Moving a county about 100 km closer to a PCA increases crop revenue per acre by approximately 20%, fertilizer spending per acre by 10%, and tractors per farm by 5%, an impressive effect given that PCAs served only 7% of farmers nationally during this period. The prior trends suggest that PCA's were placed in areas that were *less* productive, meaning the effects we measure are lower bounds.

Related Literature

Due to unique features of farming as a commercial activity, finance and credit have received specific focus in the sector, especially as it relates to evidence of credit under provision. Farmers operate in environments with a high-degree of uncertainty, and limited opportunity for direct monitoring. Stiglitz and Weiss (1981) illustrate a theoretical basis for credit rationing in equilibrium when there is information asymmetry; in order to prevent attracting high risk borrowers, banks do not offer as much credit as borrowers may like, even if borrowers getting such credit could increase welfare. Carter (1988) extends this to the case of agriculture, and shows how these asymmetries can specifically lead to small farms being rationed out of the market in equilibrium when small farm agriculture is riskier. Rationing out riskier agriculture, and even small farm agriculture, consequently limits the development of the agriculture sector. Bencivenga and Smith (1991b) illustrate the effects of credit rationing on economic growth using a similar logic; in their model, credit rationing and economic growth both arise endogenously, and credit rationing limits the extent to which projects can be undertaken, thus becoming detrimental to growth.

There is also considerable empirical support for credit rationing in agriculture at the level of farm households. In studies done in both Ghana and Nigeria, farmers were more likely to be rationed if they were low income and were not a member of a producer organization (Rahji and Fakayode, 2009; Asante-Addo et al., 2017). The phenomenon of credit rationing is not only a problem of developing economies, however. Additional empirical evidence comes from more industrialized countries such as Poland (Petrick, 2004), Canada (G and Alfons, 1997), and the United States (Belongia and Gilbert, 1990). Independent of the general income level of the country, credit rationing has been linked empirically with assets and group affiliation, the existence of informal and merchant lending, and associated with interest rates much higher than the formal sector (Hoff and Stiglitz, 1990).

The lack of affordable credit to farmers has prompted a variety of public sector responses which have had mixed success. A common policy tool has been direct financing of agriculture through government funds, though institutions that are directly financed are often criticized as being unsustainable because of the losses they take on. Khandker and Faruqee (2003) and Binswanger and Khandker (1995)analyzed agriculture credit banks in Pakistan and India respectively and, while finding positive effects on productivity and welfare, ultimately conclude they take on losses too large to be sustainable. Direct financing in the U.S. is explored generally by (Gale, 1991) and for agriculture specifically by (Ahrendsen et al., 2005), where it is also stressed that high costs of the program do not appear to generate enough growth to be justified.

Besides the problem of funding, direct financing or guarantees of loans by the government does not address the inherent cause of credit rationing: information asymmetry. As stated previously, studies often find farmers that are members of groups are less likely to be credit rationed. Membership to an organization, such as a farmer cooperative, can reduce the cost of collecting information and expand credit to farmers that would otherwise by be credit rationed. Further, banks organized as cooperative institutions arguably can reduce information frictions (Angelini et al., 1998), and better align incentives to deal with issues of moral hazard (Smith and Stutzer, 1990).

How has the FCS affected US agriculture? Thus far, the literature has focused singularly on the costs of the system without quantifying its benefits. From its conception, two points of contention have been for its "implicit guarantee" and tax exempt status (e.g., Butz, 1944; O'Hara, 1983; Lins and Barry, 1984). The second criticism has been the potential "crowding out" of other banks. O'Hara (1983) focuses on the first manifestation of the FCS, the Land Banks, and argues that Land Banks did not succeed in expanding credit but rather crowded out existing financial intermediaries, and that a better solution would have been direct financing, a view also supported by (Jensen, 2000).

While the costs of keeping FCS bonds tax exempt have been well discussed, the benefits of the system have been not been measured directly. The mission of the system from the beginning has been expanding lending to increase the growth of the agriculture sector. Has the FCS achieved this mission? Have its benefits outweighed its costs? Should this model be preferred to direct financing? Our research begins filling these knowledge gaps by answering the first question; specifically, we analyze the effects of the Production Credit System, which was mobilized to address the credit crunch following the 1929 crash.

Historical Setting and Conceptual Framework

Agriculture Credit Before the PCA's

In the early 1930's, farmers used short term credit extensively but tended to rely heavily on informal sources of credit even when commercial banks existed. Input merchants such as fertilizer dealers or tractor sellers were able to offer short term loans to farmers by allowing them to purchase on credit or give a down payment, paying the rest in installments. Arnold (1958) reports estimates from the early 1920's indicating that around half of all farmers used such credit to some extent. Other areas were even more dependent on merchant credit. A study of farm credit on the Eastern Shore of Virginia in 1929 showed that out of 7 million dollars of credit used, supply advances from input merchants accounted for over 80% (Seeley, 1938). Merchant credit did not proliferate because it was cheap, however. A study of merchant credit in the South in the years 1926-7 estimated the interest rate to be around 15% per year, with merchants charging as much as 30% (Arnold, 1958). This type of credit was not only costly to farmers, but also to the merchants lending it. A North Carolina study in 1926 reported that 24% of accounts had unpaid balances by the end of the year, and for every $100 borrowed only $24.30 was paid back (Lange and Forester, 1944).

