Production Credit Associations and Agricultural Productivity Change, 1920-1940

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Abstract

We study the impact of Production Credit Associations (PCAs) during the decade-long period shortly after their introduction as one component of the 1916 Federal Farm Loan Act. Using county distances to PCAs as a proxy for cost of access to credit, we examine the effects of credit expansion on county-level crop yield, crop revenue, and input use. Despite serving only about 7% of U.S. farmers during the period we study, we estimate that counties 100 kilometers closer to a PCA had roughly 10% higher crop revenue per acre. We also find that counties closer to PCA locations experienced significantly higher growth rates in tractor and fertilizer utilization relative to more distant counties. In years prior to the arrival of PCAs, farms in relatively close-by counties earn on average less revenue and use fewer purchased inputs than farms in counties further away. This relationship *reverses* in subsequent years, suggesting that the mechanism for identifying PCA locations targeted less well-off counties. Our estimates therefore represent lower bounds for the true causal effect of access to credit on farm revenue and input use during the period we study.

1 Introduction

A unique challenge of agriculture has always been expanding access to credit for farmers. Due to information asymmetry and the riskiness of agriculture, farmers often find that their ability to access the funds needed for successful commercial operation depend on their assets or group affiliation rather than on the interest rate they are willing to pay (Stiglitz and Weiss, 1981; Carter, 1988; Hoff and Stiglitz, 1990). This was as much a challenge a century ago in the US as it is in today's developing economies. Much like today, farmers in the early 20th century U.S. also found it difficult to access credit markets; in particular, short-term, production credit was only available through merchant lenders at interest rates often exceeding 20% (compared to less than 10% for typical commercial bank loans). High activity of merchant credit in markets with asymmetric information is indicative of "credit rationing," which is under-provision of credit to borrowers that would be willing to pay a higher interest rate. This kind of credit rationing can be detrimental to rural welfare and economic growth, but attempts to reduce credit rationing are often ineffective (Bencivenga and Smith, 1993, 1991). Common policy approaches to this problem are either for governments to lend directly to farmers or to subsidize lending to commercial banks. Both of these options are often expensive, unsustainable and do not directly address the informational and contracting frictions that are the root of credit market frictions (Binswanger and Khandker, 1995; Khandker and Faruqee, 2003; Ahrendsen et al., 2005).

In this paper, we study the impact of a third policy option: government sponsored cooperative banks. In particular, we examine the effect of the Production Credit Associations (PCA), a system of cooperative, agricultural credit banks established in the early days of the Farm Credit System (FCS), on the agricultural economy. The PCAs were a subdivision of the FCS established in 1933 to provide short term production loans to farmers at a rate far below that of merchant lenders: 6-7% versus 15-20%. We present the first empirical evidence that the influx of credit accomplished by the placement of cooperative credit banks impacted county-level crop yield and input use. Using distances to PCAs as a proxy for credit access, we use a difference-in-difference approach to examine the effect of this credit expansion on county-level crop yield, crop revenue, and fertilizer and tractor use. We use a variety of historical data sources to control for other contemporaneous policies, specifically data on the spending of other New Deal programs, and take advantage of the county level panel data set available from the agriculture census in the years 1920 to 1940. We find that areas closer to PCAs were less productive than areas farther away before program implementation, but then became *more* productive in years after. This prior trends suggest that PCAs were placed in areas that were *less* productive than their counterparts, which implies that the effects we measure are lower bounds of the true effects. Counties 100 kilometers closer to a PCA had 10% higher crop revenue per acre, and 5% higher tractors per farm and fertilizer per acre. The size of the effect is substantial given that PCAs served only 7% of farmers nationally during this period.

In the debate between government control and private sector control, the FCS approach to addressing under-provision of credit in agriculture merits analysis as a development strategy. Es-

tablishing a system of independent, cooperative banks with a specific mission to address under-provision of credit in agriculture is a third, less studied policy option that has a long history in the U.S. In 1916, the U.S. Congress passed the Federal Farm Loan Act, which created the FCS, taking heavy inspiration from the German Landschaft system (Turvey, 2017). 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. Each GSE is 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 also expected to operate in an economically sustainable manner, and to treat initial federal seed capital as debt to be repaid. This system struck a balance between providing enough backing to secure funds for the FCS in its early days while providing sufficient incentives for the FCS to be independent of the government's budget. In particular, the FCS avoided the fate of government owned development banks that inevitably took on large amounts of bad credit and ultimately ended up unsustainable (Binswanger and Khandker, 1995; Khandker and Faruqee, 2003), or of government direct lending programs that suffered similar losses and ended up a drain on government resources (Gale, 1991; Ahrendsen et al., 2005). By striking this balance, the FCS was able to operate in a sector unserved by the private sector while avoiding the typical pitfalls of most federal policies to address agricultural credit.

The FCS and the PCAs merit study as a success story in agriculture finance not only because they were cost effective, but also because they seemingly posses an advantage being organized as cooperatives. Cooperatives are uniquely qualified to address information asymmetry in agricultural lending because they can lower monitoring costs and screen more effectively than investor owned banks. Knowing little about agriculture, banks face high costs of monitoring agricultural projects; the inherent riskiness of agriculture further disincentivizes banks to lend to agriculture (Carter, 1988). Cooperative banks, in contract, can internalize the costs of monitoring their borrowers to take up a greater range of projects, thus being able to operate where investor owned firms cannot (Hueth and Marcoul, 2015). This is one potential reason that PCAs could lend at lower interest rates to farmers than the commercial sector or merchant lenders could. PCAs also offered production loans that were well suited to the needs of agriculture in terms of timing of repayment.

Another advantage cooperatives have in agricultural lending is better screening. Agriculture has large information frictions in lending because returns to projects are both risky and heterogeneous, being subject to weather shocks and a function of local, agro-climatic conditions. As a result, often commercial banks depend on other signals to determine project quality; empirical tests of credit rationing in agriculture often find that assets and group affiliation are key determinants of whether farmers receive loans from commercial banks (Petrick, 2004; Turvey and Alfons, 1997; Rahji and Fakayode, 2009). Commercial banks rely heavily on such signals to determine project quality, and as a result do not lend to many farmers that may desire funds at that interest rate. Cooperative institutions instead both internalize information about their borrowers (Besley and Coate, 1995; Karlan, 2007), or else attract low risk borrowers that are typically rationed out of markets when

there is adverse selection (Smith and Stutzer, 1990). Since the PCAs were farmer owned, it is likely that they possessed an advantage in screening that allowed them to lend where commercial banks would not.

Given these benefits, the FCS has potentially been very important for the development of the agricultural economy. The PCAs in particular significantly expanded production credit at a time when such credit could not be obtained cheaply. Accounts such as Hoag (1976), however, only laude the system for its social significance: connecting farmers to financial markets from which they had traditionally been excluded. In order to assess the importance of the FCS model as a tool of market development, we must also know the economic impacts of the system. The evidence of the impacts of the FCS on economic development are mixed, however. The current literature on the impacts of the FCS have documented significant and positive relationships between FCS lending and farm income and output at the national level (Hartarska et al., 2015) and at the regional and state level (Denis et al., 2017). However, some papers such as Belongia and Gilbert (1990) find no significant effect of total PCA funds on farm output at the country level, concluding that there is not "an important role for subsidized credit in facilitating agricultural production." Other papers have documented negative effects of the FCS on the economy, including that the government backing gives the FCS a subsidy that distorts the market (Jensen, 2000) or that the existence of the FCS crowds out other lending (O'Hara, 1983).

The issues with these studies is that they all take place in a time period where the FCS is well established, making it difficult to analyze the current effects of the FCS relative to a counterfactual where the FCS does not exist. Our research fills a critical gap in the study of cooperative banks in agriculture by analyzing the effect of an expansion of production credit by the FCS at a time when production credit was both scarce and expensive. We return to the original founding of the PCAs in 1933 and investigate the effect of their introduction on county-level crop yields and input use to determine their effect on the agricultural economy. Our work joins other efforts in historical economics to measure the impact of institutions and policies using county level panel data, including analysis of the impact of New Deal spending programs (Fishback et al., 2003, 2005), railroads (Donaldson and Hornbeck, 2016), and land grant institutions (Kantor and Whalley, 2019). Using a map of PCA locations in 1937, we utilize heterogeneity in distance from PCAs as a proxy for loan take up in 1935 and 1940. Since counties only borrow from the PCA in charge of their coverage area, we use this distance as identifying variation of the effect of PCA lending on crop yields and input use before and after their placement in 1933.

