The New Deal and Agricultural Investment in Machinery and Work Animals: Cotton Farms During the Great Depression

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Cotton Agriculture During the Great Depression

A dramatic rise in output per acre in farming started in the period between 1920 and 1940. After following a relatively flat trend for decades, crop production per acre harvested fell nearly 25 percent between 1931 and 1934, rose to a new all-time peak in 1937 and 1940 and then doubled over the next 25 years.   A significant part of this rise likely was attributable to the diffusion of a wide range of new technologies, including tractors, farm automobiles, farm trucks, and various new hybrid seeds.   During the period the process was volatile with large gyrations in agricultural prices, output per acre, and the value of implements and machinery on farms.   These measures hit their nadir in the years 1932 to 1934 and then began recovering along with the rest of the economy. Even so, the economy still remained depressed for the rest of the decade with unemployment rates that remained above 10 percent and real incomes per capita below 1930 levels until 1940. One reason for the surge in farm investment may have been the New Deal farm programs created to raise farm incomes and expand farmers' access to credit at lower interest rates.   Our goal is to measure how much the New Deal farm programs and other spending programs were related to these changes in the use of farm machinery and work animals.

As part of the process of examining these changes, we develop a greatly expanded panel data set for U.S. counties for the years 1920, 1925, 1930, 1935, and 1940. We then examine how New Deal programs and the fluctuations in farm opportunities affected the real value of farm implements and machinery, the use of work animals, and the diffusion of tractors, automobiles, and trucks between 1930 and 1940.   We focus on the decisions

in cotton agriculture for several reasons. Cotton agriculture experienced many of the rapid changes that were experienced in all forms of agriculture. The New Deal programs played significant roles in the cotton South that have been identified in a variety of narratives and quantitative analyses (Volanto (1996, 2005), Depew, Fishback, and Rhode (2013), Whatley (1983, 1985, 1987); Biles (1994), Alston (1981) and Clarke 1991 and 1994).[1] The degree to which labor inputs and capital inputs were substitutes or complements varied from crop to crop, so we focus on one crop to obtain more precise estimates of the relationships. Finally, the expanded panel for the cotton South allows us to examine measures of farm machinery on farm operations by race and at several tenure levels: owners, part owners, renters, and croppers who were hired as laborers and paid a share of the crop. Thus, the analysis can show how the farm programs influenced the situations for farms on all rungs of the tenure ladder.

We identify the effects of several New Deal programs simultaneously in an analysis using county fixed effects, year fixed effects, and state-by-year fixed effects.

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[1] There is a substantial literature on the diffusion of the tractor, which is one of the machines on which we focus in this paper. For discussions of the importance of the tractor, see Day (1967), Olmstead and Rhode (2001), White (2001, 2000), Clarke (1994), Peterson and Kislev (1986), and Martini and Silberberg (2006).   White (2001, 495) suggests that the tractor replaced a large number of work animals, releasing land that had been devoted to producing feed and providing pasture for the work animals. Olmstead and Rhode (2001) suggest that the diffusion of tractors could have led to as much as a 20 percent increase in the land devoted to crop production for markets and human consumption. In addition, they estimate that the tractor was responsible for replacing 1.7 million farm jobs by 1960. Similarly, Day (1967) suggests that tractors might have cut farm hours worked by more than half between 1940 and 1960, although Peterson and Kislev (1986) find that higher wages off the farm account for 79% of this decline, leaving only 21% to be explained by mechanization.   Nguyen (2015) has a dissertation chapter that examines the diffusion of farm automobiles and tractors in response to obtaining access to new and better roads.

The variation used to identify the relationships is variation within a county over time after controlling for state-specific changes in each year that would have influenced all counties in the state in that year the same way.   Developing instrumental variables in this context is a challenge because there are seven New Deal programs that likely influenced the process.   To allay fears that the estimates of the impact of the programs are subject to selection or endogeneity bias, we perform placebo analyses in which we rerun the analysis using panel data from the 1920s on the same dependent variables and correlates while artificially distributing the New Deal spending in the 1920s. The coefficients for the programs in the placebo analysis tend to be much smaller or of opposite signs from what is found in the analysis of the actual timing of New Deal programs.

The results show sizeable effects on machinery investment of the Agricultural Adjustment Act (AAA) program to pay farmers to take land out of production.   About 60 percent of the rise in the real value of farm machinery per farm between 1930 and 1940 likely was associated with the distribution of the mean level of AAA grants. Roughly 95 percent of the rise in tractors per farm was associated with the AAA grants, while the grants were associated with smaller increases in automobiles per farm and decreases in the number of farm trucks. These changes occurred without changing the number of horses and mules on the farm much.   Five loan programs through the Farm Credit Administration, the Farm Security Administration, the Rural Electrification Administration, the Reconstruction Finance Corporation, and the Disaster Loan Corporation, each contributed to an expansion in credit available and were associated with increases in the value of farm machinery per farm.   In the average cotton county the receipt of the mean loan values per farm was associated with about 50 percent of the rise

in the real value of machinery per farm. The impact of the programs on the mix of tractors, autos, trucks, mules, and horses varied from program to program.   The impact also varied substantially by the tenure level of the operator and the race of the farm operator. On the other hand, greater spending on New Deal relief programs slowed the expansion of farm machinery and tractors, such that the increase between 1930 and 1940 in the mean spending on New Deal relief would have counteracted about 29 percent of the rise in the real value of machinery per farm.

I.   The Dramatic Changes in Agriculture in the Interwar Period

During the early 1920s relative farm prices (the ratio of farm wholesale prices to nonfarm wholesale prices) and yields per acre in Figure 1 both declined from all-time peaks around the end of World War I to troughs in 1921. Both recovered somewhat during the late 1920s before plunging to lower troughs in the early 1930s. Relative farm prices dropped roughly 30 percent by 1933 to a low that had not been reached since prior to the Civil War. They then rose to within 10 percent of the late 1920s ratio before slipping back roughly 10 percent by the end of the decade. Meanwhile, crop yields per acre also fell roughly 30 percent between 1931 and 1934 and then rose to a new all-time peak between 1937 and 1940. World War II stimulated prices and output to new heights (not shown in Figure).   Relative prices continued rising to an all-time peak in the late 1940s and 1950s and then dropped to Depression era and Civil War levels by the late 1980s. In contrast, yields per acre rose about 12 percent during World War II. By 1990 yields per acre had more than doubled the peak at the end of the War.

Overall investments in farm implements and machinery per farm, shown in Figure 2, roughly tracked the rise and fall in relative farm prices and crop output per acre during the interwar period. The real value of farm implements and machinery per farm in 1967$ (deflated by the WPI for farm machinery) fell from a peak of around $1,353 in 1922 to $993 in 1924 and then returned to a value of $1,256 in 1930. The value of implements and machinery per farm plummeted along with relative farm prices and crop output per acre to a low of $788 in 1935 and then returned to around $1200 in 1940. From that point on machinery values rose sharply over the rest of the century.

Among the machines included in farm machinery, the number of automobiles per farm mimicked the drop in machine values per farm in the 1930s, while the diffusion of tractors and farm trucks dipped much less in the heart of the Depression. Figure 2 shows that the number of farm automobiles reached a peak of 63 per 100 farms in 1930 and then fell back to 50.2 in 1934 before recovering to a new high of 65.3 in 1940. The number of tractors and farm trucks per 100 farms rose from less than 4 in 1920 to around 15 tractors and 14 trucks by 1932. Both measures dipped slightly in 1933 and 1934 and then continued a steady rise to new peaks of 24.7 tractors and 16.5 trucks per 100 farms. By 1965 there were 142.5 tractors, 90.1 farm trucks and 106.9 farm autos per 100 farms.

Part of the decline in machinery per farms in the early 1930s was associated with a rise in the number of farms. The number of farms in Figure 3 had remained roughly constant from 1910 through 1930 at around 6.5 million while the farm population had fallen from its all-time peak of 32.5 million in 1916 to around 30.5 million in 1930. Despite the drops in relative farm prices in the early 1930s, the farm population surged to 32.4 million in 1933, and the number of farms reached a new all-time high of 6.8 million

in 1935. After reaching these peaks, the number of farms and the farm population fell back to their 1930 levels by the end of the decade and then were cut roughly in half by 1965. Meanwhile, average farm size, after falling from World War I peaks to 142.8 acre by 1925, started a continuous rise to 167.8 acres per farm by 1940 and then doubled by 1965.

I.1 Trends in Cotton

In the cotton sector, the ratio of the index of cotton prices to the index of nonfarm prices gyrated dramatically in the interwar period.   The ratio shown in Figure 4 peaked in 1919 and 1923 at around 1.6, in 1927 at 1.25 and troughed at 0.65 in 1920, 0.74 in 1925, and .5 in 1931. Over the rest of the 1930s it rose to 1 in 1934, fell to .59 in 1937 and rose to .76 again in 1940. The index for cotton bales per acre in Figure 4 typically spiked in the years when the relative cotton prices troughed.

The census does not report machinery information specifically for cotton farms. We can get a sense of the changes in the cotton sectors by examining the means in Table 1 from the sample of 905 southern counties (based on 1920 boundaries) producing more than 100 bales of cotton in each agricultural census year. The changes appear to follow roughly the same paths as for all farms. The real value of machinery per farm in the cotton sector fell from 262 in 1920 to 215 in 1925, rose to 271 by 1930 and then to 392 by 1940. In each tenure class the real value of machinery rose from 1925 to 1930 and again to 1940. Among colored farmers the value of machinery per farm rose on cropper farms and for part owners, but declined for colored full owners and colored tenants and

croppers.   The number of trucks and tractors per farm rose from 1930 to 1940 while the share of farms with autos stayed relatively flat between the two years.

II. The New Deal Programs for Farms, Relief, and Public Works

The New Deal programs that were likely to directly affect agricultural input choice were the broad array of farm programs that provided grants and loans, as well as the public works and relief programs that provided relief payments and employment for potential farm workers, croppers, and tenants.   We have compiled county-level evidence from mimeographed reports that show the cotton payments under the AAA for the first three fiscal years of 1934, 1935, and 1936 (Agricultural Adjustment Administration. Division of Finance1935 and 1936). The Office of Government Reports (1940) distributed mimeographed information on the Farm Credit Administration loans to farmers, loans through the Farm Security Administration, and loans through the Rural Electrification Administration for the period March 1933 through June 1939.

II.1 Agricultural Adjustment Administration Grants

Attempts to have a government agency control output had been passed by Congress in the 1920s but vetoed by the President. These were followed by some attempts at voluntary programs to limit output during the Hoover years. When they entered office in 1933, the Roosevelt administration and Democratic Congress enacted a series of programs that revamped the federal loan structure in agriculture and provided payments to farmers to take land out of production in an attempt to raise farm incomes and farm prices. The largest farm grant program was the Agricultural Adjustment

Administration payments to take land out of production of designated crops.[2]   The AAA

payments we use in the analysis are the cotton rental and benefit payments made for the

period from May 12 1933 through June 30, 1936 for each county contained in a

mimeographed Memorandum to the Administrator from the Division of Finance received

August 11, 1936 (Agricultural Adjustment Administration, Division of Finance 1936),

which we found in the National Agricultural Library.   The grants were distributed to

farmers who agreed to participate in a program of controlled production. Farmers signed

production agreements in which they would curtail the acreage they planted. The

program was said to be voluntary, but various taxes and regulations made it costly not to

join the program. In the original AAA the benefit payments were financed from special

processing taxes on the commodity being curtailed. There was a general belief that most

of the burden of the processing taxes would be passed on to consumers of farm products.

Under the Soil Domestic Allotment Act (SDAA) that was enacted after the AAA was

declared unconstitutional, the processing taxes were eliminated and the funds were

appropriated from the general budget. [3] [4]   The goal of the program was to increase the

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[2] The original list of crops eligible for AAA adjustment in 1933 included wheat, cotton, corn and hogs, milk and its products, tobacco, rice, and cattle. In 1934 sugarbeets and sugarcane, peanuts, rye, flax, barley, grain, and sorghums were added. Potatoes were added in 1935. See Agricultural Adjustment Administration 1936, p. 19.

[3] In *United States v. Butler, et. al* on January 6, 1935 the U.S. Supreme Court declared that the original Agricultural Adjustment Act "regulates agricultural production in violation of the tenth amendment to the Federal Constitution; that the (processing) tax is a mere incident of such regulation; that the benefit-payment plan…amounts to coercion by economic pressure; and that the act is accordingly invalid. The case came about when the U.S. government sued the receivers for the Hoosac Mills Corporation to collect certain processing and floor-stock taxes imposed by the AAA (Agricultural Adjustment Administration 1936, 99).

[4] In the corn belt states (Ohio, Illinois, Indiana, Iowa, Nebraska and Missouri) the acres rented under the AAA program in 1934 were transferred to other uses in the following ways: "About one-third for new seedings of meadow and pasture crops, chiefly alfalfa, sweetclover, and clover and timothy. About one-fourth in old meadow crops left unplowed (clover, timothy, sweet clover, bluegrass pasture). About one-third planted to emergency forage crops (soybeans, millet, Sudan grass, forage sorghums, fodder corn). About one-twelfth, used for controlling weeds, was

incomes of farmers both through benefit payments and by raising the ratio of farm market

prices to nonfarm prices to pre World War I levels (1920s levels for tobacco) through the

curtailment of the output of specific crops.[5]

The AAA was administered by the Department of Agriculture, which established

state and local committees or associations of producers to help administer the act. The

administration of the Act was often done through a series of programs specific to the

individual crops. Thus the geographic distribution of the AAA funds across counties

was determined by the crop choices made prior to the AAA involvement and by the

parameters set for each of the crops. For each crop the actual distribution of funds was

determined by a complex interaction between federal administrators, local committees,

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fallowed or left idle. In the South contracted acreage could not be used for cash crops. In five
cotton states (Arkansas, Oklahoma, Texas, Georgia, and South Carolina) about three-fourths of
the cotton acreage was planted to home food and feed crops, chiefly corn, wheat, and oats,
soybeans, cowpeas, sorghums, Sudan grass, lespedeza and Mung beans. About one-tenth was
planted to new seedings of permanent pasture and meadow crops. About one-eighth went to soil
improvement crops to be turned over. About 2 percent was left idle. In Arkansas and Tennessee
considerable acreage was moved to planting trees, primarily black locust (Agricultural
Adjustment Administration 1936, 48).