If neither farmers nor merchants preferred this type of credit, why did such an equilibrium persist? Specifically, why did farmers borrow from merchants instead of commercial banks who had significantly lower rates of interest? Reports at the time mentioned two reasons. First, farmers found the terms of commercial bank loans to not fit with their credit needs. Commercial banks usually offered loans that were 30 or 60 days, which were too short for a crop season; a typical farmer would need a loan that can be taken out at planting and then paid back at harvest, which would be multiple months but not necessarily years. Commercial banks typically did not offer these terms because such loans were against banking regulations, being viewed as unsuitable for the bank's portfolio. Lange and Forester (1944, pg. 82), in a study of commercial banks in agricultural regions of North Carolina, comments this way on loans that banks either "could not or would not" grant:

> In expressing the "could not" reason bankers were not casting reflection upon the character of the loan, but due to certain banking regulations it was impossible for the bank to grant credit. Several bankers indicated their willingness to accept these "could not" loans were it not for banking regulations. In the case of "would not" loans it was the opinion that such loans were slightly below standard for a bank portfolio.

"Below standard" loans may refer to either loans that are too risky or loans that lack collateral, another reason commercial banks did not give production loans. In a study of Texas agriculture credit in 1914, Haney (1914) gave six reasons why farmers used merchant credit instead of commercial banks; two of these reasons have to do with the ability of farmers to have sufficient collateral. First, tenant farmers did not have enough traditional collateral that banks liked to accept, and, second, commercial banks would not accept the collateral farmers had, typically a share of their crops.

While the idea of "credit rationing" would not appear in the economics literature for nearly forty more years, the puzzle that Haney (1914) described, farmers being refused from the commercial sector and instead borrowing at high rates of interest from informal sources, is nearly identical to the sort of problems described in many rural sectors today (Hoff and Stiglitz, 1990). Information asymmetry, together with the inherent risk of farming activities, can explain much of what was seen then. Commercial banks, not knowing how to screen applicants, applied credit caps to borrowers based on collateral that "rations" credit to certain groups, most likely small farmers. Commercial banks instead funnel credit indirectly to these borrowers by lending to merchants who extend credit at high interest rates to compensate for the risk. Merchant lenders take on this role either because they are closer to farmers and better able screening the good borrowers from the bad, or because they can better monitor production activities and enforce repayment. In such an equilibrium, establishing institutions that can more effectively screen and monitor borrowers may reduce the incidence of credit rationing in ways that direct subsidy of commercial lenders cannot. This was precisely the prescription of Haney (1914), that is establishment of a credit cooperative, which would share many similarities with prescription for poorly functioning rural credit markets offered by modern-day economists nearly a century later (e.g., Karlan, 2007; Ghatak and Guinnane, 1999).

The Production Credit Associations

The Farm Credit System was established in 1916 with the passage of the Federal Farm Loan act, which was meant to address agricultural mortgages by creating Federal Land Banks. Taking inspiration from the German Landschaft system, the banks had local associations of borrowers who were required to buy stock equal to 5% of their loan in the local association. Rates on their mortgages were kept low because the securitized mortgage bonds were tax-exempt. It quickly became apparent, however, that the credit needs of farmers reached beyond mortgages for farmland. The first attempt to improve access to short-term credit was the creation of the Intermediate Credit Banks in 1923, which did not directly loan to farmers but instead discounted production loans of commercial banks. The performance of these banks was in general poorer than expected, and rural bank failures in the early 1930's prompted a different strategy for expanding short term lending. The first strategy was direct financing through emergency seed loans, but lawmakers wanted a more long-term solution. Pressure to establish a more permanent source of production credit was mounting as both commercial banks and merchant lenders began to contract lending. This pressure led to the passage of the Farm Credit Act in 1933, which established the Production Credit Associations (Hoag, 1976; Arnold, 1958).

Like the FCS, PCA members had to buy stock in the association to get a loan, and organizations were established initially with government seed capital with the idea that the PCAs would pay back the money. Lending operations quickly expanded, far outpacing the Intermediate Credit Banks. However, their market reach initially was modest. As late as 1946, only 7% of the 6 million farmers belonged to PCAs and PCA lending was only 14% of loan volume by commercial banks (Butz, 1944; Murray, 1941). While on average PCA lending was a small portion of the national loan volume, in some areas PCAs handled a large portion of production credit lending, sometimes even outpacing the commercial banks. In a study of production credit in Florida among citrus and vegetable growers in 1937, PCAs had 20% of production loans while commercial banks had only 11%; 30% of lending still belonged to merchant lenders (Reitz, 1942). In a similar North Carolina study in 1940, PCAs had an even higher percentage: 44% of total lending compared to 28% belonging to commercial banks and only 11% to merchant dealers (Lange and Forester, 1944).

In general, merchant credit in many areas began to decline in this period; specifically, studies in South Carolina and Arkansas showed decreases in merchant credit in 1937 and 1938 from 1926

(Sparlin, 1940; Moore and Brannen, 1929; Ferrier, 1940; Wickens and Jensen, 1931). In the case of Arkansas and North Carolina, part of this decrease came at the same time as an increase in PCA lending. In a North Carolina study of farm credit, commercial banks even had a favorable view of PCAs because they served customers the banks were unable to serve (Lange and Forester, 1944). From these few case studies, it appears that the introduction of PCAs decreased dependence on merchant credit and expanded lending by offering credit at a lower interest rate. According to a South Carolina merchant, this is precisely what had happened (Ferrier, 1940, pg. 35):

> He stated that he couldn't conduct a credit business as he once did, that people have changed, that farmers are able to get money more readily from other sources than formerly and are preferring to pay cash, and that the user will borrow from a bank or production credit association to pay the store bill rather than make an annual fall settlement.