Before their placement, we find that counties closer to PCAs had lower crop yields and input use than their farther counterparts. This is consistent with the idea that the FCS targeted less-productive counties when placing PCAs. It also implies that the effects we find are lower bounds on the true effect of the program. Our analysis finds that after their placement this trend is reversed; after 1935, within 30 kilometers of a PCA had 10% *higher* crop revenue per acre, 5% higher tractors per acre, and 5% higher fertilizer use per acre than counties more than 100 kilometers away. The effects we find are substantial given that only about 7% of farm borrowers were served by PCAs at

the time. Our work makes an important contribution to the literature on agricultural credit and cooperatives by demonstrating a positive impact of the FCS at the time of its introduction. These effects demonstrate that the GSE model is a critical tool of rural development, and has potentially been very influential to the development of the rural U.S. economy.

The paper proceeds as follows. We first review the historical context of the PCAs, including the state of agricultural lending before and after their creation in 1933. We then talk about the potential effects of an expansion of agricultural credit on our measured outcomes. The next section discusses our data sources and our difference-in-difference strategy for measuring the effect of PCAs on crop yields and input use. After presenting our results, we conclude with some directions for future work in analyzing the historical role of the FCS in the U.S. agricultural economy.

2 Historical Setting

Before the PCAs were established, farmers used short term credit extensively but relied heavily on informal sources of credit. Short-term credit in general was not provided by commercial banks. After the crash in farm prices in 1920, nearly one-fifth of rural banks in eight key agricultural states had failed by 1925, particularly in the West; insufficient capital, speculating behavior, and a general lack of profitability in rural areas were all cited as potential reasons (Federal Council of the Churches of Christ in America, 1927). The profit opportunities in the city may have been the reason that several such banks migrated to urban areas, which worried policy makers that this movement would take away the "personal contact between the farmer and his banker," resulting in "neglect of agriculture on the part of the urban managers of the banks" (Federal Council of the Churches of Christ in America, 1927, pg.49). Whatever the reason, lawmakers worried that banks were falling away because they were ill suited to the needs of agriculture, a sentiment best articulated in the 1914 report to Congress on agricultural credit:

> One of the first very definite and fundamental observations which must be accepted as a result of an examination into the characteristics of financial institutions in this country which serve farmers, so far as credit is concerned, is that *they were not constructed to serve the special needs of the farmers.* Because the financial institutions have not been constructed to serve the special needs of the farmers, *other institutions, such as stores of all kinds, and persons who are the purchasers of and dealers in farm products, have often been forced to furnish the financial aid necessary.* (Fletcher, 1914, pg. 10, emphasis added.)

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 1926-1927 estimated the interest rate to be around 15% per year, with some 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. In a separate 1926 study done in North Carolina, 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 such an arrangement was so costly for both farmers and merchants, why did such financing persist as the main source of short-term credit? Aside from the general flight of banks to urban areas, reports at the time mentioned two reasons. First, farmers found the terms of commercial bank loans did not fit their credit needs. Commercial banks usually offered loans with durations of 30 or 60 days, which were too short for a crop season; a typical farmer instead would need a loan that can be taken out at planting and then paid back at harvest. Commercial banks typically did not offer these terms because such loans were against banking regulations, being viewed as unsuitable for the bank's portfolio. A study of commercial banks in rural North Carolina claimed that banks either "could not or would not" grant such loans:

> 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 (Lange and Forester, 1944, pg. 82).

"Below standard" loans may refer to either loans that are too risky or loans that lack collateral, the second reason commercial banks did not give production loans. In a study of Texas agricultural credit, Haney (1914) found that farmers did not have enough traditional collateral that banks liked to accept; many tenant farmers did not possess the property rights to use their own land as collateral, meaning farmers has to rely on these other forms of collateral such as assets or shares of their crops which the banks would not accept.

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). These banks, not knowing how to screen applicants, applied credit caps to borrowers based on collateral that "rationed" credit from certain groups, usually small farmers. Commercial banks instead funneled credit to farmers indirectly by lending to merchants who extended credit at high interest rates to compensate for the risk. Merchant lenders likely took up this intermediary role because they could screen applicants easier or more effectively enforce repayment.

If these merchant lenders thrived in short-term credit because of this advantage, a solution would be to establish a similar sort of institution with the same advantages in screening and monitoring. Credit cooperatives owned by farmer-borrowers were exactly this sort of solution, and was already a widely implemented policy tool for increasing credit access in agricultural markets. The first

instance of farmers organizing into a cooperative to lend to one another dates as far back as 1058 in the Northern Song Dynasty of China; in fact, Germany, Italy, and France had all by the end of the 19th century implemented some form of government sponsored, farm credit cooperative system (Turvey, 2017). The suggestion of Haney (1914) was to follow in the footsteps of these countries by implementing a similar credit cooperative for U.S. agriculture. Two years later, the U.S. would take its first steps in this direction by establishing the very first GSE: the Farm Credit System.

After an extensive study of cooperative agricultural credit institutions in Europe, The Farm Credit System was established in 1916 with the passage of the Federal Farm Loan act, which created Federal Land Banks to provide farm mortgages. Taking inspiration from the German Landschaft system, the system was made up of 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.[1] As evidenced in the original report to policymakers, however, production credit was still on policy maker's minds and could not be addressed with the Land Banks.

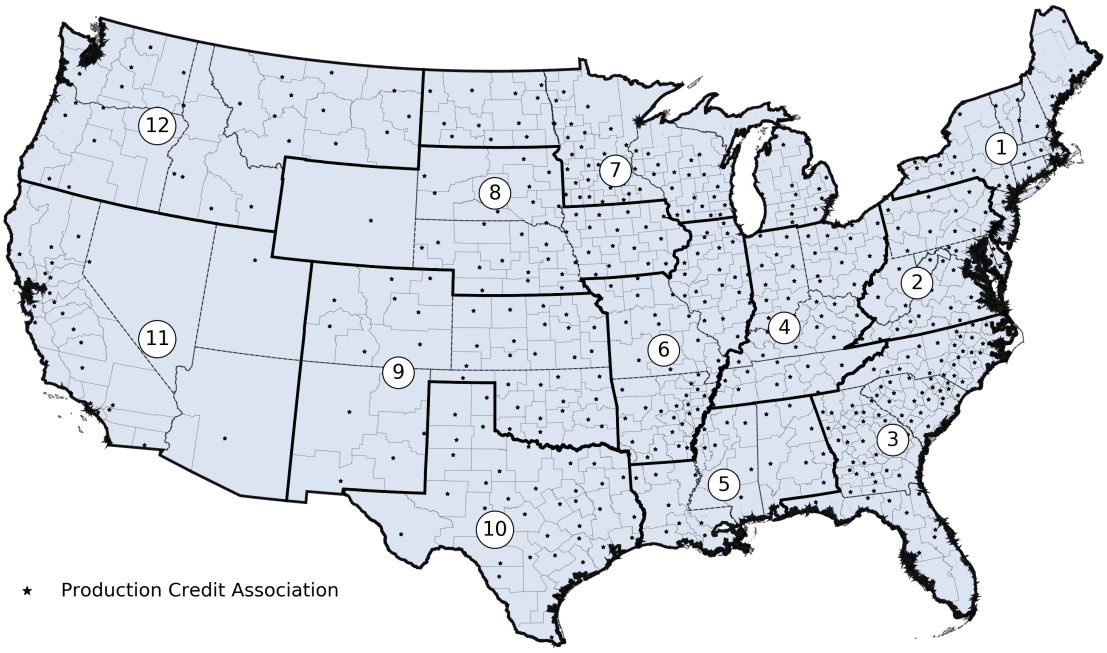
The first attempt to improve access to short-term credit was the creation of the Federal Intermediate Credit Banks (FICB) in 1923, which did not directly loan to farmers but instead discounted production loans of commercial banks and cooperatives. Commercial banks, however, in general did not use these banks; one reason was that FICBs would not discount paper where the original borrower had been charged more than 1.5 percent above the FICB rate (Butz, 1944). To commercial banks, the Federal Reserve system was a more attractive place to discount loans, and so the FICBs went unused. After the 1929 crash, bank failures in several areas made it more clear that continuing to try and funnel funds through commercial banks was not going to meaningfully expand credit in agriculture; the problem continued to be a lack of actual institutions willing to lend directly to farmers (Biard, 1933).