[5] The description of the original AAA relies heavily on Nourse, Edwin G., Joseph S.
Davis, and John D. Black (1937) and Agricultural Adjustment Administration (1936).
Descriptions of the post 1935 AAA are based on Agricultural Adjustment Administration (1937).
After 1935 under the Domestic Soil and Allotment Act, the AAA administrators claimed much
greater flexibility. "In 1936 committees of representative farmers in 2400 counties worked out
tentative over-all goals for agriculture in their counties." The AAA annual report suggested that
the AAA expanded so that it could be applied to all farms and not just the specific crops under the
pre-1935 AAA rules. The new goal shifted from reestablishing the pre-World War I parity
between farm prices and the prices of goods farmers bought to reestablishing income parity for
farmers and non-farmers to the pre-war levels (Agricultural Adjustment Administration, 1937,
pp. 10-13.)

Under the original AAA, the state and county extension services played important roles
in distributing information and gathering data on the program. There were 4000 county
agricultural adjustment associations on the 1933-35 program. In 1936 there were 2711 county
agricultural conservation associations, organized everywhere but in the Northeast, where they
were appointed in 1936 but are being formed as the others were in 1937 (Agricultural Adjustment
Administration, 1937, pp. 56-57) After 1935 the AAA state committees were appointed by
Secretary of Agriculture, the local county agricultural conservation association officers were
elected by the producers. These officers recommended bases, productivity indexes, and normal
yields for the farms in the community and assisted with paperwork and monitoring of the grants.

local extension agents, and the farmers who had some degree of choice about whether they would join the program. For signing up to reduce acreage, a farmer's payments were based on multiplying the national price set for acreage reduction and their average yield per acre over a base period. The federal decision makers influenced the attractiveness of the program by the national price they set for acreage reduction and by the acreage that they asked the farmers to take out of production. In the case of tobacco and cotton the federal decision-makers added a degree of coercion to the system by levying heavy taxes on any production beyond designated limits.[6] The local administrators influenced the attractiveness of the program through their decisions upon issues like the base-year yields for the individual farmer and their decisions about the acreage the farmers had had in production. In addition, their actions to market the program and cajole their neighbors into joining helped determine the sign-up rates.

Nourse, et. al. (1937, pp. 120-21) describe substantial variations in sign-up rates for the initial AAA programs across crops and across regions.

> The major reasons for failure to secure sign-ups as high as 90 percent or more in some areas of concentration are that many of the farms are always involved in leasing arrangements, estate management, or the like in such a way as to make participation difficult, or have been so irregular in their production as to make provision of acceptable bases very difficult or are small farms using family labor mainly or entirely and hence not able to curtail expenses in proportion to the reduction in acreage. The reasons for

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[6]The taxes were added under the Bankhead Cotton Control Act for cotton and the Kerr-Smith Tobacco Control Act. See Nourse et. al., (1937, pp. 39-40, 96-102).

the smaller sign-ups in the regions where production is small and irregular are mainly the difficulties of providing satisfactory bases, the large number of small farms, lack of interest, and preference not to be bothered with the details of participation for the sake of the small benefit payment. Also sign-up campaigns were not prosecuted with the same degree of intensiveness in such areas.

Our sense from reading the documents is that the AAA offers were packages that involved the level of payments and the amount of acreage to be reduced. The package nature of the deal suggests that looking at the total receipt from the AAA is likely to give a good picture of the quality of the deals being offered. There was some variation in the take-up rates on the AAA offers. Cotton signups were 73.2 percent of base acreage in 1933, rising to 94.4 percent in 1935.[7]

The impact of AAA payments on implement and machinery choices is complex. Consider the use of tractors, for example. We develop a model in the Appendix of tractor choice in which farmers in the long run choose the amounts of land, labor, and machinery to use in production of a AAA crop and a non-AAA crop. The farmer faces price risk for the AAA crop and maximizes the expected utility of his profits. The input demands are functions of the probability of high and low prices for the AAA crop, the prices of the AAA and non-AAA crops, the wage rate for farm work, the price of tractors, the amount of land the AAA offers to take out of production and the payment per acre

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[7] For descriptions of the operations of the individual programs under the original AAA, see Nourse, et. al., (1937, pp. 92-114, 123-146, 287-323) and Agricultural Adjustment Administration (1936, pp. 119-278). Wheat had 75 percent of acreage in the base period under contract; 80 percent of peanut base acreage was contracted; and the tobacco signups ranged from 76 to 97.6 percent for many types of tobacco. Maryland tobacco only had a 20.0 percent sign-up rate.

taken out of production. The comparative statics from the model do not provide any unequivocal predictions.   Under the most restrictive modeling scenario, where all inputs are fixed except the machinery and the farmer is risk neutral, the AAA payments will lead to more tractor usage if tractor use raises the expected value of the marginal product of land for the AAA crop more than it raises the value of the marginal product of land for the replacement crop.   Given that farmers generally chose the AAA crop over the non-AAA crop in the absence of the AAA, this seems like a reasonable expectation. However, once we allow the farmer to choose all inputs, the predicted effect of the AAA on machinery usage depends on a set of complex interactions between the cross products of inputs in the production function, and no clear prediction results.   Therefore, we offer an intuitive discussion of the predicted effect of the AAA payments.

The AAA payments may have had conflicting effects on machinery adoption. For tractors, the AAA payments did not necessarily reduce by much the amount of land on which tractors could be used. In the South farmers were restricted to using the land taken out of cotton production to the production of noncash crops to feed themselves and animals as well as forage crops like clover.[8]   In both areas tractors could still be used for initial plowing but the labor demands at harvest time for many of these crops were lower or the harvest times differed enough between the AAA crop and these crops that the peak demands for labor at harvest were lessened, resolving one of the key constraints on tractor use.

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[8] Farmers in the corn belt could use the acreage taken out of AAA crop production to produce non-designated crops like soybeans for cash as well as to plant their fields in feed, hay, food, or other forage crops.

On the other hand, the production of feed and forage on the acreage released by the AAA payments made it less costly to feed plow mules and horses because the farmer could either avoid transport costs on the cash purchase of these products or because market prices were lower due to increased supply available.   For farmers who took the land completely out of production or put it into production where tractors were less useful, the reduction of acreage under cultivation made tractors less appealing.

Finally, there are conflicting opinions on how the AAA would have influenced tenancy and sharecropping in the South and the impact of changes in the tenancy structure on tractor choice. Warren Whatley (1985, 1987) argued that the AAA led to shifts toward larger farms with more wage work away from smaller operations under share tenant and cropping arrangements. He suggests that larger farm sizes and fewer share and plantation arrangements were associated with tractor expansion in the 1920s and thus the AAA payments might have contributed to rising share tenancy.   Lee Alston (1981) on the other hand suggest that such a prediction was muted a great deal by the flexibility in contracting on plantations in the South and that the direction of causation runs more from tractors to tenure arrangements than from tenure arrangements to tractors. In her studies of corn production in the Midwest Sally Clarke (1991, 1994) suggests that to the extent that the AAA increased farm size and provided the farm operator with cash, this would lead to increased use of tractors.

II.2 Farm Loans

After the National Farm Act of 1916 the federal government worked to expand farm mortgage credit by providing seed money for 12 regional Federal Land Banks and supervision for the establishment of joint stock land banks (p. 340) In 1923 Federal

Intermediate Credit banks were established to rediscount farm loans from the commercial banking system. The regional Federal Land Banks through farm loan associations offered farm mortgages at lower interest rates and for longer periods than other farm loans. By 1930 roughly one-seventh of farm mortgages were held by the Federal Land banks or the joint-stock banks.[9] The sharp drops in both yield per acre and relative farm prices led to a larger number of loan defaults and the ultimate demise of nearly all of the joint-stock banks by 1932. In 1929 the Hoover administration and Republican Congress experimented with a Federal Farm Board, which developed loan and purchase programs meant to counteract the declines in farm prices. As farm prices declined, the board increasingly held large stocks of wheat and corn, and the program was shut down in 1931 with losses totaling roughly $300 million (Halcrow 1953, 259-261).

During the first hundred days of the Roosevelt administration, the 1933 Farm Credit Act established the Farm Credit Administration, which reorganized and expanded on the existing federal credit system. The Federal Land Banks received significant federal backing to finance farm mortgages at substantially lower interest rates, with longer repayment periods, and loan values reaching 75 percent of the *normal* value of the land to be mortgaged instead of the contemporary depressed value during the Depression. Over $800 million was provided for making Land Bank Commissioner loans that reached beyond the ordinary first mortgage loan up to a maximum of $7500 per farmer. Between 1933 and 1936 interest rates on the first mortgage land bank loans fell from 5.4 to 3.5

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[9] In the 1920s the Federal Land Banks offered 40-year loans at 5 percent interest when private loan terms were typically for 5 years with typical interest rates of 6 to 7 percent but sometimes ranging to 10 percent in parts of the South and West. The land bank loans were made through national farm loan associations organized by farmers in the local community. A loan recipient was required to use 5 percent of the face value of the loan to purchase stock in the association. Once the farmer fully repaid the loan, he potentially could withdraw the funds he paid into the association if the association's capital reserve fund was in good shape (Halcrow 1953 344-5).

percent and stayed at 3.5 percent into the 1940s. Meanwhile, rates on all farm loans declined from 6.1 to 5.1 percent.[10] The Land Bank System largely refinanced loans on the new terms and by 1936 held two-sevenths of the farm mortgage debt in the U.S.

The Farm Credit Act of 1933 also provided for a Production Credit System that distributed loans through more than 600 local credit production associations.   By June 1934 88,388 loans averaging $792 had been made. In addition, Roosevelt provided funds to finance a series of Emergency Crop and Feed Loans in 1933 and 1934 that were targeted at persons unable to obtain credit from other sources. The small loans were a mixture of credit and relief and it was anticipated that many would not be repaid. A similar program was established for drought relief in 1935. These were joined by the Disaster Loan Corporation in 1937, which was established to provide aid to rehabilitate areas hit be natural disasters.[11]

The New Deal established another set of loan programs for farm families that had been receiving public relief under the FERA relief program. This program provided for small cash loans for low income or needy farm families. The program was eventually transferred to the Resettlement Administration in 1935 and ultimately found a home in 1937 in the Farm Security Administration.   The loans were basically "character" loans to be repaid in cash and in kind by farmers who had no recourse to private or other federal loans but had put together a rehabilitation plan and received training to improve their farming practices. These loans were distributed on similar grounds to those used in

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[10]Federal Land Bank mortgage rates from Halcrow 1953, 345; U.S. average mortgage rates calculated from USDA "Average Rates of Interest Charged on Farm-mortgage Recordings...", November 1940.

[11] See Farm Credit Administration, June 30, 1936, pp. 6-10; U.S. Department of Agriculture 1934, p. 18, 26; Arnold 1958, 23-35; Halcrow 1953, pp. 340-350.   The FCA also provided for funding of cooperative marketing associations but we have no information on the size of that funding.

distributing relief.   Once the farmer's standing was improved, the FSA offered loans through a farm tenant purchase program that aided croppers, tenants, and farm laborers in purchasing their own land.[12]

The Rural Electrification Administration (REA) was established in 1935 to provide loans at subsidized rates to rural electrical cooperatives to be formed in rural areas where electrical lines had not yet reached.   Electrification might have had conflicting effects on tractor adoption. Prior to electricity farmers without electricity were purchasing tractors as a source of motor power on the farm, so electrification might have reduced this incentive. On the other hand electrification might have complemented the use of tractors.[13]

Finally, the Reconstruction Finance Corporation made a wide range of loans to banks, industry, and to areas hit by disasters between Feb 1932 through the rest of the 1930s. The loans to banks would have helped prop up credit from those banks that were involved in agricultural lending. Prior to the formation of the Disaster Loan Corporation, the RFC ended up providing a series of ad hoc loans when Congress faced pressure from constituents hit by floods. When testifying for continuation of the DLC in 1941 RFC head Jesse Jones argued that a primary reason that the DLC was originally created was to replace the ad hoc nature of the disaster lending (Committee on Banking and Currency. U.S. Senate. 1941, 3).

We have kept the FCA, FSA, DLC, and REA loans separate for the analysis. Even though all of the loan programs had the effect of easing credit constraints and

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[12] See U.S. Resettlement Administration 1936, 10-26; Fishback, Wallis and Kantor 2003. U.S. Department of Agriculture, 1938, 63-67. For discussions of the political economy of the Farm Security Administration, see Alston and Ferrie (1999).
[13] For a study of the broad-based impact of the Rural Electrification Administration, see Kitchens and Fishback 2013.

lowering interest rates, they focused on different aspects of agriculture and targeted specific groups of farmers, which we can exploit when evaluating the value of farm machinery per farm for different tenure levels.[14]

As suggested by Lee Alston (1981) and Sally Clarke (1991, 1994), the farm loan programs were likely to increase the adoption of tractors. During the farm shakeout in the 1920s and the depths of the Depression, farmers often faced limits on credit opportunities, so that the amounts of farm loans offered under the New Deal would have directly affected the farmers' ability to borrow to use tractors. The improved loan terms on all dimensions gave farmers access to expanded credit. Even if the credit was tied to mortgages for land, the expanded credit allowed farmers to redirect some savings or other resources toward farm machinery. Further, the availability of farm credit with better terms would have forced private lenders to offer lower interest rates and better terms to attract the credit-worthy farmers to whom they wished to lend.