Even if at the national level their reach was small, lending by the PCAs appears to have been meaningful to farmers. How meaningful they were nationally, in expanding output in the agricultural sector, is the subject of our analysis.

Conceptual Framework

While data is not available on each PCAs lending, we do have county-level information on farm output and input use during this period from agricultural censuses. How would this expansion of lending affect agricultural productivity? In the Bencivenga and Smith (1993) model, borrowers are characterized as either high risk or low risk in terms of whether they succeed in an investment project; ironically, due to adverse selection, in equilibrium it is the low risk borrowers that are offered less credit by lenders in order to prevent attracting high risk borrowers. Since the safe investments are rationed out of the market, the growth of both output and capital is decreasing in the amount of credit rationing. This theory applies equally well to agriculture, though the rationed group may instead be tenant or "small farms" as described in Carter (1988).

This same fact can be illustrated at the micro level with an agricultural household model as in Petrick (2004). Here, farmers face a binding credit constraint and decrease their use of inputs and, consequently their outputs, relative to a full-information setting. Small farmers and tenant farmers who lacked proper collateral were often refused by commercial banks, for example, as a matter of "regulations," even when the commercial bank was willing to serve them. Loosening these constraints would lead to expanded use of inputs, in the case of early 20th century farmers tractors and fertilizer, which could lead to growth in agricultural output.

In both models, credit rationing limits access to inputs for farmers. For example, farmers in the early 20th century wanting to use more fertilizer or rent machinery would have been restricted from doing so unless they borrowed on merchant credit at a significantly higher interest rate. Introducing the PCAs would expand credit to the "low risk" farmers that would otherwise be credit rationed (Bencivenga and Smith, 1993). The cooperative structure of PCAs implies sharing the risk of the firm, which helps screen borrowers. From a moral hazard perspective, the cooperative structure also improves monitoring and enforcement in a way similar to lending groups and ROSCA's (Karlan, 2007; Ghatak and Guinnane, 1999). Both of these mechanisms would result in an increase in increased input use and expansion of agricultural output where PCA lending was active.

Besides the direct effect of credit expansion on farmer purchase of inputs, there is another mechanism by which PCA's might have an effect on agricultural productivity. According to (Murray, 1941), the PCAs might have also been introduced to break up interest rate monopolies in commercial banks. Since PCA interest rates were capped at around 6%, this may have forced some banks

and input merchants to lower their interest rates as well. In that case, it is not only important that PCAs lent money to farmers directly, but that their policies had pro-competitive effects in the market for loans to farmers.

Using data from the agricultural census, we observe county level crop yields both before and after the placement of the PCA's in 1933. With this data source, our goal is to quantify the effect of PCA's on agricultural output and on input use, specifically tractors and fertilizer. Data is not available on individual PCA lending, but their locations in the period 1935-1940 are available. We use the distance from each county centroid to the city where the PCA was located to proxy access to PCA credit. Given travel costs at the time, county distance from a PCA should be an important factor affecting access to PCA lending. Moreover, physical distance is empirically demonstrated to be an important factor in lending relationships (Agarwal and Hauswald, 2010; Degryse and Ongena, 2005).

Summarizing the discussion in this section, we hypothesize the following:

H1 Crop yield is *decreasing* in distance from a PCA, or *increasing* in proximity to a PCA, post 1933.

H2 Fertilizer and tractor spending are decreasing in distance from a PCA, or increasing in proximity to a PCA post 1933.

Identification of these effects is complicated by the fact that bank locations were certainly not exogenous to factors affecting county-level differences in agricultural productivity. In the next section, we present our identification strategy for addressing this complication.

Data and Methodology

Data Description

To test the above hypotheses, we use the U.S. agricultural census from 1920-1940 accessed from Haines et al. (2016). This period was chosen to obtain two rounds of data prior to the establishment of the PCAs in 1933 while not including possibly confounding policy effects that happened after 1940 (including structural changes in the Farm Credit Administration and the beginning of World War II). The census has county level data on crops planted, crops harvested, farm assets, land values, and demographic characteristics such as population density. To control for environmental characteristics, FAO GAEZ soil productivity measurements for rain fed agriculture are used for corn and wheat (FAO GAEZ, 2016), and erosion map data from is used to control for areas that would have been disproportionately affected by dust storms in 1935 (Hornbeck, 2012); temperature and precipitation for this time period comes from PRISM Climate Group (2004). Finally, we use New Deal spending data available from Fishback et al. (2003) to related policy activities that might affect input use and agricultural output. The 1920 county boundaries were used for all periods of analysis and are available from Minnesota Population Center (2016).

The locations of the PCAs are gathered from a map of their location in 1937 obtained from the U.S. National Archives and Records Administration. Because only about 2% of banks closed between 1937 and 1940, their location in 1937 largely reflects where they were in 1940. Less than 1% of banks closed between 1935 and 1937, and these nine locations will presumed to be not existing since they are not observed in 1937. The process of chartering PCAs was relatively quick, and began in 1933 and finished in 1934, meaning there is no staggered heterogeneity in access to exploit. Fortunately, the quick formation of the banks means that in analyzing the effect of

one bank it is unlikely any other bank has advantage based on years operating over any other. Unfortunately, this pattern of evolution leaves distance to be the only source of heterogeneity to exploit with respect to the effect of PCAs on farming activity.