The first strategy to increase lending was direct financing through emergency seed loans, but lawmakers wanted a more long-term solution (Arnold, 1958). Pressure to establish a more permanent source of production credit was mounting as both commercial banks and merchant lenders began to reduce lending. This pressure led to the passage of the Farm Credit Act in 1933, which established the Production Credit Associations (Hoag, 1976).

All PCAs were placed in one of twelve districts. For each district, there was a Production Credit Corporation (PCC) through which money was granted to establish individual PCAs. Upon their introduction, individual PCAs were given "coverage area" in which they were allowed to do business; these coverage areas were always more than one county, and for some parts of the country were even the entire state. The location of the PCA was usually a county seat, and the association of farmers was organized by a combination of officials from the PCC and county extension agents. The coverage areas were determined by covering enough counties to provide sufficient business for

[1]The bonds were also "implicitly backed" by the government, since it was assumed that if the FCS failed than the government would rescue it from insolvency. The implicit guarantee of FCS bonds would continue to be a point of contention from the commercial sector for the next century.

Figure 1: PCA Coverage Area with PCA District Boundaries in 1937



Note: darker lines are district boundaries, lighter lines are coverage area boundaries, stars are PCAs.

the PCA while locating close to farmers.[2] The coverage area of the banks in 1937 along with the borders of the PCA districts are shown in Figure 1.

Like the Land Banks, 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 (which they eventually did). They also operated with an interest rate cap of 6% across all PCAs, regardless of location. The main distinguishing factors between PCAs and FICBs were that PCAs made direct loans to farmers and were owned by farmer borrowers, as opposed to the FICBs which only made loans to other banks or cooperatives. Arnold (1958) details the birth of the institutions, which initially had a rocky start because the member owners did not have the training to run a bank and enlisted the help of Land Bank and extension staff. They also made use of the FICBs as an initial source of discounting loans, which was vital since the associations were expected to immediately begin meeting the extensive credit needs after the 1929 crisis.

The PCAs' market reach initially was modest. By 1934, there were nearly 600 associations across the country which together lent about 130,000 loans totalling about 107 million dollars, meaning on average loans were less than one hundred dollars. Even when their reach began to grow, the PCAs still held only a modest position among agricultural lending. As late as 1946, only 7% of the 6 million farmers belonged to PCAs and PCA lending was only 14% of loan volume by

[2]the implications of this for analysis is discussed in the Methodology section. For more details about organization of PCAs, see Arnold (1958), pg. 27-30

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 commercial banks. In a study of production credit in Florida among citrus and vegetable growers in 1937, PCAs provided 20% of production loans while commercial banks provided 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 the North Carolina study of farm credit, commercial banks even had a favorable view of PCAs, claiming they served customers the banks were unable to serve (Lange and Forester, 1944).

According to some studies, merchant credit began to decline in some states in this period; specifically, studies in South Carolina and Arkansas showed decreases in merchant credit around 20 to 30 percentage points from 1926 to 1938 (Sparlin, 1940; Moore and Brannen, 1929; Ferrier, 1940; Wickens and Jensen, 1931). According to one South Carolina merchant, the decrease in their business was directly attributable to the actions of PCAs:

> 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. (Ferrier, 1940, pg. 35)

Even if at the national level their reach was small, lending by the PCAs appears to have been meaningful to farmers. Specifically, the PCAs were owned by farmers, giving them a natural advantage in monitoring and screening farmer lenders consistent with the advantages typically attributed to cooperative enterprises (Hueth and Marcoul, 2015; Smith and Stutzer, 1990). PCAs also invested in field agents who could travel to farms to advise farmers directly, a unique service at the time. Arnold (1958) mentions not only that the PCAs possessed this advantage in alleviating asymmetric information, but also introduced new types of loans such as "budgeted loans," a system that helped farmers pay in installments.

PCAs clearly had potential to improve agricultural productivity, but how important were they to improving agriculture at the time of their introduction? In the next section, we discuss the factors that would strengthen or lessen the impact of the PCAs on agricultural yields.

3 Conceptual Framework

What is the effect of credit rationing on economic outcomes? In the Bencivenga and Smith (1993) model, in equilibrium it is the low risk borrowers that are offered less credit by lenders in order to prevent attracting high risk borrowers. Since low risk projects are rationed out of the market, credit rationing decreases both output and capital as a result. In the case of agriculture, information

issues cause rationing to small farmers or tenant farmers if their projects are viewed as riskier than those of large farms (Carter, 1988). Small farms then must rely on "signaling" by either owning capital or belonging to a producer association in order to get a loan (Hoff and Stiglitz, 1990). As a result, farmers in such markets would end up credit constrained, which the literature has shown can lead to lower than optimal use of inputs into production and consequently lower yields (Carter, 1989; Foltz, 2004). In the case of the early 20th century U.S., the introduction of PCAs would have impacted these outcomes positively through three mechanisms: increased input use, knowledge transfer, and pro-competitive effects on interest rates.

Upon the introduction of PCAs, farmers likely used their production credit to increase input use. This is particularly relevant to PCAs, because they specialized in production credit that was short-term and was typically used for operating expenses. As access to production credit could help households achieve the optimal input use, this would consequently have an effect on crop yield through its effect on inputs. In our empirical analysis, we analyze use of fertilizer as one example of an input that may increase because of access to production credit. We also include number of tractors as an outcome, as increased liquidity in the household via production credit may also free up funds for farmers to invest in even larger inputs into production.

Unlike other loan programs, the cooperative structure of PCAs and their government sponsorship implies that their introduction can increase crop yields through another mechanism: knowledge transfer. Extension agents and other FCS staff were reportedly involved with the operations of PCAs, so it is likely that access to technical expertise was another benefit of borrowing from a PCA. Since the cooperatives were made up of farmer-borrowers, PCA members may have also shared information. Introducing a PCA could raise crop yields if their cooperative structure facilitated this sort of information sharing among farmers.

Finally, according to (Murray, 1941), the PCAs might have also had pro-competitive effects on interest rates. 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.

All three of these mechanisms suggest the same direction for an effect: the existence of a PCA should have increased crop yields and use of inputs. The first mechanism can be teased empirically from data by looking specifically at fertilizer and tractor use as two examples of inputs. We can also include crop yields as independent outcomes to be studied in order to see if there other effects of PCAs unrelated to input use (which can be either knowledge transfer or pro-competitive effects).

Unfortunately, identifying these effects from data is complicated by the fact that bank locations may not be exogenous to county-level trends in agricultural productivity or economic activity. In the next section, we present the data and our identification strategy, as well as a discussion of how the placement of PCAs effects our estimation strategy.

4 Data

To test the above hypotheses, we use the U.S. agricultural census from 1920-1940 accessed from Haines et al. (2016). We chose this period in order 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). In contrast to studies such as Kantor and Whalley (2019), we do not expect production credit access to have very long term effects. The census contains county level data on crops planted, crops harvested, farm assets, land values, and demographic characteristics such as population density. To control for environmental characteristics, we use soil productivity measurements for rain fed agriculture for corn and wheat (FAO GAEZ, 2016). Because our study period coincides with the Dust Bowl, a major shock to the agricultural sector, we use erosion map data from Hornbeck (2012) to control for areas that would have been disproportionately affected by dust storms in 1935. Temperature and precipitation data for this time period comes from PRISM Climate Group (2004). Finally, we use New Deal spending data available from Fishback et al. (2003) to control for related policy activities that might affect input use and agricultural output, especially the Agricultural Adjustment Act (AAA) payments. The county boundaries in 1920 were used for all periods of analysis and are available from Minnesota Population Center (2016).