II.3 Public Works and Relief

The farm sector was also likely to be influenced by the two largest New Deal grant programs, the public works and relief programs. For the farm study we estimate the impact of the public works and relief grants separately to take into account the

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[14] The Commodity Credit Corporation (CCC) also provided commodity loans to farmers that set floors on the prices that they received for their crops. We do not have information on the CCC loans at the county level, nor is there good information available by state due to reporting glitches in the sources available. However, we can at least control for difference across states in CCC loans with the state by year fixed effects. In the CCC loan agreements if the market price of the crop fell below the specified floor, the farmer repaid the loan with the crop rather than with cash. The ratio of the value of the CCC loans to the value of crops produced was relatively small for all of the major crops except cotton. In cotton the ratio was relatively high at 0.215 in 1933, 0.536 in 1934, 0.202 in 1937 and 0.043 in 1938, but close to zero in other years. The corn loan ratio was 0.10 in 1933 but 0.02 or below in other years. Wheat loans were only made in 1938 with a ratio of 0.09 and 1939 with a ratio below 0.001. The highest tobacco loan ratio was .036 in 1935 and the ratios were 0.003 or below in other years. Ratios are constructed from statistics reported in Jones (1939, 5-7), U.S. Department of Agriculture (1939, 10, 44, 103, 144) and the ICPSR data set for the population census for 1939 as adjusted by Michael Haines (undated).

differences in the types of wages offered and the reliance on the work relief rolls for obtaining workers. Both programs had broadly similar goals of providing employment for a large number of workers and building a wide variety of public works and providing other public services. Relief grants were primarily distributed under the auspices of the Federal Emergency Relief Administration (FERA) from 1933 through mid 1935, the Civil Works Administration (CWA) from November 1933 through March 1934, the Works Progress Administration (WPA) from mid 1935 through 1942, and the Social Security Administration's Aid to the Blind, Aid to Dependent Children, and Old-Age Assistance programs after 1935. The principal goal of these programs was to provide immediate relief to the unemployed and low-income people, as 85 percent of the grants were used to hire the unemployed on work relief jobs. These relief jobs ranged from make-work activities to maintenance activities to the building of sidewalks, post offices, schools, local roads, and other additions to local infrastructure. The public works grants included expenditures by the Public Works Administration (PWA), Public Buildings Administration, and the Public Roads Administration. These grants were also used largely to employ workers.

The two programs differed in the way that they dealt with the labor they employed. The relief programs were designed to provide minimum levels of income to households of the relief workers, while the public works programs employed workers in the same ways that they had before the Depression. As a result, the hourly earnings paid to work relief workers were typically half of the hourly earnings paid to public works employees. The work relief workers also faced limitations on the number of hours they could work each month that were not imposed on public works workers. Finally, the

public works programs had more freedom to hire a broader class of workers who were not on relief. The public works programs were said to be more focused on building larger scale projects such as dams, roads, schools, and sanitation facilities. The work relief programs also built many major public projects, as relief administrators typically carved large-scale projects into several small projects that allowed them to avoid administrative limits (Clarke, 1996, pp. 62-68; Schlesinger, 1958, pp. 263-96).

The relief and public works programs likely had a variety of effects on farming. For example, the building of roads could alter the prices received for farm output and paid for goods purchased. Most of the literature on tractor adoption focuses on the constraints placed on tractor adoption by the availability of farm labor at harvest time. On this dimension public works and relief might have had opposite effects depending on the policies followed by the local agency officials. The public works and relief programs might have reduced the availability of farm labor during harvest time, slowing the adoption of tractors, to the extent that the project pay exceeded harvest wages and public works and relief officials penalized their workers if they left the programs for harvest work. Some relief officials argued that the payments to farm workers were unacceptably low and therefore refused to encourage or force WPA workers to take such jobs. On the other hand, there is evidence in some areas that public works and relief officials were willing to release workers temporarily during the harvest without prejudice against returning to relief work, having more relief and public works kept more people in the area and thus provided a ready labor force at harvest time that made tractors more attractive. In reading the archival reports and secondary literature, we have found evidence of both. A number of farmers complained that the WPA pay was so high that they had trouble

hiring the normal number of workers during harvests. WPA officials offered different

opinions on this issue. Some excoriated the farmers for paying such low wages that

WPA pay was higher. Others said that they actively encouraged work relief recipients to

find available work during peak seasonal demands but did not penalize them when the

season ended.[15]

III. Empirical Analysis

The structure of the analysis is a panel analysis using least squares with county

and year fixed effects. In this case the estimation is performed on a panel with each

observation as an average from county i in state s in year t.

$$O_{ist} = \beta_0 + \beta_1 New\ Deal_{ist} + \beta_2 X_{ist} + \beta_e Y_{ist} + \varphi + \hat{o} + \mu_{ist},$$

where O_{ist} is the outcome measure in year t and county i in state s. The outcome

measures include the the average real value of implements and machinery used by farms

deflated by the wholesale price index for farm machinery (1926=100) in 1920, 1925,

1930, and 1940; the number of tractors per farm in 1925, 1930, and 1940; the share of

farms with tractors in 1930 and 1940; the share of farms with automobiles in 1930 and

1940; the share with trucks in 1930 and 1940; the number of horses per farm in 1920,

1925, 1930, 1935, and 1940; and the number of mules per farm in 1920, 1925, 1930,

1935, and 1940. The real value of machinery per farm is available for different tenure

levels, including full owners, part owners, tenants (including croppers), croppers, and

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[15]See for example, Howard 1943, 486-496; Coyle 1939, Brimhall 1937, and Works Progress Administration 1937. Neumann, Fishback, and Kantor 2010 have a more detailed discussion with extensive citation of sources.

noncropper tenants, for the years 1925, 1930, and 1940. Race specific information on the value of machinery is available for 1930 and 1940 for full owners, part owners, tenants (including croppers) and for croppers. We can use this information to show how the New Deal policies influenced overall machinery value, specific forms of machinery, the use of animals, and then the extent to which the policies affected farmers at different tenure levels.

New Deal$_{ist}$ is a vector of average annual measures of the various New Deal policies in real dollars, measured as annual AAA cotton rental and benefit payments per farm between May 12, 1933 and June 30, 1936, relief spending per capita between July 1933 and June 1939, Public Works spending per capita between July 1933 and June 1939, the value of Reconstruction Finance Corporation (RFC) loans per capita, and the values of loans per farm for the Farm Security Administration (FSA), the Farm Credit Administration (FCA), the Rural Electrification Administration (REA), and the Disaster Loan Corporation (DLC) lending per farm. The population and number of farms used to normalize the New Deal data were for 1930 to avoid having changes in the number of farms in response to the New Deal programs influencing the New Deal coefficients. All of the New Deal values and other values besides machinery were deflated with the CPI (1967=1). The *X$_{ist}$* vector contains a series of socio-economic correlates: percent illiterate, percent colored, percent urban, percent foreign born, and the shares attending school of children ages 7 to 13, 14 and 15, 16 and 17, and 18 to 20. Each of these are reported by the census in 1920, 1930, and 1940 and we used straight-line interpolations of the percentages to obtain the 1925 and 1935 values.

To control for weather and disasters, we incorporated a series of time-varying weather measures for each of the prior 4 years, including average time-of-day adjusted temperature for the year; total precipitation. We measure extremes like drought and potential for flooding using the number of months of extreme wetness, severe wetness, extreme dryness, and severe dryness based on Palmer index measures. The Dust Bowl in the 1930s and the Great Mississippi Flood of 1927 have been found to have significant effects on economic behavior (Cunfer 2005, Hansen and Libecap 2004, Hornbeck 2012, and Hornbeck and Naidu (2014). To capture the longer range effects of the 1927 flood we added an interaction term for the years following the flood. We did not use data from the same year because the Census was conducted early in the census year and thus that year's weather was not known.

To examine whether more productive farms were more likely to adopt machinery, we included the cotton bales per acre in the prior year. In the analyses where we were not examining machinery by tenure class we included measures of the share of farm operators who were owners, part owners, croppers and noncropper tenants; the left out group was managers. We controlled for farm size with measures of the share of farms with less than 10 acres, 10 to 49 acres, 50 to 99 acres, 260 to 499 acres, 500 to 999 acres, and more than 1000 acres in the regressions that did not have a dependent variable for specific types of tenure.[16]

We have information on access to roads for 1925, 1930, and 1940 and farm cooperative activity for 1930 and 1940. We did not include these variables in regressions for machinery values, horses, and mules, where their missing values would

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[16]Inclusion of the farm size variables had little impact on the qualitative results.

limit the number of years in the sample, particularly since our identification is coming from variation across time within counties.[17] In the regressions for tractors, trucks, and automobiles we included access to gravel, shale, and clay roads and access to hard roads. In regressions where the dependent variable was available only in 1930 and 1940, we included the share of farms buying through cooperatives and the share selling through cooperatives.

To control for factors in each county that do not vary across time within the county but do vary across counties, a vector " of county fixed effects is included. Such factors might include the nature of the terrain and the soil, climate, access to rivers and oceans, and the extent of the rail network (which changed very little over the time period). A vector $\hat{o}$ of year effects were included to control for factors that hit all counties in the same year in the same way, but varied across years, such as wars, monetary policy, and the introduction of new knowledge nationwide.

There are a number of factors for which we have information at the state level but not the county level, particularly for cotton prices, animal values, automobile prices, farm mortgage interest rates, farm wages, We have estimated the model with these state values. We also have estimated the model where we instead included state by year fixed effects that would be collinear with these factors and those control for them as well as other factors within the same year and same state that were common to all counties.   The

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[17] When ran implements with just 1925, 1930, and 1940 as opposed to 1920, 1925, 1930, and 1940 (to accommodate coops and road access) the only change was a sharp fall in FCA per farm coefficient.   But this was not from adding coops and roads, it was from eliminating a year from the panel.

estimates we report in the paper include the state by year fixed effects because they control for more factors.[18]

We have considered using instrumental variables. However, there were several New Deal programs operating simultaneously with differences in anticipated effects; therefore, we followed an alternative strategy to allay fears about endogeneity or selection bias in the coefficient estimates. In situations where we had data for years in the 1920s, we estimated placebo regressions for the period 1920, 1925, 1930, or the period 1925 and 1930. In the placebo regressions for 1920, 1925, and 1930 we used the values of the New Deal programs from 1935 for the 1925 observation and from 1940 for the 1930 observation. In the placebo regressions for 1925 and 1930, I had no New Deal value in 1925 and used the value from 1940 for the 1930 observation. The placebo results are reported just below the estimations.

IV. RESULTS

The regression coefficients for the actual patterns of New Deal spending and the placebo regressions for the 1920s are reported in Table 2 with t-statistics in italics below the coefficients. Each row of coefficients is from a single regression equation with the correlates listed in the notes to the Table. Table 3 shows how the machinery measure changes with respect to a move from zero in 1930 to the average annual mean value of the New Deal variable during the 1930s. Table 4 then shows the percentage of the change in the mean of each machinery variable between 1930 and 1940 that can be

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[18] The results in which we replace state by year fixed effects with measures of the state level of horse prices, mule prices, daily unskilled farm wages, and the list of other state stuff are similar to those reported here. They are available from the author Price Fishback.]

attributed by a move from no New Deal activity in 1930 to the average annual value later in the decade.

In discussing the analysis for simplicity we will focus on the coefficients from the actual regressions. The coefficients still might reflect some selection or endogeneity bias, which is why we estimated the placebo regressions. In discussing the results, we will signal where there was the potential for bias. One rough way to measure the causal effect of the New Deal program is to take the values for the actual regressions in Tables 2 through 4 and subtract the values related to the coefficient for the placebo regressions for the same machinery measure.

IV.1. AAA

The AAA had a sizeable effect on the real present market value of all farm implements and machinery used in operating the farm. In Table 2 the coefficient of AAA per farm shows that an additional dollar of cotton AAA spending (1967$) per farm increased the value of machinery per farm by a statistically significant 90.8 cents in 1926 dollars. (We need to fix this so they are all on the same year basis.) The mean AAA spending per 1930 farm was $82.20, shown at the bottom of Table 2. So AAA spending per farm was associated with a rise of roughly $74.65 in Table 3. The mean value of implements and machinery rose from $270.50 in 1930 to $392 in 1940, a rise of $121.50 shown at the far right of Table 2. The $74.65 rise associated with the New Deal would have accounted for 61.4 percent of the rise in the average value of implements and machinery per farm between 1930 and 1940.

The coefficient from the placebo test for the 1920s in Table 2 is 0.1765 and is also statistically significant (Table 1). This suggests that counties with more machinery per farm in the 1920s were more likely to receive cotton AAA spending, and thus the 91-cent relationship may be overstated as a measure of the causal effect. The difference between the original and the placebo coefficients of 74 cents potentially is a rough estimate of the causal relationship. Thus, the share of the rise in the average value of machinery that can be causally attributed to the New Deal in Table 4 would have been 61.4 minus 11.7 or 49.7 percent.

This rise in machinery seems to have come largely from increased use of tractors. An additional dollar of AAA spending per farm increased the number of tractors per farm by a statistically significant 0.0009 in Table 2. The placebo estimate in Table 2 was negative and one-ninth the size, suggesting that the AAA tractor coefficient is not an overestimate of the causal effect. The AAA coefficient of 0.0009 suggests that the increase from no AAA spending in 1930 to a mean of $82 per farm later in the decade would have raised the number of tractors per farm by 0.074 in Table 3. As shown in Table 4, this rise would have accounted for 97 percent of the rise from 0.057 to 0.133 tractors per farm that occurred in the cotton counties between 1930 and 1940. The Census did not report the number of farms with tractors, trucks, or autos in 1925. As a check on the similarity of the results with 1925 included and without it, we also ran the analysis for the percentage of farms with tractors in 1930 and 1940. The results for percentage of farms with tractors were similar to the results for tractors per farm with the rise in the mean AAA explaining roughly 105 percent of the rise in the percentage of farms with tractors.

AAA spending also helped promote farm ownership of automobiles. However, the rise in AAA spending could not fully offset the downward pressure on auto ownership from other forces, as the mean percentage of farms with automobiles fell from 41.9 to 40.4 percent during the Depression. The AAA automobile coefficient of 0.019 is statistically significant in Table 2. Pumping $82 of AAA money per farm into the county would have raised the share of farms owning automobiles by 1.57 percent in Table 3. This finding suggests that the share of farms with autos would have fallen to 38.8 percent without the AAA spending. In contrast, the AAA was negatively related with the share of farms with trucks. The statistically significant coefficient of -.0084 suggests that $82 in AAA spending was associated with lowering the share of trucks by 0.7 percent during a period when the average share of farms with truck rose from 8.2 to 10.4 percent.[19]

The rise in ownership of tractors and automobiles associated with the AAA spending was not associated with a decline in ownership of horses and mules per farm in the cotton counties. The AAA coefficient in the equation for horses per farm in Table 2 is a statistically significant and positive 0.00076. The true effect might be larger because the coefficient is negative and larger in magnitude in the placebo regressions for 1920 through 1930. The coefficient of 0.00076 implies that the addition of $82.2 in AAA spending per farm per year would have increased the number of horses per farm by 0.06 during a decade when the number of horses per farm fell from 1.05 to 1.02. The AAA coefficient for mules per farm was negative, but it was much smaller than in the horse regression at -0.0001 and not statistically significant. There is a chance that the

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[19] We cannot run placebo regressions for the autos and trucks because we have only 1930 and 1940 data. When I run regressions of the levels in 1930 for autos, the coefficient is statistically insignificant and small. The coefficient for the AAA in the truck regression is – and significant so there may be negative selection bias for trucks.

coefficient underestimates the negative effect because the placebo regression coefficient is positive although not statistically significant. The effect of $82 of spending would have reduced the number of mules per farm by -0.01 while the average mules per farm rose from 1.2 to 1.5.