We test for impact of PCA lending across six outcome measures: corn yield, wheat yield, crop revenue per acre, number of tractors per farm, equipment spending per acre, and fertilizer spending per acre. One caveat to using these outcomes is that three of them are value measurements due to limitations in the data, which could be subject to local price fluctuations. One advantage with crop revenue, however, is that this measure gives a more general picture of crop production which focusing on two staple crops, corn and wheat, cannot. Regardless, all of the value measurements are adjusted for inflation. In terms of inputs, fertilizer and tractors were two inputs that were increasingly being used in this period (Arnold, 1958); they are also inputs that are likely to increase farm-level output.

The distance from a PCA was calculated as the straight distance, in kilometers between the city where the PCA was located, and the centroid of the county in 1920. Distance to a bank is shown in the literature on banking to be important in determining access to credit and even the terms and rates of loans (Petersen and Rajan, 1994; DeYoung et al., 2008; Agarwal and Hauswald, 2010). During the period for our analysis, distance to a bank would have been a significant cost to accessing credit, so the distance from the county centroid to the bank will be our measure of variation in access to credit. In choosing a functional form for $L(x_i)$, it is important to consider what restrictions each specification places on how distance can affect yield and inputs. In general, there is no reason to think that distance has a linear effect on outcomes, as this applies the same effect at every level of distance. If a log-log specification is chosen, as in Kantor and Whalley (2014), we restrict the effect to be a constant elasticity at every level; there is no theoretical reason to think this is the case either, and in fact we might imagine larger distances have different elasticities than small distances. Additionally, measuring the variable as continuous means the effect will be a "marginal cost," which may not be realistic; when deciding whether to travel or not, borrowers may be thinking of the fixed cost of traveling a certain distance, not the marginal cost of an extra kilometer. Measuring the distance discretely on quartiles captures this "fixed cost" idea while also allowing the effect of distance to change at different levels. Given these costs and benefits, a log-log model and a log-discrete model will be run to see whether the effect is sensitive to difference in specification.

Methodology

The identification problem lies in the fact that this calculated distance is likely related to unobserved county characteristics that could relate to the outcomes we are evaluating. Put differently, banks were likely placed in a systematic and non-random fashion. What goals were in mind with bank placement? The details on the bank location decisions are most clearly laid out in Arnold (1958) who suggests placement of production credit associations had two conflicting goals: first, to increase credit access for the population, meaning make coverage area *small*, and second, to ensure a baseline level of profitability for the banks, meaning to make the coverage area of the banks *large enough*:

> It had been determined that the area to be included in each association's territory should be *as small as possible* for convenient service and, at the same time, of *sufficient* size so that the fees and interest spread on the future volume of loans would pay expenses and provide some reserves for losses. (pg. 29, emphasis added)

The authors goes on to say that data from the U.S. agricultural census was prepared to aid the decision of where to locate PCAs, how big their coverage area should be, and how much capital

was given to each state. Since the PCAs operated under a national uniform interest rate, profits had to be made by increasing the customer base and not by increasing interest rates.

In placement of the PCAs, this suggests two different competing incentives. One incentive is to place the PCAs in areas that are already successful to assure profitability of the banks; given that PCAs had to pay back their loans from the federal government, placement had to assure some level of profitability to make them sustainable (making their banking areas of *sufficient* size). If the PCA areas were better off on average than non-PCA areas, any effect we find on productivity or input use is biased upwards. The other incentive is to place PCAs in areas that are not successful in order to expand lending in under served areas (coverage areas that are "as small as possible"). If the PCA areas were actually worse than average, any estimated effect is biased downward.

Figure 1 shows where the PCAs were located in 1937 with Volroni polygons drawn around each point to show their approximate coverage area. What is immediately apparent in the figure is that many of the banks are very clustered in the Southeast, particularly in Georgia, South Carolina, and North Carolina. This roughly correlates with population density. This would tacitly suggest some sort of selection process, though it is not clear on whether population density or productivity was the driving force.