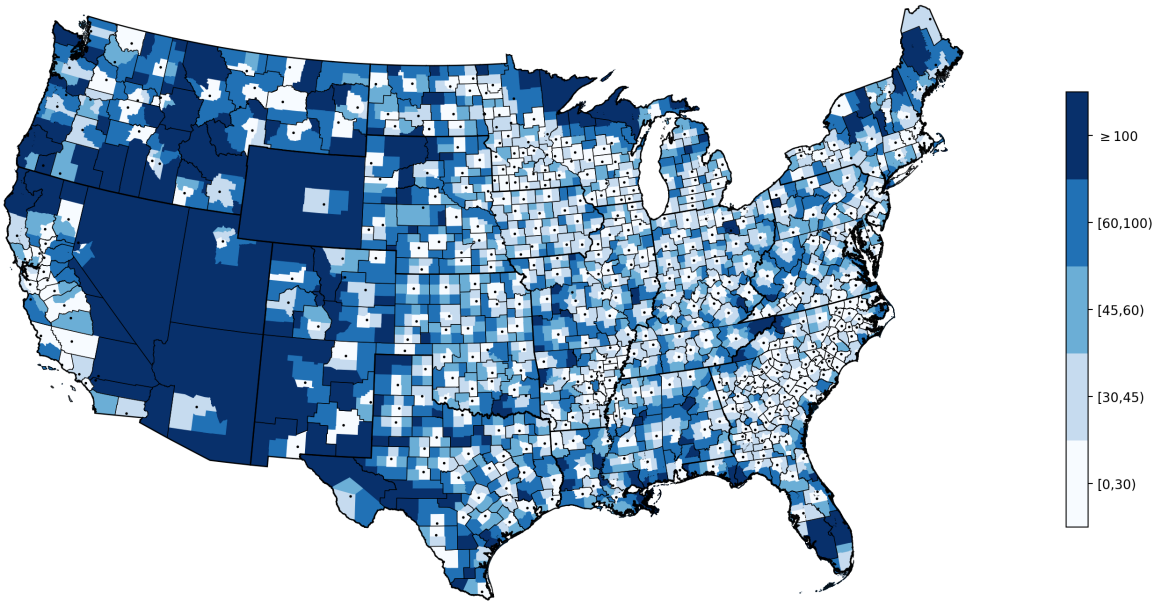
4.1 PCA Locations

Data are not available on individual PCA lending, but PCA locations in the period 1935-1940 are available. Following such studies as Kantor and Whalley (2019) and Altonji et al. (2005), we use the distance from each county centroid to the city where its "serving PCA" was located to proxy access to PCA credit. Note that PCAs were not allowed to lend outside their coverage areas, so we do not use Euclidian distance from the closest PCA but rather distance from the PCA in charge of that coverage area. Distance to a bank has been shown to negatively impact credit access (Agarwal and Hauswald, 2010; Degryse and Ongena, 2005), and would have had an even larger effect on credit access in the early days of PCAs. Given travel costs at the time, county distance from a PCA was an important factor affecting access to PCA lending, to the extent that counties further away from their "coverage area" were typically under-served at first:

> Checks on the location of borrowers after 2 or 3 years of operation almost invariably showed that most of the business was within the home county or at least relatively near the association headquarters. Service in the more distant areas was not satisfactory and a large percentage of the farmers living there had no knowledge about the associations. (Arnold, 1958, pg. 50,)

Over time, this became less and less the case as the PCAs established "field offices" to reach farmers that were more distant from the main office. In our analysis, we take advantage of the fact that in the first five or ten years of operation the probability of getting a loan from a PCA

Figure 2: PCA Bin Distances by County



Note: darker lines are PCA coverage areas, dots are PCAs.
Distances from county centroids to serving PCAs are measured in kilometers.

was strongly affected by whether a farm was in a county close to the PCA office or not. We bin distance into rough quintiles of 30 kilometers, 45 kilometers, 60 kilometers, and 100 kilometers.[3]

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 (see Figure 1). Because only about 3% of banks closed between 1935 and 1940, their location in 1937 largely reflects where they were in 1935 and 1940, though admittedly with some error. The process of chartering PCAs was relatively quick, and began in 1933 and finished in 1934, leaving distance. This pattern of evolution leaves distance to be the only source of heterogeneity in bank access to exploit. Figure 2 shows the distance values across the country. Note that the largest distances are in the western part of the country, where four states – Arizona, Wyoming, Nevada, and Utah – had only one PCA for the entire state. What goals were in mind with bank placement? Arnold (1958) states that placement of production credit associations had two conflicting goals: to make the coverage areas large enough to keep the PCA solvent, while making them small enough to be close to farmers:

> 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. (Arnold 1958 pg. 29, emphasis added)

[3]While not strictly quintiles of the distribution, the bins were chosen to be more economically meaningful. For example, given that a typical car in the 1930's could go roughly 60 kilometers on a highway, these bins represent half hour, forty five minutes, and hour traveling times.

This suggests there is reason to believe bank placement is highly correlated with county outcomes. In order to garner enough business to stay solvent, PCAs may have been located in areas with a high amount of agricultural activity. In estimation, this may bias the effect of PCAs upward, as they may have been placed in areas that were already going to succeed. Conversely, it may also be that PCAs were placed in under-served areas that had higher potential but lower amounts of agricultural activity. This would bias the effect downward.

4.2 County Agricultural Data

Using county-level data, we can look at trends across distances to a PCA. This gives an indication of whether we expect PCAs to have been in under-served areas or areas with already high activity. We test for the impact of distance to a PCA across five outcome measures: corn yield, wheat yield, crop revenue per acre, number of tractors per farm, and fertilizer spending per acre. The first three test whether PCAs had in general had effects on crop yield, whereas the last two test if PCAs changed use of inputs (as could be expected for credit constrained farm households). One caveat to using these outcomes is that two of them, crop value and fertilizer spending, 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. As every census year did not measure the same outcomes, for some years various outcomes are missing. For corn and wheat yield, data is available for all five census years (1920, 1925, 1930, 1935, and 1940). However, for crop value and fertilizer spending no information is available in 1935, and for number of tractors information is not available for 1920 or 1935. All yield measurements are divided by the amount of planted acres in the county, fertilizer is divided by the number of farm acres in the county, and tractors are divided by the number of farms.[4]

Given that we are interested in the trends for counties with differing distances to PCAs, we graph the levels of relevant variables through time across the bins of distance in Figure 3 and Figure 4. In general, three events are important to remember when looking at these trends. First, the crash of farm prices in 1925 (evidenced by the dip in most graphs at this time). Second, the establishment of the PCAs in 1933 (show with a dashed vertical line). Third, the dust storms which happen between 1933 and 1935 (evidenced by another dip in most crop outcomes).

Figure 3 shows that in terms of number and farms and average farm size the trends do not look radically different; because the counties farthest from PCAs are out west, the largest distance bin has the lowest crop revenue and also the largest farm sizes. This bin also has a radically different trend than every other category: the amount of acreage in farms is steadily increasing in the whole period, whereas every other distance category shows similar trends to one another. In terms of fertilizer use and crop value trends, all categories exhibit different trends. Specifically, fertilizer use and crop value is decreasing at a faster rate in areas closest to PCAs.

[4]Dividing number of tractors by farm area would indicate intensity of use, but here we focus instead on whether more farms owned tractors. For the latter, tractors by farm number is a more relevant measure

In terms of per acre measurements, the trends across crop value and fertilizer use are even more pronounced. Specifically, the areas farthest from PCAs experience large increases in fertilizer and crop value per acre relative to areas closest to PCAs. Evidently, these areas were actually expanding in their cropping intensity even as other areas were stagnating or decreasing. Corn yields, wheat yields, and tractor adoption look roughly the same across distances. In none of these trends does it appear that areas closer to PCAs have significantly altered trends post-1933. It does appear, however, that counties closest to PCAs experience large rates of decline between 1925 and 1930 in these indicators. This suggests PCAs may have been placed in these places not to take advantage of the high amount of commercial activity but instead to aid areas that were trending downward in terms of these outcomes.