IV.2 AAA Effects for different Tenure groups.

The Census reported information on the value of machinery per farm used on farms at different tenure levels for the years 1925, 1930, and 1940, so we can estimate both the model with actual spending and placebo regressions for the years 1925 and 1930 using the 1940 estimates of the AAA as 1930 values. The results in Tables 2, 3, and 4 show that AAA spending was associated with higher values of machinery per farm at all tenure levels although the effect differed by level. The results from the placebo regressions suggest that the coefficients may be underestimates of the relationship with the AAA for all but full owners. At all tenure levels except for full ownership the placebo AAA coefficients are negative, implying that the AAA funds were being distributed to areas with lower values of machinery per capita before the program went into effect. The coefficient for full owners might be overestimated somewhat because the placebo coefficient was positive and statistically significant, but the placebo coefficient is only about one-seventh the size of the coefficient in the actual regressions and thus the overestimation is likely to be small.

The marginal effect of the AAA was largest for part owners with an additional dollar of AAA spending per farm raising the value of farm machinery by $1.50, followed by full owners at 87 cents and noncropper tenants at 94 cents. An additional AAA dollar

per farm raised the value of machinery by 59 cents for croppers and 47 cents per cash tenants.

The average value of machinery per farm rose in the cotton counties over the decade of the 1920s at all tenure levels. Table 3 shows that the average AAA spending of $82 per 1930 farm might account for as much as 123 percent of the rise in mean value of machinery for full owners and 167 percent of the rise for noncropper tenants. The AAA funds can account for more than the rise in spending for croppers and noncropper tenants, suggesting that other factors were working the other way. The rise in spending for croppers and noncropper tenants may seem odd in light of the findings that the AAA was associated with reductions in the number of croppers and managing share tenants in the mid 1930s (Depew, Fishback, and Rhode 2013). One reason is that the value of machinery reported is the amount that was used to operate the farm, which would have included the capital owned by the landlord as well as any capital owned by the farmer. Another reason may be that landlords had every incentive to cut the less productive tenants and croppers and kept the tenants who were in a better position to increase investment and/or will willing to invest in more machinery to complement the more highly productive tenants.[20]

The Census also reported the value of machinery on farms operated by whites and colored farmers. We cannot perform panel placebo tests for this information because

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[20]The 1940 Census (U.S. Bureau of the Census, *Sixteenth Census of the United States, 1940, Agriculture, Volume III, General Report, Statistics by Subjects.* 1943,.27) reported: "The value of implements and machinery used jointly by two or more farmers was to be enumerated for the farm where the machinery was located on the census date. Specific mention was made of automobiles; motortrucks; trailers; tools; wagons; harnesses; dairy equipment; cotton gins; threshing machines; combines; and apparatus for making cider, grape juice, and sirup, and for drying fruits. Commercial mills and factories, and permanently installed irrigation and drainage equipment were not to be included. For earlier censuses the question…was essentially the same as for 1940 except that no mention was made of permanently installed irrigation and drainage equipment."

information is reported only for 1930 and 1940. To the extent that the comparison of placebo results to actual results found for farm operators of all races are the same for individual races, the reported results by race would likely not be overstated.   The results show that the positive effects for AAA spending on the value of machinery used on the farms were much larger for whites than for colored farmers at all levels. The AAA coefficients for whites at different tenure levels were all positive and statistically significant, while only full owners and tenants among the colored farmers had positive coefficients. As seen in Table 4 the introduction of the AAA would have accounted for 145 percent of the rise in the average value of machinery on white fully owned farms, over 80 percent of the rise for tenants and croppers, and 49 percent for part owners. For colored full owners and tenants, the positive coefficients helped offset declines in the value of machinery and implements on their farms.

IV.3 Results for Loans

The federal farm loan programs offered several types of loans, all at low interest rates. The Farm Credit Administration (FCA) offered mortgages through the Land Bank Commissioner and production loans for seed and tools at the beginning of harvest through a production loan program.   The FCA started with a much larger burst of lending per farm per year in its first two years and then scaled back over time. The amount of average annual loans per farm in the cotton counties was around $100 in 1967$ between 1933 and 1935 and then scaled back to around $50 in the second half of the decade. The Farm Security Administration (FSA) provided loans designed to improve the productivity of specific tenant farmers chosen for their character with the anticipation that they could eventually purchase their own farms. The program got its

start after 1935 and was distributing an average of roughly $50 per farm across the cotton counties. The Disaster Loan Corporation (DLC) began providing loans in response to natural disasters in fiscal year 1937. Because it was so tightly targeted, the mean annual DLC loan per farm in the period from fiscal years 1936 through 1939 was only around 39 cents; in the counties where loans were made the average value per farm per year was $9.30. The Rural Electrification Administration provided loans averaging about $20 per year per farm to electricity cooperatives to extend electric distribution lines to somewhat isolated farms (Kitchens and Fishback 2013) beginning in fiscal year 1936. The Reconstruction Finance Corporation, which started in February 1932 under the Hoover administration would have had indirect effects on farm machinery through loans to banks and industrial entities. In the second half of the decade it was distributing loans of about $1 per capita per year to the cotton counties.

When estimating the relationship between machinery and loans, we include the amount of loans while controlling for interest rates with state-year fixed effects on the grounds that there were a limited number of loans, so that access to loans was important in a credit environment that was heavily constrained by several years of financial problems.

All five loan programs were associated with an increase in farm machinery between 1930 and 1940. In Table 1 the value of machinery per farm rose by 28 cents per farm for an additional dollar of FCA loans, 73 cents for FSA loans, $7.65 for the DLC loans, 71 cents for REA loans, and $2.44 for RFC loans. The placebo coefficients are all either much smaller than the actual coefficients or negative, so the extent to which selection bias would lead the coefficients to overstate the relationship was small. We will

focus on the actual coefficient to examine size, but note that some adjustment might be reasonable.

A move from their zero values to their mean annual values in the late 1930s would help explain a substantial share of the rise in the value of machinery per farm from $270.5 in 1930 to $392 in 1940 shown in Table 3. The average annual loans per 1930 farm of $44.46 for the FCA and $17.90 for the REA each contributed to around 10.5 percent of the increase. The average FSA loans per farm of $43.8 account for 26.4 percent of the change. The small average loan per farm of only 20 cents by the DLC explains only about 1.5 percent of the overall rise, but in the distressed counties where it was heavily targeted, it would have accounted for much more. Using the $5.86 average per farm for counties with positive DLC loans, the DLC loans would help explain about 44 percent of the rise. The $1.10 in RFC loans per capita helps explain about 2.2 percent of the rise.

The loan programs had differential effects on the mix of farm machinery and animals. The FCA mortgage and production loans were related to shifts from farmers using horses, mules, and automobiles to the use of trucks. The FCA coefficients in Table 2 imply that a rise in FCA loans from zero to the mean in the late 1930s of $44.60 was associated with a 0.45 percent increase in the percentage of farms with trucks and a decline of 12 horses and 6 mules per 100 farms. The FCA was statistically significantly associated with more tractors but the FCA placebo coefficient of 0.00066 in the tractor equation is larger than the FCA coefficient of 0.00038 in the actual panel estimation, suggesting that the FCA relationship may have been an artifact of the selection of counties where more loans were distributed. FCA loans did not contribute to increased

automobile purchases, because the FCA coefficient was negative and statistically significant.

The FSA loans to help poor farmers get a new start had little effect on tractors, trucks, autos, or the number of horses or mules on farms. It looks like the higher values of machinery and implements found for the FSA loans went to new implements and smaller machinery.

The REA electrification loans helped promote the use of tractors, automobiles, and trucks with positive and statistically significant coefficients in Table 1. The addition of $17.90 per farm in REA loans was associated in Table 4 with increases of 0.5 tractors per 100 farms, 0.2 percent in the share of farms with trucks, and 0.3 percent in the share of farms with automobiles.

The Disaster Loan Corporation loans stimulated the use of automobiles, mules and tractora while reducing the number of horses per farm. An additional dollar of DLC loans raised the percentage of farms with autos by 0.16 percentage points and the number of mules per 100 farms by 1.69. Both of these marginal effects are larger than any of effects for other New Deal programs.   The DLC loan program was the only program that was associated with a statistically significant increase in the number of mules.

IV.4 Loan Effects in Different Tenure Classes.

When we consider the impact of FSA loans on machinery usage on farms of different tenure classes, it appears that the FSA was following its mandate by targeting tenants and not other parts of the tenure distribution.   An additional dollar of FSA loans increased the value of machinery per farm on tenant (including croppers) farms by 41.8

cents, while having no positive relationship with the machinery per farm on full owners,

part owners, and croppers.   The FSA had similar effects for black and white tenants with

marginal effects of an additional dollar of FSA loans of roughly 60 cents for both white

and colored tenants (including croppers), although only the effect for white tenants.

White croppers appear to have benefited slightly more with a gain of 64 cents associated

with an additional dollar of FSA loans.

The positive effects for black and white tenants and the lack of a positive effect

for colored croppers suggests how the FSA was choosing candidates for its programs.

Their goal was to help farm tenants and workers whom they considered to have the

potential to become independent land owners.   Since colored croppers, particularly the

older ones, were farm laborers paid a share of the crop, they were less likely candidates

for the FSA program than were share tenants; therefore, it is not a surprise that most of

the effects of the program on machinery use were on tenant farms.   There was also some

racial selection into the program going on, as white croppers appear to have benefitted

from the program, while colored croppers did not. [21]

The Disaster Loan Corporation loans aided farms at all levels above croppers.

The marginal effect for the part owners was the largest, followed by noncropper tenants

and cash tenants, then full owners. Many of the placebo coefficients were positive,

although much smaller than the actual coefficients, suggesting that the actual coefficients

should probably be scaled down some. When we focus on race, the DLC loans were

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[21]There is one issue worth considering in more depth. In the case of croppers and to some
degree tenants, the machinery used on the farm may have been owned by the landlord
and not by the farm operator. It might be possible that landlords were grabbing some of
the proceeds from the FSA loans for themselves. To get a better sense of this possibility
will require deeper digging into the narratives about the FSA.

particularly helpful to white part owners and black tenants with marginal effects of $14.77 and $6.24 per dollar for the DLC loans, respectively. These effects should probably be reduced given that we could not do a placebo test for blacks and that the placebo tests for tenants of all races implied some positive selection bias into the programs.

The REA is the one loan program that has statistically significant and positive effects on machinery ownership for full and part owners in the actual panel. In both cases the coefficients are positive and statistically significant in both the actual panel and also in the placebo regression for the 1920s, but the coefficients from the actual panel are about double the size of the placebo coefficients.   In comparisons across race, the machinery on colored part owner farms had the most positive relationship with the REA.

The results for the FCA administration are not consistent with the findings for all farmers or the findings for other farm programs at the various tenure levels. The placebo coefficients are all strongly positive and statistically significant, while many of the actual coefficients are negative. We are not sure what to make of these at this point, and we plan to recheck the data.

IV.5 Public Works and Relief Programs

Relief spending per capita was negatively related to the value of implements and machinery. An additional dollar per capita in relief spending was associated with a statistically significant reduction of $2.50 in the value of machinery. The rise of relief spending to 14.20 in the latter half of the 1930s worked against the trend towards greater use of machinery.   However, there were no specific positive and statistically significant effects for tractors, trucks, or automobiles.   The negative effects were found for full owners, part owners, and tenants (including croppers), noncropper tenants, and cash tenants but were not found for croppers.

If labor was a binding constraint and labor and machinery were complements, then greater availability of labor at lower wages would have been associated with more machinery.   The finding of a negative effect of relief spending on the value of machinery would be consistent with a view that the relief spending was keeping labor out of agricultural work on net. This occurred either because being on relief was an attractive alternative to work or because people were not being released for harvest by the relief programs.

If machinery was a substitute for labor, then having more labor would lead to the use of less machinery. In that situation the negative effect of relief would imply that the relief spending was keeping people in place in the south and thus providing a substitute for machinery that cut the demand to use more machinery. This raises a question as to whether machinery and labor were substitutes or complements. Our plan is to examine

more narrative evidence on farming practice and to start the process of estimating farm production functions.

Public works had a positive and statistically significant effect at the 10 percent level on overall machinery, and specifically on automobiles. The coefficient for the value of overall machinery is statistically significant at 0.103 in Table 3, but the coefficient is roughly one-ninth the size of the AAA coefficient. The addition of public works spending accounted for about 2 percent of the rise in the value of machinery. The primary effect appears to have come through increased spending on automobiles, but the effect was not very large.

IV.6 Results for Other Variables:

The results for other variables are largely consistent with expectations. Machinery per farm was greater in more urban areas, in the dustbowl areas, in areas where the flood of 1927 is interacted with a 1940 year coefficients, in areas with higher temperatures, and in areas with farms that were larger than 259 acres relative to areas with farms of size 100 to 259 acres. Also areas with farms ranging from 50 to 99 acres had more machinery per farm than the areas with more farms between 100 and 259 acres.