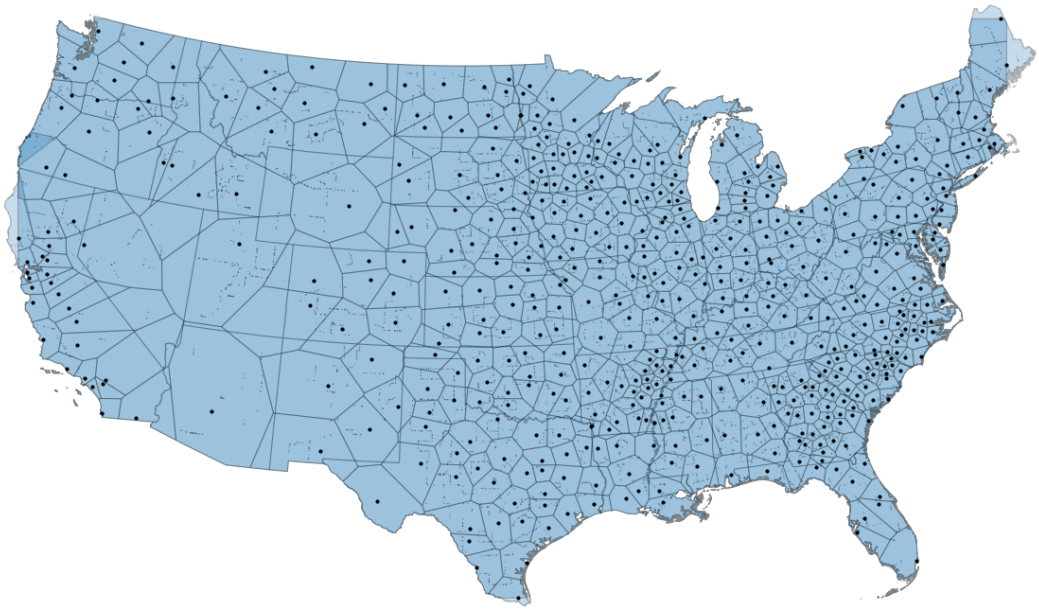

Figure 1: Production Credit Association Locations, 1935.

Because we observe a county panel, we can use a within transformation on the data to net out permanent, unobserved heterogeneity specific to counties that might confound estimates of the impact of PCA lending. Using distance to PCA as the "treatment" variable, we use a difference-in-difference type specification where the distance, being time-invariant, is interacted with year indicators. Given that the PCAs were established in 1933, we expect the relationship between distance and productivity to change after 1935. Specifically, similar to Kantor and Whalley (2014), we expect the effect of distance to be zero before 1935, when no bank existed, and negative after 1935; in other words, the closer banks were to the county the higher crop yields or input use that

county had.

We use the following specification for out estimation,

$$IHS(Y_{it}) = \alpha + \mu_i + \tau_t + \sum_{j=1920}^{1940} \beta_j L(x_i) \times I\{\text{year}_t = j\} + \gamma Z_{it} + \sum_{j=1920}^{1940} \delta_j E_i \times I\{\text{year}_t = j\} + \epsilon_{it},$$

where Y_{it} is outcome for county i in period t; τ_t is time indicator for year t; μ_i = is county fixed effect; $L(x_i)$ = a function (described below) of distance from county centroid to the nearest PCA; Z_{it} is a vector of time-varying controls; and E_i is a vector of time invariant controls. To account for zero values of Y_{it}, we use the inverse hyperbolic sine (IHS) transformation, which still has the same interpretation as a log-log model (Carboni, 2012).

We are interested in β_{1935} and β_{1940}, which we expect to have a negative sign relative to the immediate prior period, 1930; as lending began to expand from the PCA location, counties farther away should have had lower input use and yield. In other words, we expect PCA proximity (negative of distance) and productivity to be positively related.

The main assumptions behind our difference-in-difference approach giving us the true estimate of the relationship between the expansion of production credit and input spending and yields are paralell trends, exogeneity of $L(x_i)$ conditional on controls, and absence of confounding programs. The first two assumptions relate to econometric identification of the effect of $L(x_i)$ post treatment while the last relates to identifying the effect as production credit, specifically.

In order to attribute the effect of distance to the PCAs, we rely on the assumption of parallel trends for counties that had banks close and those that did not; in other words, we do not expect distance to have prediction power before 1935, or $\beta_{1920} = \beta_{1925} = 0$ where the year 1930 is the base period. With this data, we observe a prior period, 1920 and 1925, so this assumption is directly testable and the sign of the coefficients, if different than zero, say something about the placement process; positive effects would imply banks were actually in places with worse outcomes than average and negative affects would imply the opposite. The first of these cases in turn implies that any measurable effect post-PCAs is understated while the second implies it is overstated.

Aside from parallel trends, one worry might be that there is unobserved heterogeneity that affecting distance and the outcome in the post-period. One example is a county's propensity to take-up loans, which likely affects agriculture outcomes as well as distance. This is not a problem as long as the propensity to take up a loan is time-invariant in the period 1920-1940, as then it is a component of μ_i. If the effect is not time invariant, but happens as a state level policy, this is controlled for using a state-year trend.

Finally, even if a negative effect is clearly identified in the model, it may falsely be attributed to the PCA if there is a concurrent program out of the same location that has a similar effect; this is a relevant concern since the period of interest had a number of government programs running parallel to the roll out of the PCA's, including Agricultural Adjustment Act (AAA) payments, emergency seed loans, and public works projects (Fishback et al., 2005). In the case of AAA payments, this would bias the affect downward when looking at corn and wheat yields since the program paid farmers to take these crops out of production, but seed loans would have the same effect as the PCAs. Given the close involvement of county extension agents, it may also be that borrowers received technical advice in addition to a production loan; in this case, there is no way to disentangle the mechanisms by which PCAs are increasing yields. There are two reasons this is plausibly not a concern. First, because New Deal spending had to be distributed at the county level, distance to the county seat, the likely location of distribution, would transmit the effect of the spending and not closest distance to a PCA. Second, PCA's were intentional early on about

making membership and operations independent of any other government programs; according to (Arnold, 1958), this was a policy that aimed to stress the independence of the Farm Credit System from its government funders and to give a sense of legitimacy to the system. Regardless, we control for the level of New Deal spending directly in our analysis.

Results

Each difference-in-difference model is run on two samples, the full sample of lower 48 states and a restricted sample; the restricted sample omits four states, Wyoming, Utah, Nevada, and Arizona, because there is one PCA per state, so the distances to counties is unusually large; since there would be low agricultural activity in the areas with these large distances, this would bias the effect of distance upward and confound the analysis. The South is also omitted in the restricted sample for a robustness check, since the system of agriculture in that region is quite different from the rest of the country due to systemic issues of tenancy (Fishback et al., 2003).