5 Methodology

From the trends graphs, it is not evident whether PCA distance changed the trends of any of these outcomes. To test their effects, we use use the following specification for out estimation,

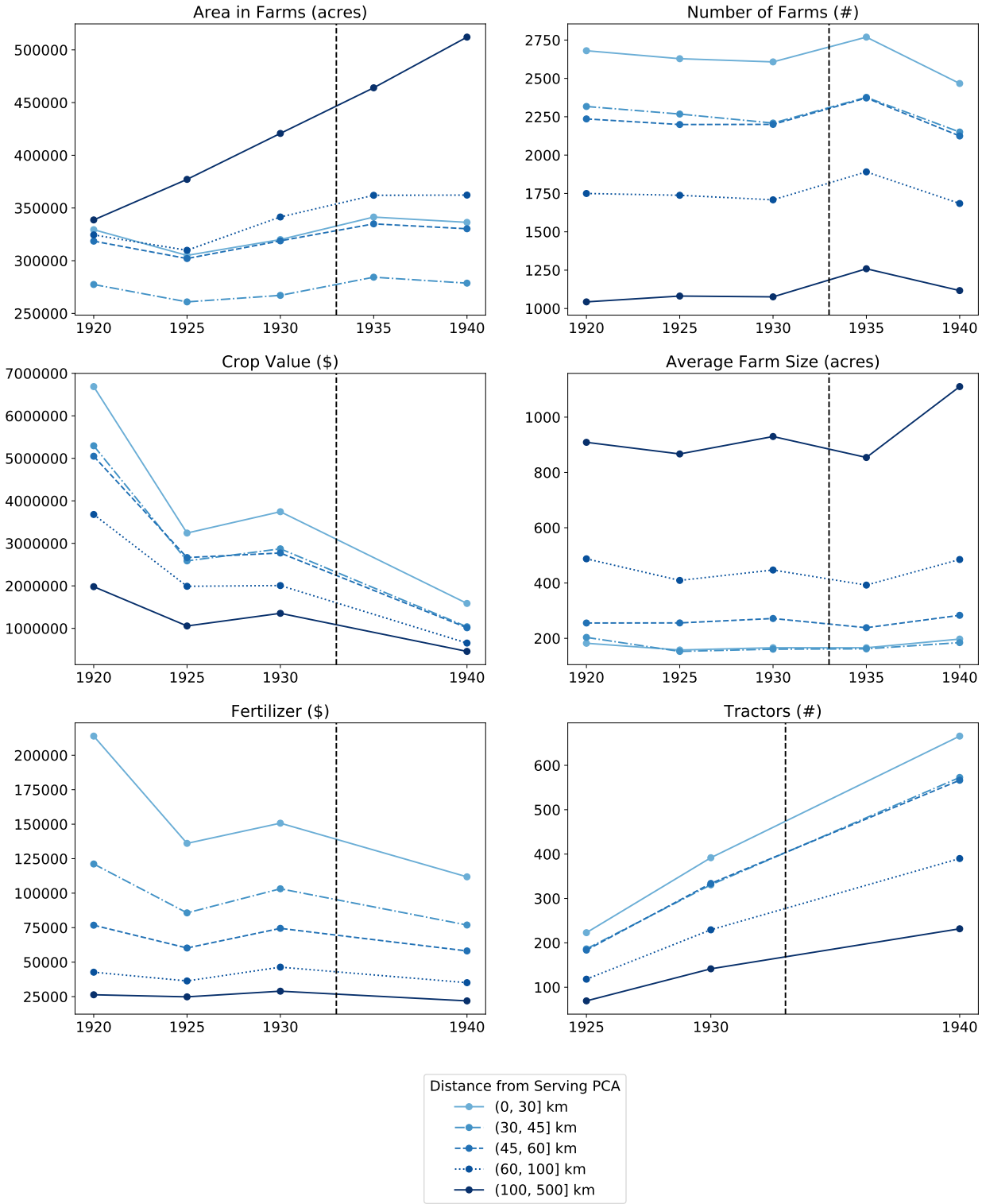
$$IHS(Y_{it}) = \mu_i + \tau_t + \gamma Z_{it} + \sum_{j=1920}^{1940} \beta_j x_i \times \mathbb{1}\{t = j\} + \sum_{j=1920}^{1940} \delta_j E_i \times \mathbb{1}\{t = j\} + \epsilon_{it},$$

where Y_{it} is the outcome for county i in period t, x_{it} is some function of distance to the serving PCA (either log or binned), Z_{it} contains time varying control variables (average farm size, average farm value, temperature, rainfall, ect.), E_i contains time invariant control variables (soil quality, New Deal Spending, erosion levels, ect.) interacted with time to allow for different trends for each of the levels, and τ_t and μ_i are time and county fixed effects. 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). A state by year interaction is also included and standard errors are clustered at the county level.

In order to identify the effect of PCA distance on the outcomes, the assumption of "parallel trends" must hold; conditional on observables, counties close to PCAs must have the same trends in the outcome as counties farther from PCAs (Angrist and Pischke, 2008). Figures 3 and 4 show that unconditioned on observables this is not true. A within transformation via fixed effects adjusts for the different levels we see but not for the differing modes of expansion for the counties. These differing expansion paths are no doubt driven by such factors as soil quality, erosion damage from the 1933-1935 dust storms, and the amount of attention given to each county when apportioning funding and projects as part of the New Deal. The time invariant variables E_i interacted with year are important because they allow all counties to have differing trends in terms of the levels of these variables. Because we observe a prior trend, the significance of distance in 1920 and 1925 gives us an indication of whether the PCA selection process continues to violate parallel trends even after we condition out these trends.

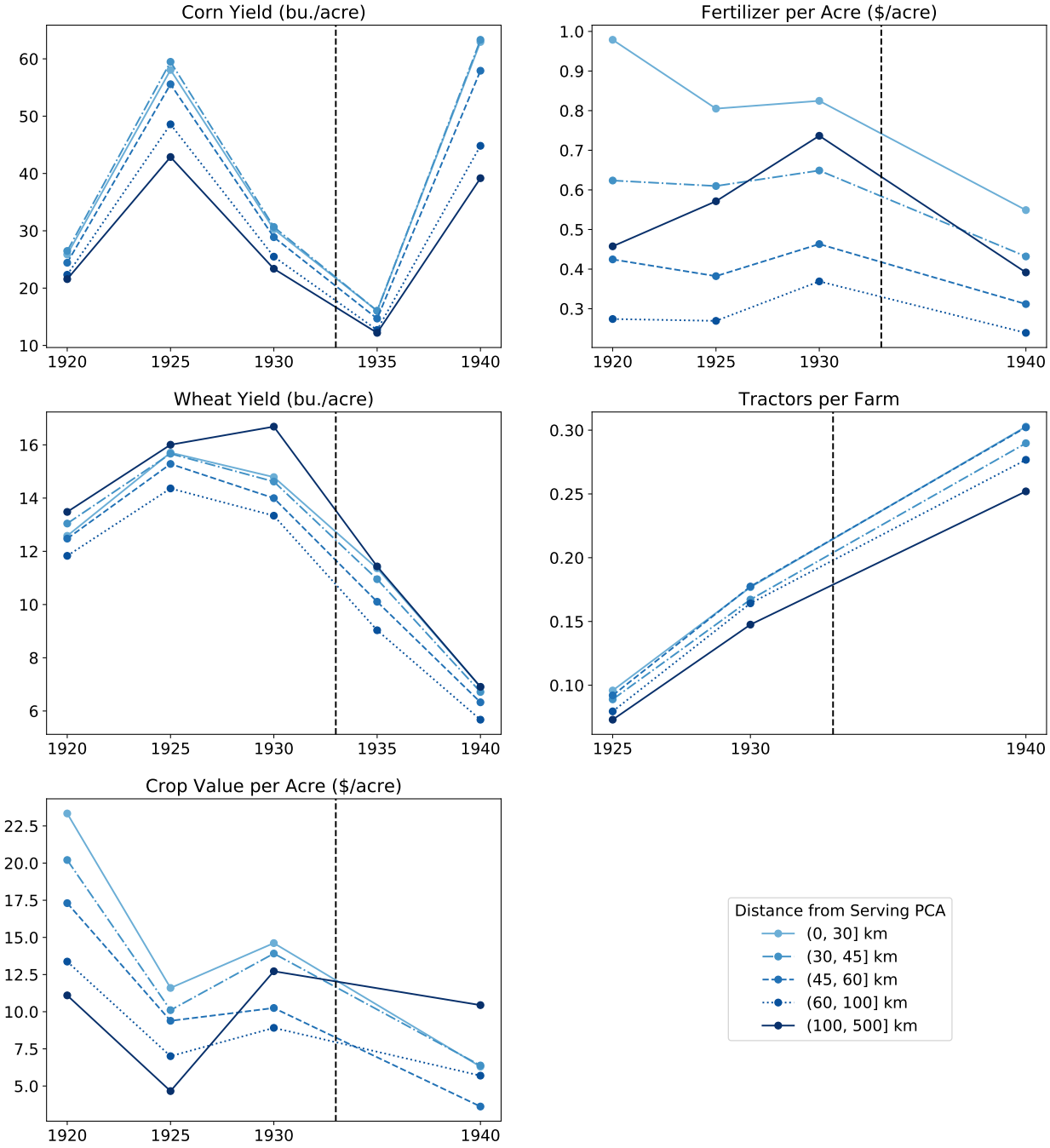
In choosing a functional form for distance, it is important to consider what restrictions each

Figure 3: Trends in Levels For Major Variables



Note: each point estimate is the mean across counties in that distance category for that year.