V. CONCLUSIONS

During the worst depression in American History, farms increased their use of farm machinery. In the cotton South the rise occurred at every tenure level, ranging from croppers to full ownership. A large part of this rise was stimulated by the introduction of New Deal farm programs. Our regression analysis suggests that the introduction of AAA payments to farmers to take land out of production accounted for about half of the

increase in the real value of farm machinery between 1930 and 1940. The AAA led to more tractors, automobiles and trucks per farm. The strong impact of the AAA was distributed across farms operated by full owners, part owners, tenants and share croppers, as well as for operators of both races. Much of the rest of the increase in farm machinery is associated with the New Deal's introduction of various types of farm loans that provided funds for mortgages, production loans, access to electricity, and disaster loans. The loans typically offered lower than typical market interest rates and access to cash in a

The major New Deal programs that had the most negative influence on farm machinery investment were the relief programs. They were associated with a reduction in the value of farm machinery per farm that was roughly 29 percent of the size of the actual rise that occurred. The interpretation of this finding is determined by whether farm machinery and labor were complements or substitutes in production on the farms. If they were substitutes, the negative result for relief programs suggests that the relief programs helped keep a supply of workers in agricultural areas, which reduced the likelihood of farmers purchasing machinery. If they were complements in production, the negative result implies that relief spending made it more difficult to hire farm workers and thus reduced the demand for farm machinery. We plan further work in studying the narratives of farming and estimating production functions to get a sense of which is the correct interpretation.

The results here add more depth to the understanding of the impact of the New Deal agricultural programs. The AAA powerfully stimulated the use of machinery in farming, but this came at the expense of a significant group of people in the lower parts of the agricultural income distribution. When the AAA paid farmers to take land out of

production, it reduced the demand for labor, which contributed to a sharp decline in the

number of tenants and croppers (Depew, Fishback, and Rhode 2013) and contributed to

outmigration from the areas (Fishback, Horrace, and Kantor 2006). The net effect on

consumption of the AAA was either zero or slightly negative, as the rise in the average

incomes of owners who received the AAA payments rose were offset by the decline in

economic opportunity for farm workers, tenants, and croppers (Fishback, Horrace, and

Kantor 2005).   There were positive effects of the AAA in other dimensions, as there is

evidence that the AAA fostered programs to prevent soil erosion that, in turn, helped

prevent another Dust Bowl in the 1970s (Hansen and Libecap 2004). The out-migration

generated by the AAA came largely from areas where malaria was a problem and thus

reduced the average malaria rates in the South (Barreca, Fishback, and Kantor

REFERENCES

Agricultural Adjustment Administration. Agricultural Adjustment, 1933-1935: A Report
    of the Administration of the Agricultural Adjustment Act May 12, 1933 to
    December 31, 1935.   A76.401:33-40. Washington, D.C.: Government Printing
    Office, 1936.
Agricultural Adjustment Administration. Agricultural Conservation, 1936 Washington,
    D.C.: Government Printing Office, 1937.
Agricultural Adjustment Administration, Division of Finance. 1936 "Memorandum for
    the Administrator.   Report Showing Detailed Analysis of Expenditures from May
    12, 1933 to June 30, 1936." Mimeo. National Agricultural Library in Maryland.
Agricultural Adjustment Administration, Division of Finance. 1935 "Memorandum for
    Mr. Davis. Report Showing Detailed Analysis of Expenditures from July 1, 1934
    to June 30, 1935." Mimeo. National Agricultural Library in Maryland.
Alston (1981) "Tenure Choice in Southern Agriculture." *Explorations in Economic
    History* 18 (1981): 211-232.
Alston, Lee J. and Joseph P. Ferrie. *Paternalism and the American Welfare State:
    Economics, Politics, and Institutions in the U.S. South, 1865-1965*. Cambridge:
    Cambridge University Press, 1999.
Alston, Lee J. and Joseph P. Ferrie. "Time on the Ladder: Career Mobility in
    Agriculture, 1890-1938." *Journal of Economic History*. 65 (December 2005):
    1058-1081.

Alston Lee J. and Robert Higgs (1982) "Contractual Mix in Southern Agriculture Since the Civil War: Facts, Hypotheses and Tests," *Journal of Economic History*, XLII (June 1982): 327-353.

Arnold, C.R. (1958). *1933-1958: Farmers Build Their Own Production Credit System…Organization and first 25 years*. Washington, DC: Farm Credit Administration, August 1958.

Barreca, Alan, Price Fishback, and Shawn Kantor "Agricultural Policy, Migration, and Malaria in the 1930s United States." *Explorations in Economic History* 49 (2012): 381-398.

Biles, Roger, *The South and the New Deal* (Lexington, KY: University of Kentucky Press, 1994).

Bodenhorn, Howard. "A More Perfect Union: Regional Interest Rates in the United States, 1880-1960," in _Anglo-American Financial Systems: Institutions and Markets in the Twentieth Century, pp. 415-53. Edited by Michael D. Bordo and Richard Sylla. Burr Ridge, IL: Irwin Professional Publishing, 1995.

Bodenhorn, Howard. "State Interest Rates in the United States, 1880-1960." Dataset accessed at http://ww2.lafayette.edu/~bodenhoh/DataFiles.htm on January 15, 2008.

Clarke, Sally. "New Deal Regulation and the Revolution in American Farm Productivity: A Case Study of the Diffusion of the Tractor in the Corn Belt, 1920-1940." The *Journal of Economic History*: 51(1), March, 1991, 1201-1213.

Clarke, Sally. *Regulation and the Revolution in United States Farm Productivity*. Cambridge University Press, New York, 1994.

Committee on Banking and Currency. U.S. Senate. 1941. "Hearing on S. 1438 to Extend the Operations of the Disaster Loan Corporation and the Electric Home and Farm Authority, to Provide for Increasing the Lending Authority of the Reconstruction Finance Corporation, and for Other Purposes, May 8, 1941." 71st Congress 1st session. Washington, D.C.: Government Printing Office.

Coyle, David Cushman. "The WPA—Loafers or Workers?" Reprint from *Forum and Century*. March 1939, no page numbers listed. WPA Records. Records of the Statistics Division, Entry 27. Box 40, National Archives II in College Park, Maryland.

Cunfer, Geoffrey. 2005. *On the Great Plains: Agriculture and Environment.* College Station, TX: Texas A&M Press.

Day, Richard. "The Economics of Technological Change and the Demise of the Sharecropper." *American Economic Review*, 57(2), June 1967, 427-449.

Depew Briggs, Price Fishback, and Paul Rhode. "New Deal or No Deal in the Cotton South: The Effect of the AAA on the Agriculture Labor Structure." *Explorations in Economic History* 50 (October 2013): 466-486.

Farm Credit Administration, *Financing Agriculture in 1934* (Washington, D.C: GPO, 1935).

_____, *Farm Credit Quarterly*, June 1936 (Washington, D.C.: GPO, 1936).

Federal Trade Commission. *Report on the Agricultural Implement and Machinery Industry, 2 parts.* House Document No. 702, 75th Congress, 3d session. Washington, D.C.: U.S. Government Printing Office, 1938.

Fishback, Price, William Horrace, and Shawn Kantor. 2005. "Did New Deal grant programs stimulate local economies? A study of Federal grants and retail sales during the Great Depression," *The Journal of Economic History 65 (*March): 36-71.

_____. 2006. "The Impact of New Deal Expenditures on Mobility During the Great Depression," *Explorations in Economic History*," 43 (April): 179-222

Haines, Michael. Historical, Demographic, Economic and Social Data: The United States, 1790-2000. Inter-University Consortium for Political And Social Research Data Set 2896, undated.

Haines, Michael, Price Fishback, and Paul Rhodes. 2014. United States Agriculture Data, 1840-2010. ICPSR 35206.

Halcrow, Harold G. *Agricultural Policy of the United States*. New York: Prentice-Hall, 1953.

Hansen, Zeynep and Gary Libecap. "Small Farms, Externalities, and the Dust Bowl of the 1930s." *Journal of Political Economy* 112 (June 2004): 665-694.

Hoffsomer, Harold, editor. *The Social and Economic Significance of Land Tenure in the Southwestern States: A Report of the Regional Land Tenure Project*. Chapel Hill, NC: University of North Carolina Press, 1950.

Holley, William C., Ellen Winston, and Thomas Jackson Woofter. *The Plantation South, 1934*-1937. Freeport, NY, Books for Library Press, 1971 (reprint of 1940 edition).

Hornbeck, Richard. 2012. "The Enduring Impact of the American Dust Bowl: Short- and Long-run Adjustments to Environmental Catastrophe." *American Economic Review* 102(4) (June): 1477-1507.

Hornbeck, Richard and Suresh Naidu. 2014. "When the Levee Breaks: Labor Mobility and Economic Development in the American South." *American Economic Review* 104(3) (March): 963-990.

Howard, Donald S., *The WPA and Federal Relief Policy* (New York: Russell Sage oundation, 1943).

Inter-University Consortium for Political and Social Research, Historical, Demographic, Economic, and Social Data: The United States, 1790-1970, ICPSR Number 2856.

Jones, Jesse H, Reconstruction Finance Corporation Seven-Year Report to the President and the Congress of the United States, February 2, 1932 to February 2, 1939, Reconstruction Finance Corporation pamphlet, 1939.

Jones, Jesse H., *Summary of the Activities of the Commodity Credit Corporation through June 30, 1939.* U.S. House of Representatives Document No. 449, 76th Congress, 1st Session. Washington, DC: U.S. Government Printing Office, 1939.

Kitchens, Carl and Price Fishback. Forthcoming. "Flip the Switch: The Spatial Impact of the Rural Electrification Administration 1935-1940" *Journal of Economic History*.

Manuelli, Rodolfo and Ananth Seshadri. "Frictionless Technology Diffusion: The Case of Tractors." Unpublished working paper. University of Wisconsin-Madison Department of Econmics, September 2004.

Martini, Dinah Duffy and Eugene Silberberg. "The Diffusion of Tractor Technology." *The Journal of Economic History* 66 (June 2006): 354-389.

Mertz, Paul E. *New Deal Policy and Southern Rural Poverty*. Baton Rouge, LA, Louisiana State University Press, 1978.

National Climate Data Center, Time Bias Corrected Statewide-Regional-National Temperature-Precipitation, 1895-2000, http://www.noaa.ncdc.gov.

Neumann, Todd, Price Fishback, and Shawn Kantor. 2010. "The Dynamics of Relief Spending and the Private Urban Labor Market During the New Deal." *Journal of Economic History* 70 (March 2010): 195-220

Nguyen, Hoa. 2015. "The Impact of Access to Roads on Farm Ownership of Cars and Trucks." Dissertation Chapter. University of Arizona.

Nourse, Edwin G., Joseph S. Davis, and John D. Black, Three Years of the Agricultural Adjustment Administration. Washington, D.C.: The Brookings Institution, 1937.

Olmstead, Alan L. & Rhode, Paul W. "Reshaping the landscape: The Impact and Diffusion of the Tractor in American Agriculture, 1910-1960." *The Journal of Economic History* 61(3), Sep 2001: 663-698.

Olmstead, Alan. "The Mechanization of Reaping and Mowing in American Agriculture, 1833-1870." *Journal of Economic History* 35 (June 1975): 327-52.

Olson, James S., *Saving Capitalism: The Reconstruction Finance Corporation and the New Deal, 1933-1940* (Princeton, NJ: Princeton University Press, 1988).

Peterson, Willis & Kislev, Yoav. "The Cotton Harvester in Retrospect: Labor Displacement or Replacement?" *The Journal of Economic History*: 46(1), March 1986, 199-216.

Saloutos, Theodore. "New Deal Agricultural Policy: An Evaluation." *The Journal of American History*: 61(2), September, 1974, 394-416.

Schuler, E.A. *Social Status and Farm Tenure—Attitudes and Social Conditions of Corn Belt and Cotton Belt Farmers*. Social Research Report No. 1, V., U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington, April 1938.

Sechrist, Robert P. *Basic Geographic and Historic Data for Interfacing ICPSR Data Sets, 1620-1983 (United States)*. Inter-university Consortium for Political and Social Research, Spring 1984.

Spatial Data Set "ussoils", USGS: http://water.usgs.gov/lookup/getspatial?ussoils

U.S. Bureau of Agricultural Economics. Division of Crop and Livestock Estimates. "Prices Paid by Farmers for Farm Machinery, January 24-27, 1934." Washington, D.C, December 27, 1934. Mimeo.

U.S. Bureau of the Census. *Fifteenth Census of the United States, 1930, Population, Volume III: Reports by States, Showing the Composition and Characteristics for Counties, Cities, and Townships or Other Minor Civil Divisions. Parts I and II*. Washington, D.C.: Government Printing Office, 1932.

U.S. Bureau of the Census. *Fifteenth Census of the United States, 1930, Population, Volume VI: Families*. Washington, D.C.: Government Printing Office, 1933.

U.S. Bureau of the Census, *United States Census of Agriculture, 1935, Statistics by Counties with State and U.S. Summaries*. 2 volumes. Washington, D.C.: Government Printing Office, 1936.

U.S. Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970* (Washington, DC: GPO, 1975).

U.S. Bureau of the Census. *Sixteenth Census of the United States: 1940 Agriculture, First and Second Series State Reports: Statistics for Counties*. Washington, DC: Government Printing Office, 1942.

U.S. Bureau of the Census. *Sixteenth Census of the United States, 1940, Agriculture, Volume III, General Report, Statistics by Subjects.* Washington, DC: Government Printing Office, 1942.

U.S. Department of Agriculture, *Agricultural Statistics*. Washington, DC: U.S. Government Printing Office, 1939.

US Department of Agriculture. 1940. Average Rates of Interest Charged on Farm-mortgage Recordings...", November 1940. ????Need fuller Citation..

U.S. Department of Agriculture. *Report of the Secretary of Agriculture*. Washington, D.C.: Government Printing Office, various years.

U.S. Office of Government Reports, Statistical Section, Report No. 9, Volume 1, "Direct and Cooperative Loans and Expenditures of the Federal Government for Fiscal Years 1933 through 1939." Mimeo, 1940.

U.S. Office of Government Reports, Statistical Section, Report No. 10, Volume 1, "County Reports of Estimated Federal Expenditures March 4 1933-June 30, 1939," Mimeo, 1940.

U.S. Resettlement Administration. *First Annual Report of the Resettlement Administration*. Washington, D.C.: Government Printing Office, 1936.

Virts, Nancy. "Change in the Plantation System: American South, 1910-1945." *Explorations in Economic History* 43 (January 2006); 153-76.

Volanto, Keith J., "Leaving the Land: Tenant and Sharecropper Displacement in Texas during the New Deal," *Social Science History*, 1996, *20* (4), 533-551.

Volanto, Keith J., *Texas, Cotton, and the New Deal*, Texas A&M University Press, 2005.