Two models are presented here: the first assumes a constant elasticity effect between bank distance and agricultural outcomes and uses a log-log regression, a "marginal cost" interpretation, and the second allows distance to affect outcomes discretely by using dummy variables for the quartiles, a "fixed cost" interpretation. Table presents the coefficients on the year-distance interactions for the log-log model. Figure 4 and Figure 5 present the coefficients on the discrete categories of distance for each year, including one "placebo" period, 1925, and the two "after" periods, 1935 and 1940. The bands on each coefficient are 95% confidence intervals.

In the log-log model, there are small but statistically significant effects in the prior period for corn and wheat, though in a positive direction; this implies that bank placement was targeted in areas that were *worse* than areas farther away. From 1935 on, the sign flips to negative, so the areas close to PCA's became *better* than areas farther away. The effects are very small for corn and crop value, however, and is practically non-existent for wheat. Tractors and fertilizer spending shows a similar trend.

Results for the restricted sample are reported in Table . Here, most of the coefficients get stronger in both the pre and post periods. Wheat and equipment spending per acre continue to exhibit no change. The difference in elasticities in these two different samples shows the effects are heterogeneous across regions; keeping the South in the sample appears to bias all of the effects downward, and removing them reveals a slightly higher effect on corn yields and fertilizer. However, the prior trend also gets much stronger, suggesting that the selection problems are even bigger outside of the South and the West.

In general, there appears to be evidence that the placement of banks increased corn yields, crop values, fertilizer spending, and the number of tractors. The fact that there is a positive trend in the prior period suggests that there is actually a downward bias on the effects of the banks, and so the effect may be understated; regardless, the hypothesis of no effect is rejected at the 95% level for corn yield, crop value, fertilizer, and number of tractors. While statistically significant, the elasticities are quite small; when the effect is assumed to be constant across all levels of distance, it implies that a 100% increase in distance causes, at most, a 3% change in any outcome. This is much lower than the elasticities found with experiment stations and crop productivity, for example (around -.24 compared to -.03 in this study) (Kantor and Whalley, 2014).

For the discrete model, in conjunction to seeing an effect, we can also see how the effect changes as a function of distance. Figures shows crop outcomes while Figure shows input outcomes, and all effects are relative to the base category, being 0-30 km away from a bank. As in the log-log regression, corn yields, crop values, fertilizer spending, and tractors increase in proximity to

Table 1: Estimation Results on Full Sample

	Crop Yield		
	IHS(Corn Yield)	IHS(Wheat Yield)	IHS(Crop Value/Acre)
1920 × IHS(Distance to PCA)	0.0151*	0.0319***	0.00317
	(0.00876)	(0.00978)	(0.00903)
1925 × IHS(Distance to PCA)	-0.00271	0.0191**	-0.00700
	(0.0120)	(0.00893)	(0.0104)
1935 × IHS(Distance to PCA)	-0.0155	-0.00874	
	(0.0128)	(0.0147)	
1940 × IHS(Distance to PCA)	-0.0136	0.00253	-0.0326**
	(0.0142)	(0.0117)	(0.0135)
Observations	13840	13217	11256
R^2	0.712	0.571	0.802
	Inputs		
	IHS(# Tractors/Farm)	IHS($ Equip/Acre)	IHS($ Fert/Acre)
1920 × IHS(Distance to PCA)			-0.00195
			(0.00855)
1925 × IHS(Distance to PCA)	0.00214*		-0.00458
	(0.00126)		(0.00585)
1940 × IHS(Distance to PCA)	-0.00723***	-0.00871	-0.0157**
	(0.00172)	(0.00867)	(0.00733)
Observations	8442	5628	11124
R^2	0.839	0.440	0.378

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Clustered standard errors in parentheses.

All New Deal spending variables are the sum of the years 1933-1939. All value measurements in 1982 dollars. Controls: Average farm size, percentage of county in farms, average farm value, annual average temperature (mean and std of county cells), annual average precipitation (mean and std of county cells), GAEZ corn soil potential (average of cell), GAEZ wheat soil potential, longitude value, latitude value, state by year trend, erosion levels, total public works spending, total grants, total relief spending, total loans.

Table 2: Estimation Results on Restricted Sample

	Crop Yield		
	IHS(Corn Yield)	IHS(Wheat Yield)	IHS(Crop Value/Acre)
1920 × IHS(Distance to PCA)	0.0239**	0.0285**	0.0187*
	(0.0116)	(0.0114)	(0.0109)
1925 × IHS(Distance to PCA)	0.0085	0.0151	0.00471
	(0.0132)	(0.0097)	(0.0120)
1935 × IHS(Distance to PCA)	-0.0250	0.00451	
	(0.0172)	(0.0177)	
1940 × IHS(Distance to PCA)	-0.0295*	0.0114	-0.0385**
	(0.0166)	(0.0133)	(0.0168)
Observations	9668	9491	7876
R^2	0.746	0.599	0.812
	Inputs		
	IHS(# Tractors/Farm)	IHS($Equip/Acre)	IHS($ Fert/Acre)
1920 × IHS(Distance to PCA)			0.00308
			(0.0091)
1925 × IHS(Distance to PCA)	0.0053***		0.00197
	(0.0017)		(0.0060)
1940 × IHS(Distance to PCA)	-0.0110***	-0.00542	-0.0279***
	(0.0024)	(0.0095)	(0.00805)
Observations	5907	3938	7752
R^2	0.856	0.495	0.348

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Clustered standard errors in parentheses.