Figure 4: Trends in Outcomes



Note: each point estimate is the mean across counties in that distance category for that year.

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 (2019), 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, as in Altonji et al. (2005), captures this "fixed cost" idea while also allowing a non-linear effect of distance. Given these costs and benefits, we run a log-log model and a log-discrete model to see whether the effect is sensitive to difference in specification.

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.

6 Results

We estimate each of our models run on two samples: the full sample of lower 48 states and a restricted sample. The restricted sample omits six states, Wyoming, Utah, Nevada, Arizona, New Mexico, and Idaho. For many of these states there is only one PCA covering the whole state, so in these states more than 50% of counties are more than 100 kilometers away from a PCA. They are dropped from the analysis to check whether their inclusion significantly affects estimation, especially since these areas had lower agricultural activity. The results for the restricted sample are in Appendix A.1.

We use two different specifications for distance. The first assumes a constant elasticity effect between bank distance and agricultural outcomes and uses a log-log regression. The second uses discrete bins of distance to broadly represent travel costs. Table 1 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 the pre-trend period 1920 and 1925 and the one post-trend period, 1940. The bands on each coefficient are 95% confidence intervals.

All coefficients in the log-log model in Table 1 are with respect to the base period 1930. In the log-log model, there are small but statistically significant, negative effects in the post period, that is post 1930, for all outcomes except corn and wheat yield. The effects in the prior trend are also statistically significant, indicating something about the selection process for PCAs. For corn and wheat yields, the prior trends are positive, suggesting that PCAs were placed PCAs in areas with lower on average yields. The elasticities calculated here suggest that a 100% increase in distance changes crop value per acre by 2.4% after their placement. The elasticities for tractors and fertilizer indicate no prior trend, but a small, negative elasticity in 1940.

Table 1: Estimation Results on Full Sample

	Crop Yield		
	IHS(Corn Yield)	IHS(Wheat Yield)	IHS(Crop Value/Acre)
1920 × IHS(Distance to PCA)	0.0195**	0.0320***	-0.00512
	(0.00848)	(0.00928)	(0.00857)
1925 × IHS(Distance to PCA)	0.000147	0.0219**	-0.0149
	(0.0117)	(0.00852)	(0.00985)
1940 × IHS(Distance to PCA)	-0.00340	0.0137	-0.0240*
	(0.0136)	(0.0116)	(0.0126)
Observations	14,224	13,570	11,568
Number of Clusters	2,823	2,823	2,823
R^2	0.710	0.566	0.801
	Inputs		
	IHS(# Tractors/Farm)	IHS($ Fert/Acre)	
1920 × IHS(Distance to PCA)		-0.00864	
		(0.00801)	
1925 × IHS(Distance to PCA)	0.00194	-0.00403	
	(0.00120)	(0.00544)	
1940 × IHS(Distance to PCA)	-0.00699***	-0.0118*	
	(0.00162)	(0.00669)	
Observations	8,676	11,436	
Number of Clusters	2,823	2,823	
R^2	0.837	0.375	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the county-level.

All New Deal spending variables are the sum of the years 1933-1939. 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 and wheat soil potential (average of cell), longitude value, latitude value, state by year trend, erosion levels, total public works spending, total grants, total relief spending, total loans. Details on the New Deal spending variables can be found in Fishback et al. (2003).

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 2.4% change in any outcome. As noted in the trends, this may be because there are thresholds of distance that matter to these outcomes, which is not reflected in the log-log specification. In our log-discrete model, the effects are with respect to the base outcome of being within 30 kilometers of a PCA in the year 1930. If PCAs have a positive effect on outcomes, we should expect effects to be negative, as areas farther out should have lower input spending or productivity as compared to counties near PCAs. In conjunction to seeing an effect, we can also see how the effect changes as a function of distance.

If the effect size increase in proximity, we would also expect the curve to be *concave* in distance, reflecting the fact that the effects increase as counties are closer. Figures 5 shows crop outcomes while Figure 6 shows input outcomes both as per acre/farm and in total levels (bushels for corn and wheat, dollars for crop value).

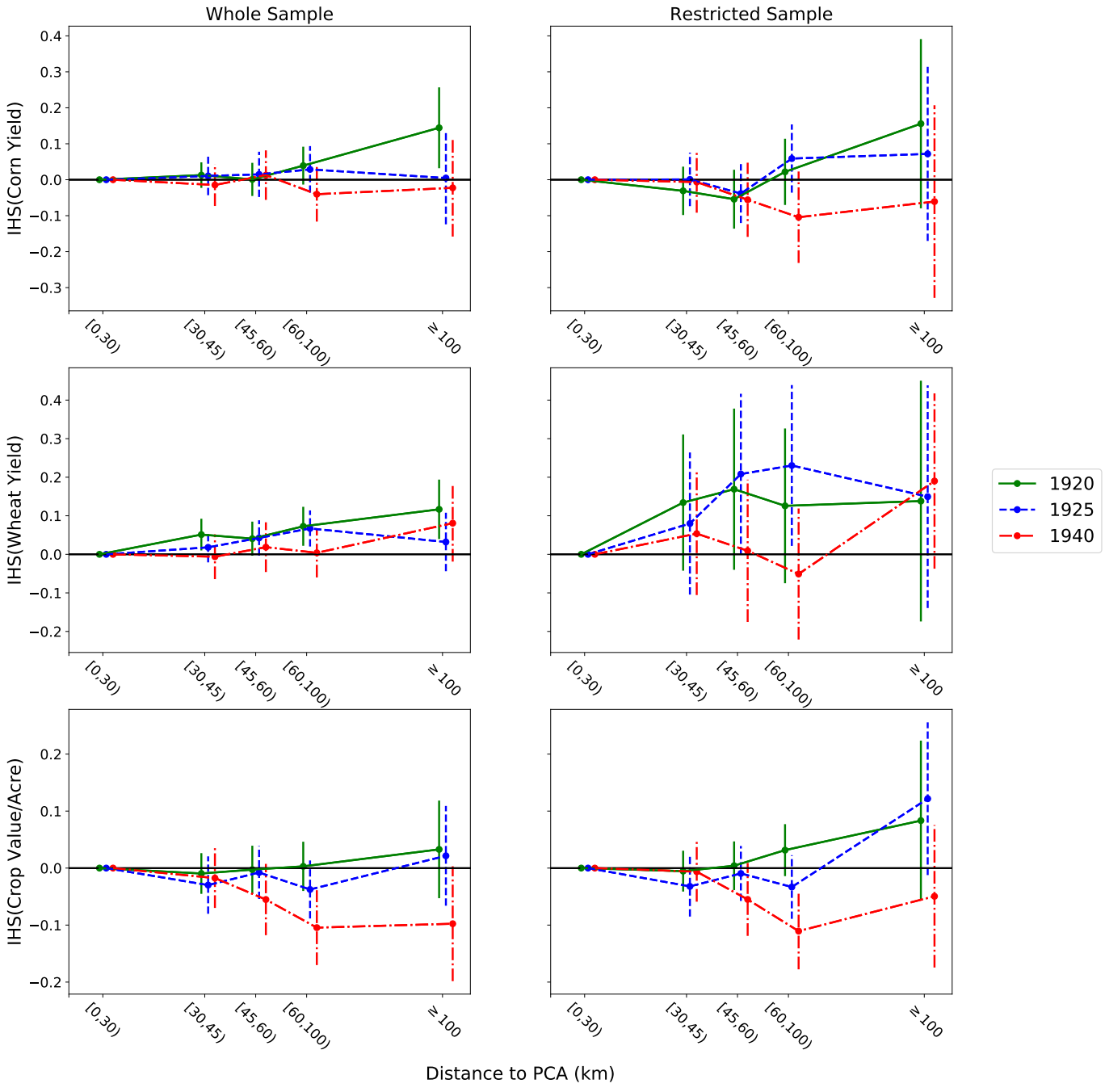
Corn yields and output are not statistically different at further distances, though further areas have lower corn yields and output in 1940 compared to 1930. In terms of total corn output, counties within 60 to 100 kilometers away from a PCA had 10% lower output. Wheat yields and output are not negatively affected by distance, and are larger at further distances. This confirms the result in the log-log model: before PCA placement, counties further away had larger wheat yields. In 1940, this is not the case, however, as all levels of distance are statistically indistinguishable.