Whatley, Warren C. "Labor for the Picking: The New Deal in the South." *The Journal of Economic History*: 45(4), Dec 1983: 905-929.

Whatley, Warren C. "A History of Mechanization in the Cotton South: The Institutional Hypothesis." *The Quarterly Journal of Economics*: 100(4), Nov 1985, 1191-1215.

Whatley, Warren C. "Southern Agrarian Labor Contracts as Impediments to Cotton Mechanization." *The Journal of Economic History*: 47(1), March 1987, 45-70.

White, William. "An Unsung Hero: The Farm Tractor's Contribution to Twentieth-Century United States Economic Growth*." The Journal of Economic Histor*y 61 (June 2001): 493-496.

White, William. "An Unsung Hero: The Farm Tractor's Contribution to Twentieth-Century United States Economic Growth." Unpublished Ph.D. dissertation, The Ohio State University, 2000.

Williams, Edward Ainsworth*, Federal Aid for Relief* (New York: AMS Press, reprint, 1968).

Works Progress Administration. Series of Internal Memos on Labor Shortages with no names attached. 1937. WPA Records. Records of the Statistics Division, Entry 27, Box 40, National Archives II in College Park, Maryland.

Figure 1
Indices of Ratio of Farm Wholesale Prices to Nonfarm Wholesale Prices and Crop Production per Acre Harvested, (1967=100)
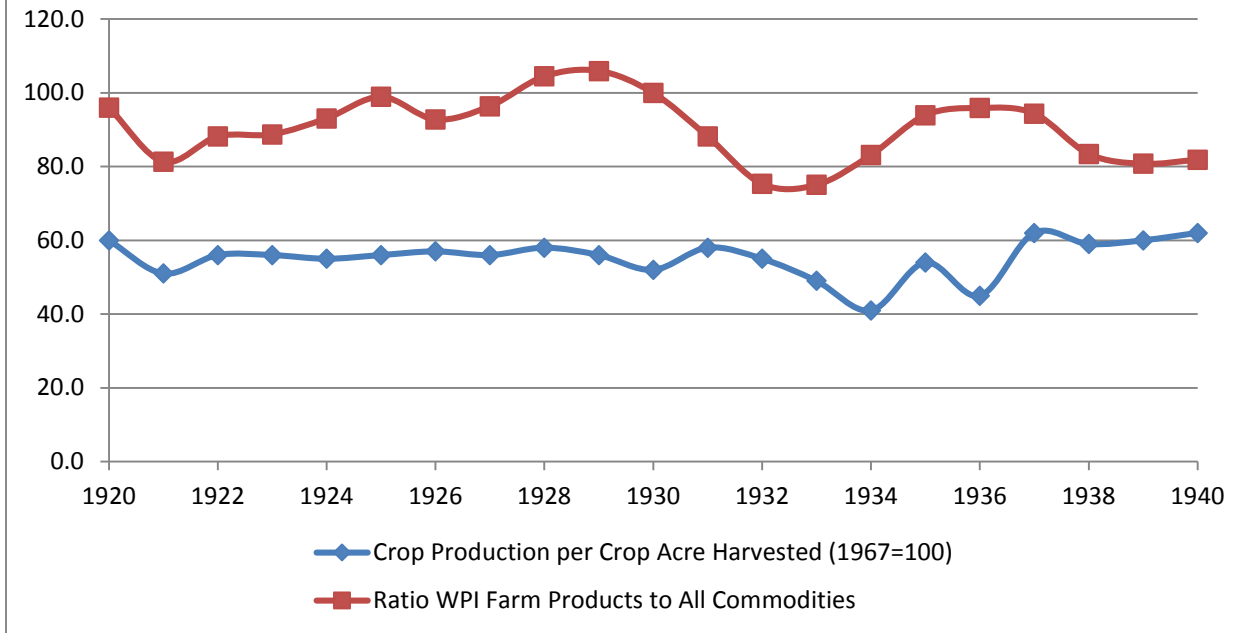
Figure 2
Real Value of Machinery Per Farm (1930=100) and the Number per Farm of Tractors, Automobiles, and Trucks
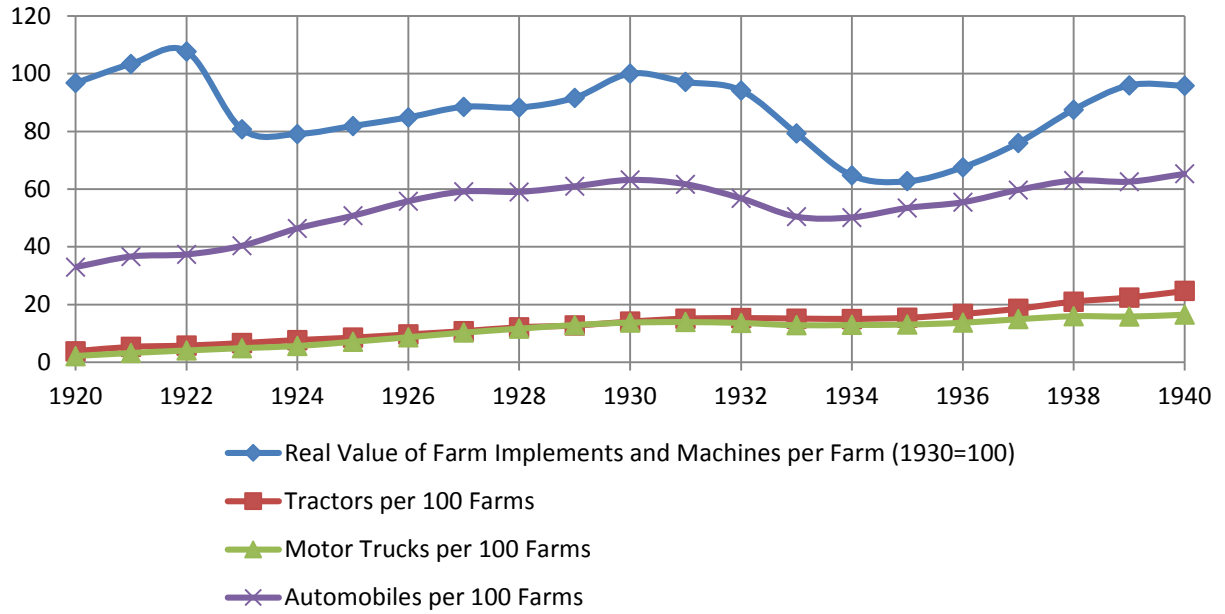
Figure 3
Indices (1930=100) for Number of Farms, Farm Population, Total Acreage in Farms, and Average Farm Size, 1920-1940
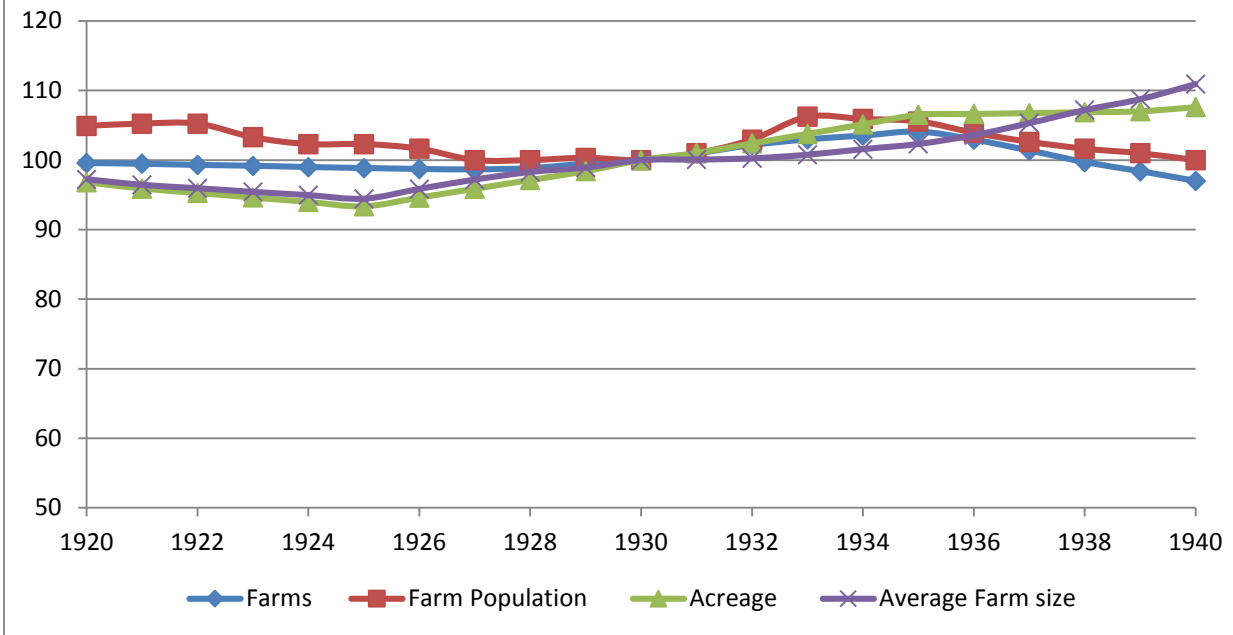
Figure 4
Indices of Cotton Bales per Acre and Ratio of Cotton Prices to NonFarm Wholesale Prices, 1890=1
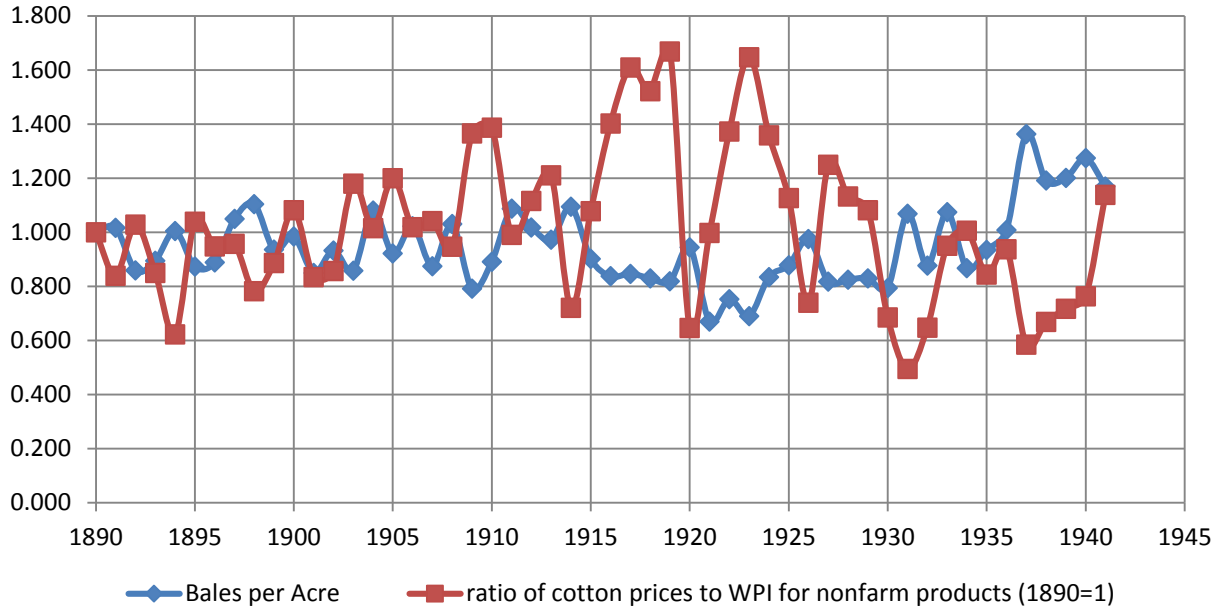
TABLE 1
Unweighted Means for Implements and Machinery and Animals per Farm from Counties
Producing more than 100 Bales of Cotton Per Year

	1920	1925	1930	1935	1940
Number of Tractors per Farm		0.032	0.056		0.13
Percent of Farms with Tractors			4.8		11.4
Percent of Farms with Autos			41.9		40.4
Percent of Farms with Trucks			8.2		10.4
Number of Autos per Farm					
Number of Trucks per Farm			0.087		0.113
Number of horses per farm	1.88	1.35	1.05	0.906	1.02
Number of mules per farm	1.4	1.62	1.54	1.34	1.21
Real Value Machinery Per Farm					
All	262	215	271		392
Full Owners		311	383		441
Part Owners		343	480		700
Tenants and Croppers		143	181		275
Croppers		101	122		147
Noncropper Tenants		163	211		257
Cash Tenants		194	214		274
Colored Full Owners			184		122
Colored Part Owners			141		173
Colored Tenants and Croppers			77		73
Colored Croppers			65		87

Sources and Notes: U.S. Bureau of Census (1923, 1927, 1933, 1937, 1943).
Information for years is blank when the Census did not report county data for that year.