All New Deal spending variables are the sum of the years 1933-1939. All value measurements in 1982 dollars. Controls: Average farm size, percentage of county in farms, average farm value, annual average temperature (mean and std of county cells), annual average precipitation (mean and std of county cells), GAEZ corn soil potential (average of cell), GAEZ wheat soil potential, longitude value, latitude value, state by year trend, erosion levels, total public works spending, total grants, total relief spending, total loans.

the bank and the relationship appears to be convex; this confirms that the effect of distance on agricultural outcomes is indeed non-linear, and the effect decreases with distance (or increases in proximity). Only the 1925 trend is shown on the graph, but the 1920 trend in all cases was either indistinguishable from zero or positive.

Corn and wheat yields do not appear to be affected by distance to the PCA; while somewhat negative in 1940 compared to 1935, they are most of the time indistinguishable from zero over all levels of distance. Corn yields appear to decrease with distance in 1940, but the effect goes back to zero at the largest distance. Crop value per acre shows the greatest effect, as counties that are more than 100 km away from a PCA have around 20% lower crop revenue per acre. Interpreted differently, moving a bank about 70 km closer to a county would increase crop revenue per acre by about 20%. The relationship is once again convex, as the biggest changes in crop revenue come from moving the first 60 km away while the effect of going 60k km to 100 km is smaller. The 1925 trend is positive, indicating that the effect of that particular location was reversed from 1935 on; this again implies the 20% increase in crop revenue is a lower bound on the effect.

When looking at use of inputs, the trend for fertilizer and tractor use is similar to crop revenue: a more or less decreasing, convex relationship to distance in 1940 and a positive trend in 1925. The

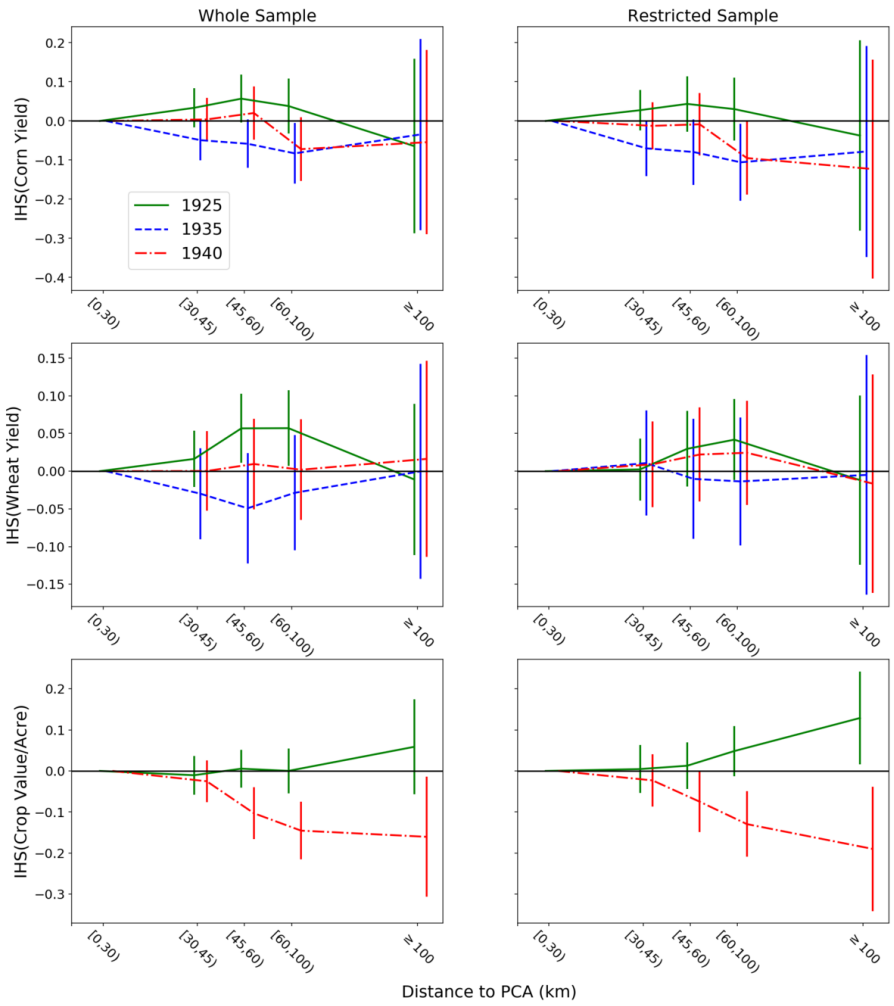

Figure 2: Crop Yield Outcomes

effect of moving 70 km closer to a PCA is about a 10-15% increase in fertilizer use per acre and a 4-6% in tractor per acre. The coefficient on tractor per farm is very small in logs, but the same specification in levels shows something quite large; tractors per farm in the base category, that is within 30 km of a PCA, is about .22, and the effect of moving out 70 km is a reduction of tractor ownership by .05, or about 25%.