Crop value per acre shows the greatest effect, as counties that are more than 60 km away from a PCA have around 8%-10% lower crop revenue per acre; this effect only exists post-1930 and distance has no significant effect in 1925, which is consistent with the PCAs driving the effect. The relationship is also convex, as the biggest changes in crop revenue come from moving the first 60 km away while there is no difference going from 60km to more than 100km.

When looking at use of inputs, the trend for fertilizer and tractor use confirms the effects seen in the log-log model. Tractors in particular have a positive relationship to distance in 1925 but have a negative relationship in 1940 (and no effects on total tractors). Despite being small effects, in the range of .03 and .04, they are the most tightly identified and have the smallest standard errors; the effect of moving from the largest distance to the smallest distance is about a 4% increase in tractors per farm. In terms of fertilizer spending, areas close to PCAs used more fertilizer than areas farther away after their introduction, especially areas more than 100 kilometers away. For these areas, they had 5% lower fertilizer use per acre than those farther away. In terms of total output, there is a positive trend in 1920 that is similar to tractors: areas farther away from PCAs used *more* fertilizer in 1920, whereas in 1940 the areas were statistically indistinguishable in terms of fertilizer use. These effects have a very large variance, however; none of them are significant at the 95% level.

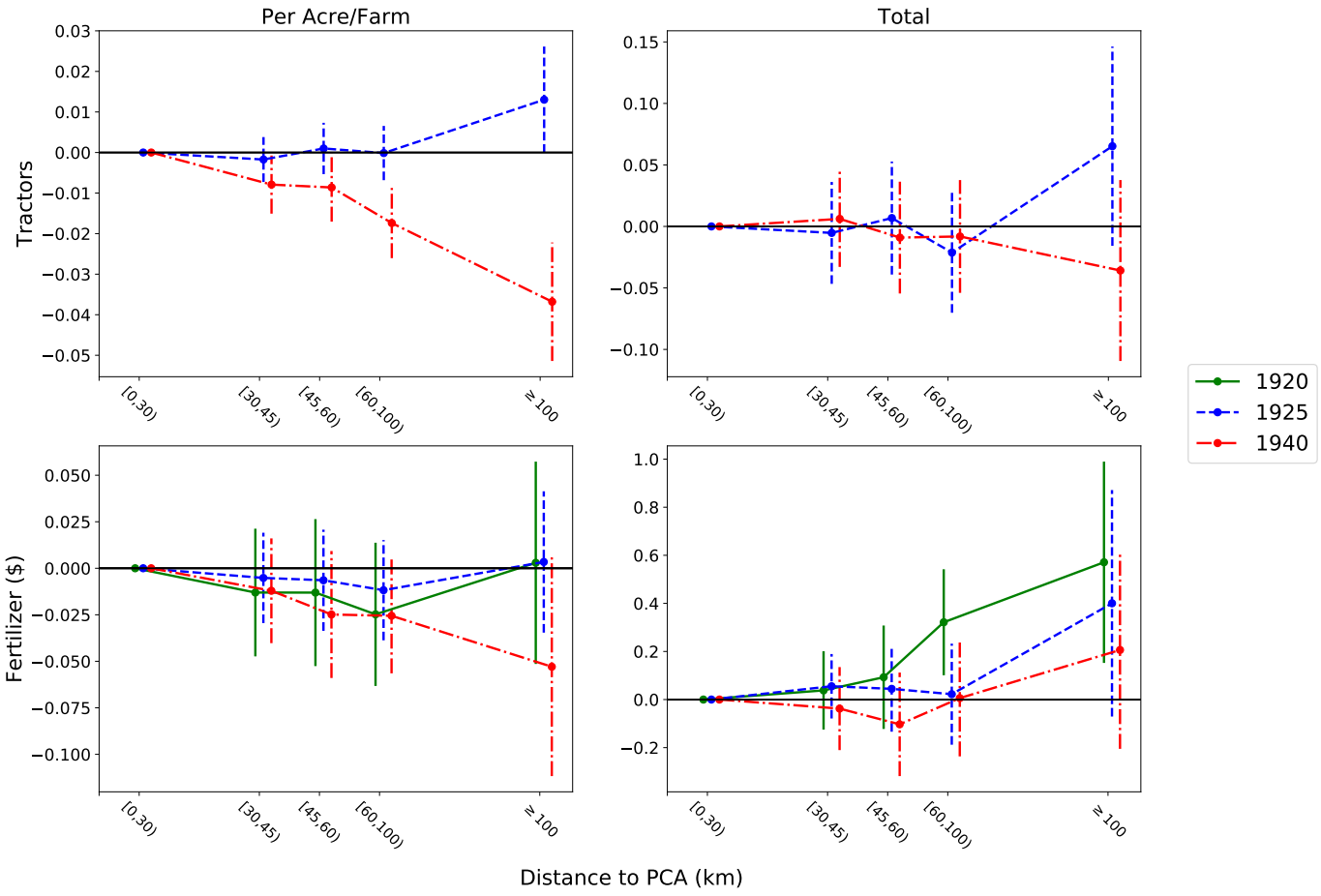
The results of this model appear to be consistent with the story that PCAs had a small but meaningful impact on input spending and crop value per acre. The positive pre-trends indicate that, as our descriptive statistics showed, parallel trends does *not* hold for PCAs. In fact, PCAs

Figure 5: Crop Yield Outcomes



were placed in areas that *decreasing* crop yields and input use relative to their farther counterparts. By 1940, the reverse is true: areas closer to PCAs have either higher crop yields and input use or the same as their farther counterparts. One interpretation is that PCAs were targeted to counties that had experienced losses, and so helped them either become better than their neighbors or helped

Figure 6: Input Spending Outcomes



them *catch up* (consistent with all distance bins being statistically indistinguishable). In terms of mechanisms, this was in part due to modest increases in input use, specifically fertilizer and tractors. Tractors, however, are likely not able to be purchased with operating credit. This result may be due to the fact that fertilizer and other inputs are complementary to tractors; tractors enhance the capacity to plant seeds and fertilizer, for example. As the price of credit goes down, input purchases of seed and fertilizer may increase and as a consequence tractor use increases.[5] In this case, access to operating credit had impacts not just on variable inputs but also on major investments such as machinery.

The effect on crop value per acre suggests that there are effects beyond increases in inputs, however. Investigating knowledge transfer or pro-competitive effects on commercial sector lending is beyond the scope of this paper, but both of these mechanisms are potential reasons for these

[5]This can be derived from a relatively simple profit maximizing problem for an agricultural firm where tractors and other variable inputs are complements. Decreasing the price of credit would cause an increase in income, which could subsequently be invested in complementary goods.

effects.

7 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. In this paper, we tested this claim by investigating its expansion into production credit with the placement of PCAs in rural areas. Various studies done in the period 1920-1940 suggest that PCAs 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. The PCAs 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 trends in these areas implies our effects are underestimates of the true effects.