Table 2
Estimates of the Relationship between New Deal Programs and Machinery Choices with Time and County Fixed Effects and State by Year Fixed Effects, Actual and Placebo Regression Results
t-statistics in italics below the coefficient

Category with Years used in Estimation	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Real Value Machinery per Farm 20, 25, 30, 40	0.908	0.103	-2.512	0.733	0.280	0.713	7.653	2.437	392	271	122
	4.72	*1.65*	*-2.71*	*2.53*	*2.92*	*1.55*	*4.85*	*1.84*	*389*	*323*	
Placebo 20-30 putting 40 in 30, 35 in 30	0.173	-0.037	0.436	0.262	-0.615	0.145	0.894	-0.367	392	271	122
	4.32	*-0.88*	*1.13*	*1.23*	*-33.70*	*1.19*	*1.60*	*-4.63*	*389*	*323*	
Tractors per farm 25, 30, 40	0.0009	0.00007	-0.0007	-0.00002	0.00038	0.00029	0.0011	0.00061	0.133	0.0566	0.076
	8.20	*2.97*	*-2.13*	*-0.45*	*6.49*	*2.07*	*1.63*	*0.93*	*0.20*	*0.11*	
Placebo 25 30 using 1940 values	-0.0001	0.00002	0.00003	-0.00006	0.00066	-0.00005	0.0004	0.0012	0.133	0.0566	0.076
	-3.79	*0.80*	*0.12*	*-1.41*	*16.27*	*-0.51*	*1.93*	*1.32*	*0.20*	*0.11*	
Pct. Farms with Tractors, 30 40	0.0839	0.0015	-0.0686	0.0026	0.0157	0.0165	0.0556	0.0287	11.4	4.82	6.580
	8.29	*0.73*	*-1.45*	*0.70*	*3.94*	*1.26*	*0.86*	*0.50*	*16.80*	*8.49*	
Pct Farms with Trucks 30 40	-0.0084	0.00005	-0.0106	-0.0064	0.0045	0.0775	0.0775	-0.1677	10.39	8.24	2.150
	-5.19	*0.03*	*-0.55*	*-1.28*	*2.62*	*1.38*	*1.38*	*-1.83*	*7.51*	*7.15*	
Pct. Farms with Autos, 30 40	0.0191	0.0060	0.0059	-0.0048	-0.0116	0.0190	0.1601	0.0233	40.4	41.87	-1.470
	3.08	*1.69*	*0.14*	*-0.91*	*-2.30*	*1.66*	*1.70*	*0.64*	*22.07*	*18.71*	
Horses per Farm, 20-40	0.00076	-0.00029	0.005	-0.00058	-0.0027	-0.0022	-0.0154	-0.002	1.02	1.048	-0.028

	6.10	-1.92	1.30	-1.70	-14.69	-1.13	-2.70	-4.06	1.34	1.41	
Placebo 20-30 putting 40 in 30, 35 in 25	-0.0014	-0.0007	0.0002	-0.0001	0.0008	0.00166	0.00155	-0.0011	1.02	1.048	-0.028
	-10.70	*-1.66*	*0.11*	*-0.24*	*3.71*	*0.89*	*0.35*	*-0.98*	*1.34*	*1.41*	
Mules per Farm, 20-40	-0.00013	-0.0003	-0.0005	-0.0009	-0.0013	-0.0003	0.0169	0.0008	1.21	1.539	-0.329
	-0.47	*-0.95*	*-0.44*	*-1.09*	*-17.90*	*-0.45*	*2.04*	*1.43*	*0.48*	*0.668*	
Placebo 20-30 putting 40 in 30, 35 in 25	0.0001	-0.0004	-0.0008	-0.002	0.0007	-0.001	0.003	-0.008	1.21	1.539	-0.329
	0.61	*-1.53*	*-0.46*	*-3.90*	*5.30*	*-1.80*	*1.54*	*-1.28*	*0.48*	*0.668*	

TABLE 2 Cont.	Coefficient with t-statistics in italics below										
REAL VALUE MACHINERY PER FARM 25, 30, 40 by Type of Operator	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full	0.870	0.012	-0.893	-0.176	-0.127	1.113	3.193	0.267	441	383	58
	5.36	*0.28*	*-1.43*	*-1.67*	*-0.98*	*2.33*	*1.78*	*0.14*	*358*	*319*	
Placebo 25-30 using 40 values	0.115	0.066	0.869	-0.804	1.598	0.589	0.143	1.499	441	383	58
	1.75	*0.62*	*3.13*	*-4.24*	*10.24*	*2.29*	*0.19*	*1.12*	*358*	*319*	
Own Part	1.501	-0.109	-1.773	0.014	-0.221	1.359	10.895	-0.205	700	480	219
	7.87	*-0.42*	*-1.03*	*0.02*	*-2.03*	*1.69*	*2.50*	*-0.05*	*679*	*588*	
placebo 25-30 using 40 values	-0.835	0.169	-1.890	1.162	2.708	0.892	4.326	7.288	700	480	219
	-2.48	*1.23*	*-0.65*	*1.78*	*20.80*	*1.23*	*1.14*	*2.64*	*679*	*588*	
Tenant (includes croppers)	0.825	0.168	-1.943	0.611	-0.003	0.502	6.822	2.798	275	181	94
	4.77	*4.76*	*-1.79*	*3.40*	*-0.02*	*1.50*	*2.84*	*2.56*	*328*	*277*	
Placebo 25-30 using 40 values	-0.427	0.020	0.245	-0.394	1.897	-0.197	1.953	0.562	275	181	94
	-7.38	*0.71*	*0.62*	*-3.07*	*10.04*	*-0.52*	*2.41*	*0.88*	*328*	*277*	
Croppers	0.585	0.034	0.161	-0.335	0.289	0.175	-2.204	-0.124	147	122	25

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
	4.04	*0.42*	*0.30*	*-1.86*	*3.05*	*1.04*	*-1.57*	*-0.15*	*212*	*182*	
Placebo 25-30 using 40 values	-0.320	0.032	0.041	-0.275	0.973	-0.030	-0.450	-0.861	147	122	25
	-2.47	*1.64*	*0.08*	*-2.09*	*14.46*	*-0.25*	*-0.25*	*-1.57*	*212*	*182*	
Tenant noncropper	0.943	0.132	-0.873	0.418	-0.111	0.414	5.849	5.848	257	211	47
	6.14	*1.66*	*-0.94*	*1.54*	*-0.56*	*1.28*	*1.51*	*1.51*	*281*	*292*	
Placebo 25-30 using 40 values	-0.235	0.030	0.366	-0.547	1.994	-0.208	1.287	0.411	257	211	47
	-6.03	*0.99*	*0.94*	*-2.76*	*8.71*	*-0.47*	*1.34*	*1.32*	*281*	*292*	
Tenant Cash	0.472	0.158	-1.597	-0.140	0.081	0.303	7.777	-3.163	274	214	59
	3.41	*4.47*	*-2.65*	*-0.76*	*0.60*	*1.23*	*2.93*	*-1.61*	*296*	*219*	
Placebo 25-30 using 40 values	-0.249	0.065	-0.226	-0.431	1.017	-0.462	-0.455	-4.917	274	214	59
	-1.56	*1.17*	*-0.25*	*-3.35*	*6.94*	*-0.72*	*-0.77*	*-2.20*	*296*	*219*	

TABLE 2 Cont. Coefficient with t-statistics in italics below

REAL VALUE MACHINERY PER FARM 25, 30, 40 by race and type of operator	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full Colored, 30 40	0.470	-0.573	-3.963	-3.829	2.274	0.373	-0.301	10.590	122	185	-63
	1.54	*-1.79*	*-0.91*	*-0.90*	*1.05*	*0.47*	*-0.19*	*0.91*	*104*	*1029*	
Own Part Colored 30 40	-0.923	0.187	-5.445	-0.608	1.405	1.116	-1.159	7.329	174	141	33
	-1.34	*1.90*	*-2.01*	*-2.12*	*1.05*	*2.39*	*-0.29*	*3.31*	*341*	*210*	
Tenant Colored 30 40	0.120	-0.157	-0.246	0.609	-0.367	-0.413	6.239	0.984	73	77	-4
	2.49	*-8.88*	*-0.51*	*1.49*	*-1.92*	*0.16*	*2.09*	*0.44*	*110*	*73*	
Cropper Colored 30 40	0.054	0.048	-0.017	-0.071	-0.653	-0.321	-0.975	1.199	73	66	7
	0.38	*0.53*	*-0.04*	*-0.51*	*-1.69*	*-2.22*	*-0.45*	*0.95*	*110*	*67*	
Own Full White, 30 40	1.082	-0.085	-1.835	0.009	-0.675	1.006	0.388	-2.193	494	433	62
	3.97	*-0.97*	*-2.73*	*0.08*	*-4.75*	*1.65*	*0.17*	*-1.03*	*458*	*364*	

Own Part White 30	2.190	-0.166	-0.446	-0.447	-1.239	0.086	14.774	-5.277	802	433	369
40	*6.83*	*-0.33*	*-0.28*	*-0.28*	*-3.60*	*0.06*	*1.82*	*-0.95*	*784*	*364*	
Tenant White 30	1.055	0.086	-1.782	0.601	-0.827	0.303	3.425	1.734	308	210	98
40	*4.21*	*1.51*	*-2.65*	*2.07*	*-5.31*	*1.51*	*1.22*	*1.14*	*329*	*277*	
Cropper White 30	1.078	0.025	-0.499	0.641	-0.340	0.581	-4.279	-1.078	238	139	99
40	*3.38*	*0.26*	*-0.68*	*1.93*	*-3.01*	*2.18*	*-1.42*	*-0.69*	*264*	*187*	
Mean/St. Dev in 40	82.2	23.1	14.2	43.8	44.6	17.9	0.2	1.1			
	75.8	*40.1*	*10.1*	*36.7*	*58.9*	*21.4*	*2.8*	*2.6*			

Notes and Sources: Each row in the table is from a separate Regression with county fixed effects, year fixed effects, state by year fixed effects and the following time-varying covariates: percent illiterate, pct colored, percent urban, percent foreign born, percents of various age groups attending school (7-13, 14-15, 16-17, and 18-20), dustbowl, flooding in 1927 interacted with years 1930, 1935, and 1940; the following weather variables for each of the previous four years: average daily time-adjusted temperature, precipitation, number of months with extreme drought, number of months with severe drought, number of months of extreme wetness, and number of months of severe westness; output per acre of cotton lint harvested; percentages of farms in which the operator owned in full, part-owned, was a cropper, or was a noncropper tenant (left out category was manager); percentages of farms under 10 acres, 10 to 49 acres, 50 to 99 acres, 260 to 499 acres, 500 to 999 acres, and more than 1000 acres (left out category was 100 to 259 acres). The sample was restricted to the 905 counties with cotton production of at least 100 bales all of the census years. For sources, see text and Data appendix. No placebo tests were run for the percentages of farms with tractors, trucks, and autos because we only have information for 1930 and 1940 and therefore cannot run a panel using data from the 1920s. When we do placebo tests using the levels of each in 1930 with artificial New Deal programs, the coefficients are typically not statistically significant.

Table 3
Change in Mean Machinery Measures Attributable to the New Deal Annual Mean Value,
Based on Coefficients in Table 2

TABLE 3	Percentage of Change from 1930 to 1940 attributable to Program										
	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Real Value Machinery per Farm 20-40	61.4	2.0	-29.3	26.4	10.3	10.5	1.5	2.2	392 389	271 323	122
Placebo 20-30 putting 40 in 30, 35 in 30	11.7	-0.7	5.1	9.5	-22.6	2.1	0.2	-0.3	392 389	271 323	122
Tractors per farm 25, 30, 40	96.8	2.1	-13.0	-0.9	22.2	6.7	0.4	0.9	0.133 0.203	0.057 0.108	0.076
Placebo 25 30 using 1940 values	-10.8	0.6	0.6	-3.4	38.6	-1.2	0.1	1.8	0.133 0.200	0.057 0.108	0.076
Pct. Farms with Tractors, 30 40	104.8	0.5	-14.8	1.7	10.7	4.5	0.2	0.5	11.400 16.800	4.820 8.490	6.580
Pct Farms with Trucks 30 40	-32.1	0.1	-7.0	-13.0	9.3	64.6	0.9	-8.7	10.390 7.510	8.240 7.150	2.150
Pct. Farms with Autos, 30 40	-106.8	-9.5	-5.7	14.3	35.2	-23.1	-2.7	-1.8	40.400 22.070	41.870 18.710	-1.470
Horses per Farm, 20-40	-223.1	23.9	-252.7	90.8	425.7	140.7	13.5	7.9	1.020 1.340	1.048 1.410	-0.028

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Placebo 20-30 putting 40 in 30, 35 in 30	411.0	57.7	-10.1	15.7	-127.5	-106.2	-1.4	4.4	1.020 / 1.340	1.048 / 1.410	-0.028
Mules per Farm, 20-40	3.1	2.1	2.2	12.0	17.6	1.6	-1.3	-0.3	1.210 / 0.480	1.539 / 0.668	-0.329
Placebo 20-30 putting 40 in 30, 35 in 30	-2.5	2.8	3.4	26.6	-9.5	5.4	-0.2	2.7	1.210 / 0.480	1.539 / 0.668	-0.329

TABLE 3 (cont) — Percentage of Change from 1930 to 1940 attributable to Program

REAL VALUE MACHINERY PER FARM 25, 30, 40	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full	123.4	0.5	-21.8	-13.3	-9.8	34.4	1.3	0.5	441 / 358	383 / 319	58
Placebo 25-30 using 40 values	16.3	2.6	21.2	-60.7	123.0	18.2	0.1	2.9	441 / 358	383 / 319	58
Own Part	56.2	-1.1	-11.4	0.3	-4.5	11.1	1.2	-0.1	700 / 679	480 / 588	219
placebo 25-30 using 40 values	-31.3	1.8	-12.2	23.2	55.1	7.3	0.5	3.7	700 / 679	480 / 588	219
Tenant (includes croppers)	72.0	4.1	-29.2	28.4	-0.1	9.5	1.8	3.3	275 / 328	181 / 277	94
Placebo 25-30 using 40 values	-37.3	0.5	3.7	-18.3	90.0	-3.8	0.5	0.7	275 / 328	181 / 277	94
Croppers	190.0	3.1	9.0	-58.0	51.0	12.4	-2.1	-0.5	147	122	25

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
									212	182	
Placebo 25-30 using 40 values	-103.9	2.9	2.3	-47.7	171.6	-2.1	-0.4	-3.8	147 / 212	122 / 182	25
Tenant noncropper	166.7	6.5	-26.6	39.3	-10.7	15.9	3.1	14.1	257 / 281	211 / 292	47
Placebo 25-30 using 40 values	-41.5	1.5	11.1	-51.5	191.4	-8.0	0.7	1.0	257 / 281	211 / 292	47
Tenant Cash	65.4	6.1	-38.1	-10.3	6.1	9.1	3.2	-6.0	274 / 296	214 / 219	59
Placebo 25-30 using 40 values	-34.5	2.5	-5.4	-31.9	76.6	-14.0	-0.2	-9.3	274 / 296	214 / 219	59

TABLE 3 (cont) Percentage of Change from 1930 to 1940 attributable to Program

REAL VALUE MACHINERY PER FARM 25, 30, 40	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full Colored, 30 40	-61.5	21.1	89.4	267.6	-161.8	-10.6	0.1	-18.9	122 / 104	185 / 1029	-63
Own Part Colored 30 40	-228.0	12.9	-231.6	-80.1	188.5	60.1	-0.9	24.7	174 / 341	141 / 210	33
Tenant Colored 30 40	-270.7	99.8	95.5	-732.7	450.1	203.2	-42.0	-30.3	73 / 110	77 / 73	-4
Cropper Colored 30 40	60.0	15.0	-3.2	-42.1	-396.1	-78.0	-3.2	18.2	73 / 110	66 / 67	7
Own Full White, 30	144.3	-3.2	-42.1	0.6	-48.9	29.2	0.2	-4.0	494	433	62

40									458	364	
Own Part White 30	48.8	-1.0	-1.7	-5.3	-15.0	0.4	1.0	-1.6	802	433	369
40									784	364	
Tenant White 30 40	88.4	2.0	-25.7	26.8	-37.6	5.5	0.9	2.0	308	210	98
									329	277	
Cropper White 30 40	89.2	0.6	-7.1	28.3	-15.3	10.5	-1.1	-1.2	238	139	99
									264	187	

Notes and Sources: See notes to Table 2 to see the information about the regressions run. Each row refers to a single regression with the correlates listed in the notes to Table 2. The formula for calculating the change in the machinery variable attributable to the New Deal mean is Coeff*(NDA), where Coeff is the coefficient from Table 2 and NDA is the mean of the annual average of the New Deal variable.   Since the New Deal variable is zero in 1930 the NDA measure is a measure of the change in the impact of the New Deal measure between 1930 and 1940.