Areas close to PCA's, despite having comparatively lower crop revenue and input use in 1925, had reversed the trend in 1940; counties close to banks had about 10-20% higher crop value per acre as well as 5-10% higher fertilizer use per acre and about 5% more tractors per farm. This increase in input use and in crop revenue per acre may be either because PCA's directly lent to farmers that previously could not access credit or because the presence of the PCA's brought down interest rates for all commercial agriculture loans. The effects of the PCA banks on outputs and inputs is somewhat small considering other studies such as Kantor and Whalley (2014), but is comparatively large considering the small scale at which the PCA's operated. By 1940, the year with the largest effects, only 7% of farm borrowers were borrowing from PCA's, and the loan volume of the entire system was 13% of that of commercial banks. For such a small amount of lending actually done, the results are quite impressive, especially since all of the initial money paid to these corporations

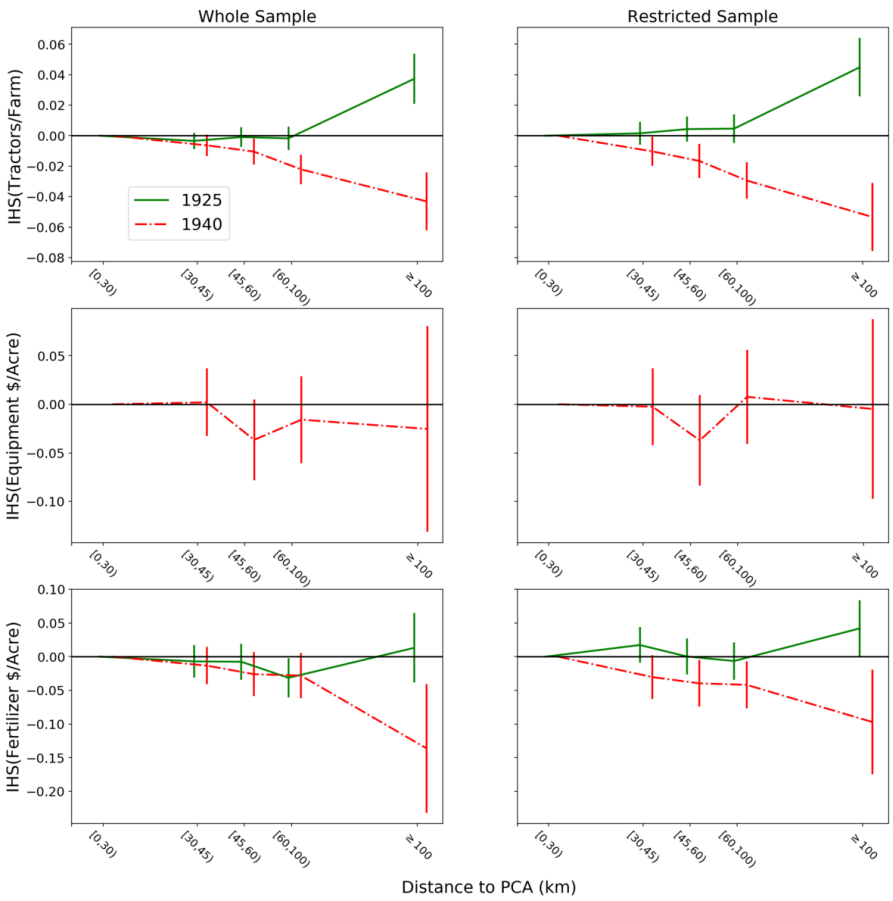

Figure 3: Input Spending Outcomes

was paid back to the US government.

Conclusion

The Farm Credit System has often been heralded as the backbone to US agricultural credit and a catalyst for the development of US agriculture. The Production Credit System is a particular part of the system that is said to have pioneered credit innovations and expanded credit access in an area of lending relatively unserved by the commercial banking sector and dominated by merchant lenders. Various studies done in the period 1920-1940 suggest that PCA's expanded cheaper credit in areas previously dominated by merchant credit, but there is no evidence that their lending had any real effects on the development of the agriculture sector at this pivotal time. We present the first empirical evidence that these institutions increased both crop revenue per acre and spending on tractors and fertilizer. This research presents the first evidence that the placement of the banks did impact these outcomes and increased crop yields and some input spending in the counties closest to their placement. The PCA's were located in areas that were worse than the areas around them, but after their placement these areas were *more* productive than their immediate areas. Given the small reach of the program, only around 7% of farmers nationally, the effects of the program found here are quite large. Moreover, the prior trend in these areas implies our effects are underestimates

of the true effects.

In agriculture credit markets, asymmetric information is frequently an issue, as evidenced by the proliferation of informal lending in these sectors. As this informal lending is more of a service provided by the merchants than a business itself, it might be argued there is no proper market for production loans in this context. This is as much true today as it was in the early 20th century United States. When asymmetric information persists, the literature tells us that direct financing and lending by the government is a band-aid at best. The Production Credit System was a different approach altogether, that merits further research in both what it means for the development of US agriculture and how cooperatives can be instantiated by the government in areas with no market.

Empirically there are more in-roads to be made in building on the results of this paper. Our results are aggregate effects that cannot parse the mechanisms by which PCA's affected the agriculture sector. Specifically, with data on individual PCA lending, we could find out what role the actual credit played in increasing productivity and what role the "pro-competitive" effects of the institution played in expanding lending in other institutions as well. Given that the cooperatives had to be formed by farmers after being instantiated by the government, it would also be fruitful to understand their evolution during this period, as many of them had to close early on when there was inadequate business. Such bank records, being public documents, can be collected from the National Archives and analyzed. This would be fruitful both as a historical case study and as a study on how agricultural credit cooperatives form and do business.

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