Of the three mechanisms by which PCAs could affect agricultural outcomes, we provide evidence that PCAs increased use of variable inputs and consequently use of complementary inputs such as tractors. This suggests that farmers in this period were credit constrained for short-term credit, and that the placement of PCAs increased access to credit for these variable inputs. Given the complementarity between variable inputs and larger assets, specifically machinery, easing production credit constraints not only increased use of fertilizer but also use of tractors. We also provide evidence that PCAs had effects on crop yields beyond use of inputs, which could be a result of either knowledge transfer through the PCAs or pro-competitive effects on commercial lending which could have brought the cost of credit down overall. Understanding the power of these mechanisms on these and other economic outcomes is beyond the scope of this paper but is a fruitful direction for future research. In particular, the literature on social learning proves that the cooperative aspect of PCAs could potentially have impacted these outcomes by facilitating knowledge transfer, which is a unique aspect of the FCS approach to increasing credit access in agriculture.

The U.S. agricultural sector has developed as a result of the FCS together with many other structural innovations such as infrastructure and land grant universities. Our work is the first to quantify the role of the FCS in rural development as a first step to understanding the importance of the FCS and the efficacy of its approach to rural credit. While so many policy options have used either direct or subsidized financing, the FCS represents a unique but largely understudied approach: instantiation of independent, cooperative financial institutions. We make a critical contribution by analyzing their impact into a market where they did not previously compete. In future work, the economics literature should focus more on how the cooperative aspect of these institutions has impacted rural development. Understanding the unique advantages of the GSE approach to rural credit marked development would be of great benefit to our understanding of

U.S. economic development and also to understanding how to approach current policy today.

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A Robustness Checks

As evidenced by Figure 2, the greatest share of counties more than one-hundred kilometers from a PCA are in the Western U.S. where there were only one or two PCAs to serve the entire states. This is most likely because there was not sufficient population density and farms to have enough income to run a PCA in those states if coverage areas were any smaller. Unfortunately, this means the trends for these counties are not likely to be parallel; these counties are fundamentally different from their counterparts in the rest of the country. Also, crop agriculture is not suitable for this area, and the outcomes we are studying are measuring the activity of crop agriculture. As a robustness check to see whether these Western states are driving the effect of large distances, we drop them from the sample below. Specifically, we dropped the states Arizona, Utah, Nevada, Wyoming, New Mexico, and Idaho.

Table A and Figures A and 8 show the results of the model having dropped those states. In the log-log model, the coefficients are not drastically different compared to Table 1, though crop revenue per acre and fertilizer spending are no longer statistically significant (though the effect size is the same). It appears that dropping these states makes the standard errors larger but does not affect the size of the effect. Figures A and 8 compare the distance effects side-by-side. The effects are largely unchanged by dropping these states. One slight change is that there is a larger effect on crop revenue per acre when these states are dropped. This is consistent with what we see in the trends: counties in these states were already trending upward in terms of crop revenue per acre, which pushes our estimate more towards zero when the effect is relative to closer areas.

Our robustness check appears to suggest that these states biased effects towards zero by a small amount, but that the results are largely unchanged by dropping these states from the sample.

Table 2: Estimation Results on Restricted Sample

	Crop Yield		
	IHS(Corn Yield)	IHS(Wheat Yield)	IHS(Crop Value/Acre)
1920 × IHS(Distance to PCA)	0.0201*	0.0374***	-0.00582
	(0.00910)	(0.0102)	(0.00932)
1925 × IHS(Distance to PCA)	-0.000633	0.0251**	-0.0193
	(0.0124)	(0.00939)	(0.0109)
1940 × IHS(Distance to PCA)	-0.0112	0.0161	-0.0244
	(0.0147)	(0.0127)	(0.0134)
Observations	13,714	13,025	11,088
Number of Clusters	2,725	2,725	2,725
R^2	0.719	0.576	0.807
	Inputs		
	IHS(# Tractors/Farm)	IHS($ Fert/Acre)	
1920 × IHS(Distance to PCA)		-0.00817	
		(0.00876)	
1925 × IHS(Distance to PCA)	0.00177	-0.00506	
	(0.00132)	(0.00597)	
1940 × IHS(Distance to PCA)	-0.00784***	-0.0136	
	(0.00179)	(0.00732)	
Observations	8,316	10,966	
Number of Clusters	2,725	2,725	
R^2	0.842	0.383	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the county-level.

All New Deal spending variables are the sum of the years 1933-1939. 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 and wheat soil potential (average of cell), longitude value, latitude value, state by year trend, erosion levels, total public works spending, total grants, total relief spending, total loans. Details on the New Deal spending variables can be found in Fishback et al. (2003).

Figure 7: Crop Yield Outcomes

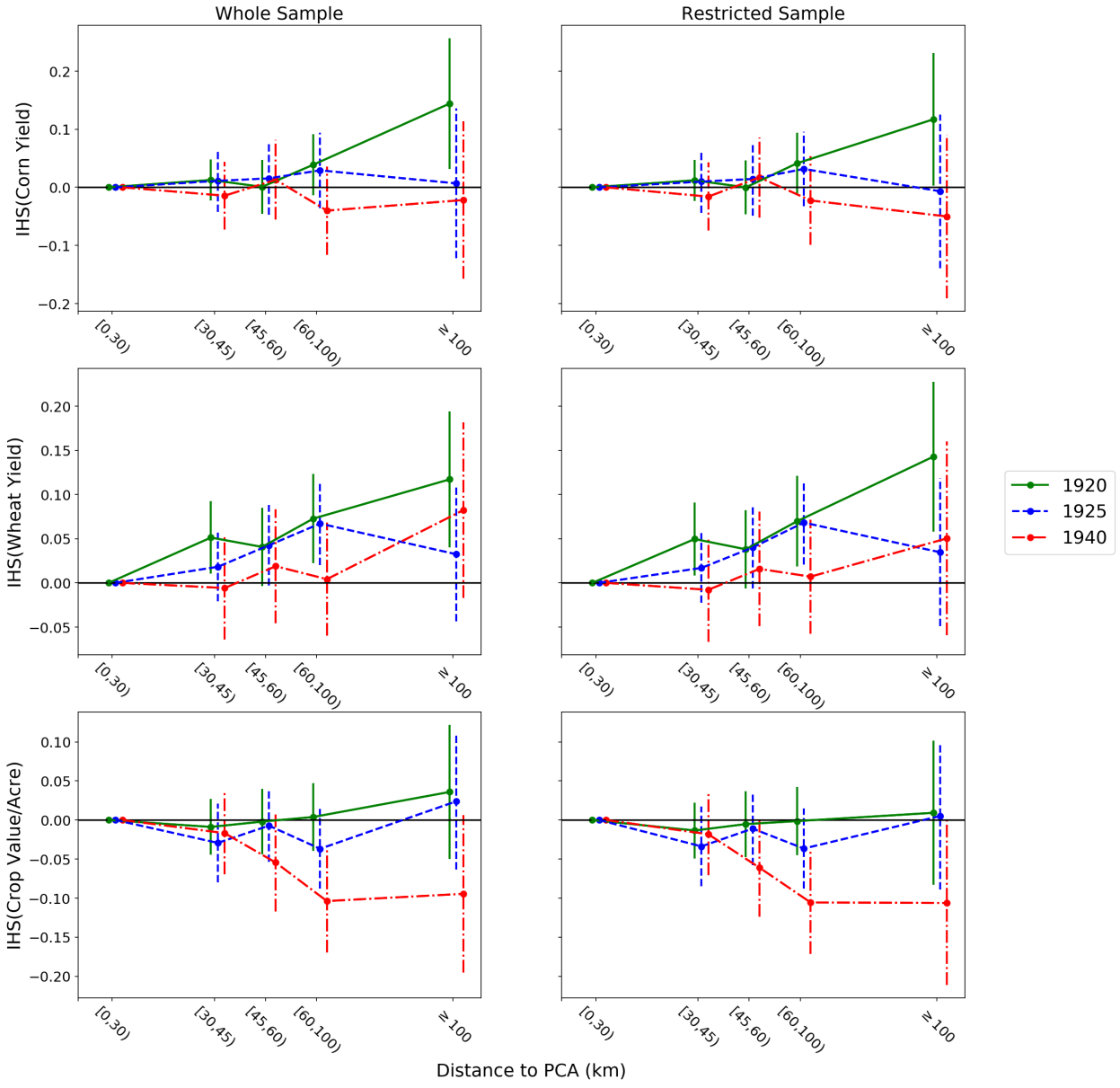

Figure 8: Input Spending Outcomes