Table 4

Percentage of Change in Mean Value Between 1930 and 1940 Attributable to the New Deal Variables,
Based on Estimates in Tables 2 and 3.

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Real Value Machinery per Farm 20-40	61.4	2.0	-29.3	26.4	10.3	10.5	1.5	2.2	392 389	271 323	122
Placebo 20-30 putting 40 in 30, 35 in 30	11.7	-0.7	5.1	9.5	-22.6	2.1	0.2	-0.3	392 389	271 323	122
Tractors per farm 25, 30, 40	96.8	2.1	-13.0	-0.9	22.2	6.7	0.4	0.9	0.133 0.203	0.057 0.108	0.076
Placebo 25 30 using 1940 values	-10.8	0.6	0.6	-3.4	38.6	-1.2	0.1	1.8	0.133 0.200	0.057 0.108	0.076
Pct. Farms with Tractors, 30 40	104.8	0.5	-14.8	1.7	10.7	4.5	0.2	0.5	11.400 16.800	4.820 8.490	6.580
Pct Farms with Trucks 30 40	-32.1	0.1	-7.0	-13.0	9.3	64.6	0.9	-8.7	10.390 7.510	8.240 7.150	2.150
Pct. Farms with Autos, 30 40	-106.8	-9.5	-5.7	14.3	35.2	-23.1	-2.7	-1.8	40.400 22.070	41.870 18.710	-1.470
Horses per Farm, 20-40	-223.1	23.9	-252.7	90.8	425.7	140.7	13.5	7.9	1.020 1.340	1.048 1.410	-0.028

58

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Placebo 20-30 putting 40 in 30, 35 in 30	411.0	57.7	-10.1	15.7	-127.5	-106.2	-1.4	4.4	1.020 / 1.340	1.048 / 1.410	-0.028
Mules per Farm, 20-40	3.1	2.1	2.2	12.0	17.6	1.6	-1.3	-0.3	1.210 / 0.480	1.539 / 0.668	-0.329
Placebo 20-30 putting 40 in 30, 35 in 30	-2.5	2.8	3.4	26.6	-9.5	5.4	-0.2	2.7	1.210 / 0.480	1.539 / 0.668	-0.329

TABLE 3 (cont)   Percentage of Change from 1930 to 1940 attributable to Program

REAL VALUE MACHINERY PER FARM 25, 30, 40 by type of operator	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full	123.4	0.5	-21.8	-13.3	-9.8	34.4	1.3	0.5	441 / 358	383 / 319	58
Placebo 25-30 using 40 values	16.3	2.6	21.2	-60.7	123.0	18.2	0.1	2.9	441 / 358	383 / 319	58
Own Part	56.2	-1.1	-11.4	0.3	-4.5	11.1	1.2	-0.1	700 / 679	480 / 588	219
placebo 25-30 using 40 values	-31.3	1.8	-12.2	23.2	55.1	7.3	0.5	3.7	700 / 679	480 / 588	219
Tenant (includes croppers)	72.0	4.1	-29.2	28.4	-0.1	9.5	1.8	3.3	275 / 328	181 / 277	94
Placebo 25-30 using 40 values	-37.3	0.5	3.7	-18.3	90.0	-3.8	0.5	0.7	275 / 328	181 / 277	94
Croppers	190.0	3.1	9.0	-58.0	51.0	12.4	-2.1	-0.5	147	122	25

	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
									212	182	
Placebo 25-30 using 40 values	-103.9	2.9	2.3	-47.7	171.6	-2.1	-0.4	-3.8	147	122	25
									212	182	
Tenant noncropper	166.7	6.5	-26.6	39.3	-10.7	15.9	3.1	14.1	257	211	47
									281	292	
Placebo 25-30 using 40 values	-41.5	1.5	11.1	-51.5	191.4	-8.0	0.7	1.0	257	211	47
									281	292	
Tenant Cash	65.4	6.1	-38.1	-10.3	6.1	9.1	3.2	-6.0	274	214	59
									296	219	
Placebo 25-30 using 40 values	-34.5	2.5	-5.4	-31.9	76.6	-14.0	-0.2	-9.3	274	214	59
									296	219	

TABLE 3 (cont) Percentage of Change from 1930 to 1940 attributable to Program

REAL VALUE MACHINERY PER FARM 25, 30, 40 by race and type of operator	AAA per farm	Public Works Per Capita	Relief Per Capita	FSA per Farm	FCA per Farm	REA per Farm	DLC per farm	RFC per capita	Mean/St. Dev in 40	Mean/St. Dev in 1930	Diff in Mean
Own Full Colored, 30 40	-61.5	21.1	89.4	267.6	-161.8	-10.6	0.1	-18.9	122	185	-63
									104	1029	
Own Part Colored 30 40	-228.0	12.9	-231.6	-80.1	188.5	60.1	-0.9	24.7	174	141	33
									341	210	
Tenant Colored 30 40	-270.7	99.8	95.5	-732.7	450.1	203.2	-42.0	-30.3	73	77	-4
									110	73	
Cropper Colored 30 40	60.0	15.0	-3.2	-42.1	-396.1	-78.0	-3.2	18.2	73	66	7
									110	67	

Own Full White, 30 40	144.3	-3.2	-42.1	0.6	-48.9	29.2	0.2	-4.0	494 458	433 364	62
Own Part White 30 40	48.8	-1.0	-1.7	-5.3	-15.0	0.4	1.0	-1.6	802 784	433 364	369
Tenant White 30 40	88.4	2.0	-25.7	26.8	-37.6	5.5	0.9	2.0	308 329	210 277	98
Cropper White 30 40	89.2	0.6	-7.1	28.3	-15.3	10.5	-1.1	-1.2	238 264	139 187	99

Notes and Sources: See notes to Table 2 to see the information about the regressions run. Each row refers to a single regression with the correlates listed in the notes to Table 2. The formula for calculating the percentage of the change in mean attributable to the New Deal program is Coeff*(NDA)/(M40-M30), where Coeff is the coefficient from Table 2, NDA is the mean of the annual average of the New Deal variable, and M40 and M30 are the means of the machinery measure from 1930 and 1940. Since the New Deal variable is zero in 1930 the NDA measure is a measure of the change in the New Deal measure between 1930 and the later years.

Data Source Appendix (Incomplete)

New Deal funding information is from the U.S. Office of Government Reports (1940). For the case of the AAA farm payments, we had information for 1933 through 1937. The AAA grants and farm loans were divided by the number of farms in 1930. New Deal spending on public works and relief was divided by the overall population in 1930.

Population , unemployment, layoffs, percent black, percent illiterate, county land area, the farm size measures, average family size, percent of acres of farms run by cash tenants and by other tenants (including share croppers and share tenants), average annual manufacturing earnings, average farm size, and percent of cultivated acreage that experienced farm failures from 1929 and 1930 are from the 1930 files in ICPSR study number 0003, as corrected by Michael Haines in ICPSR dataset number. Manufacturing earnings were not reported separately for some counties in 1929 where there were few establishments. For those counties we inserted the average annual manufacturing earnings that were reported for the whole group of counties in that state for which information was not reported separately. These were reported in U.S. Bureau of Census (1935????).

The information on crop values, percent cotton, percent corn, percent wheat, and percent tobacco in 1929 are from the 1940 files in ICPSR study number 0003, as corrected by Michael Haines (undated). Information on tractors in 1929 and 1939 is from Table 11 in U.S. Census Bureau's Census of Agriculture (1942). The percentage nonfarm of the gainfully employed in each county was calculated from information loaded from Table 20 in Volume III parts I and II of the 1930 Population Census (1932).

Information on cows, beef cattle, and swine in 1929 and 1930 is from the U.S. Bureau of the Census (1936). The number of cows milked during the course of the year, is from County Table V, volume II; the number of cattle and calves of all ages and number of swine of all ages is from County Table II, volume I.

A series of price variables were created from information collected by Paul Rhode that was only available at the state level. To measure price changes for major crops influenced by the AAA, we calculated the change in natural logs of the average crop prices between the periods 1920-1929 and 1933-1939 for cotton, corn, wheat, and tobacco. We then created a summary price measure by weighting the percentage change for each crop by its share of the states' crop values as of 1929. To measure the change in price uncertainty, a factor that Sally Clarke (1991, 1994) identifies as important, we calculated the coefficient of variation (the ratio of standard deviation to the mean) of prices for each crop over the period 1933-1939 and again over the period 1920-1929 and then calculated the change in the natural log of the coefficient of variation for each crop. We then created a summary measure by weighting the coefficient of variation for each crop by its share of crop values as of 1929. The farm prices were provided to us by Paul Rhode from data that he had compiled from the USDA reports on prices that he downloaded from the National Agricultural Statistics Service website (http://www.nass.usda.gov/). To capture key input price effects, we included the growth rate in the average price of horses from 1920-1929 to 1933-1939, also obtained from Paul Rhode. Tractor prices were not as readily available across time periods; therefore, we included the level of tractor prices for the International Harvester Corporations Farmall

tractor in 1934 (U.S. Bureau of Agricultural Economics, 1934).   Farmers were also

borrowing funds from private sources.

Information on average interest rates on state bank loans for the periods 1920-29
and 1930-39, measured as the value of bank loan earnings divided by bank loans, is from
Bodenhorn (2008) with discussions of the methods used available in Bodenhorn (1995).
The CCC state level loan measures are from the Office of Government Reports, Report
No. 9 (1940).

"Dust Bowl" counties were obtained from Hansen and Libecap (2004).

The climate data are available from the National Climatic Data Center (NCDR).

Text files of the data were accessed from ftp://ftp.ncdc.noaa.gov/pub/data/cirs/ (August

2003). The NCDR reports historical monthly data by climate division within each state,

so each county's climate information pertains to its respective climate division. In some

cases a county was located within two or three divisions. In these cases, the county's

climate information was calculated as the average across the climate divisions in which it

was located.

Roger Paine and Joe Johnson of the U.S. Geological Survey gave us a list of all

the "streams" listed in the GNIS names topographical map database with all of the

counties in which each stream was currently located. This information also can be

obtained stream by stream through query at

http://geonames.usgs.gov/pls/gnis/web_query.gnis_web_query_form as of August 2003.

Streams is a broad definition including creeks and rivers.   There were over 100,000

stream names in the data base.   Each stream name has a numeric feature code as well as

the name.   Using the numeric feature code, we performed frequencies on the number of

counties in which each stream was listed. We then developed a series of variables

showing access to streams that ran through different numbers of counties. The riv51up is the number of rivers running through the county that ran through over 50 counties. Only the Mississippi, Missouri, and Ohio Rivers, ran through as many as 50 counties, and they are the major rivers in the Eastern and Midwestern United States. We also experimented with a second variable (riv2150) for access to rivers passing through 21 to 50 counties (includes the Red, Arkansas, Tennessee, Snake, Rio Grande, Canadian, Chattahoochie, Columbia, Brazos, Cumberland, Colorado, White, Cimarron, Des Moines, and James). Another dummy, riv1120, encompasses the next largest 53 rivers. Of the rivers passing through over 10 counties, most are considered navigable by modern definitions by the Army Corps of Engineers. The ones not listed as navigable are mostly western rivers and include the Niobrara, Sheyenne, Washita, Catawba, Cheyenne, North Canadian, Canadian, Smoky Hill, Alapaha, Big Sioux, Neches, Pecos, Wisconsin, Yellowstone, Des Moines, Rio Grande, Nueces, Platte, Big Black, Rio Brazos, Cimmarron, Wapsipinicon, and Sabine. The variable for riv0510 encompasses 384 rivers. The information on which waterways were navigable was provided by Amy Tujaque, who is a Survey Statistician for the Waterborne Commerce Statistics Center for the U.S. Army Corps of Engineers. We used a relatively coarse measure of access because the Geological Survey staff warned us that sometimes the same river might have multiple feature numbers. On the other hand, there are also quite a few stream names that appear multiple times but are clearly not connected. We examined the situation for the major rivers and found that this was not a significant problem for them.

The data set consists of 3,067 counties and county/city combinations in the United States. The New Deal program information was reported for some combined counties.

For example, the New Deal information was reported for all of New York City. Thus, in New York state, Bronx, King, New York, Queens, and Richmond counties were combined into New York City. Similar situations developed in other states. In Missouri the city of St. Louis and St. Louis County were combined. In Virginia we combined the following districts that were reported separately in the Census: Albemarle County and Charlottesville city; Allegheny County and Clifton Forge city; Augusta County and Staunton city; Campbell County and Lynchburg city; Dinwiddie County and Petersburg city; Elizabeth City County and Hampton city; Frederick County and Winchester city; Henrico County and Richmond city; Henry County and Martinsville city; James City County and Williamsburg city; Montgomery County and Radford city; Nansemond County and Suffolk city; Norfolk County with Norfolk city, South Norfolk city, and Portsmouth city; Pittsylvania County and Danville city; Prince George County and Hopewell city; Roanoke County and Roanoke city; Rockbridge County and Buena Vista city; Rockingham County and Harrisonburg city; Spotsylvania County and Fredericksburg city; Warwick County and Newport News city; Washington County and Bristol city; Arlington County and Alexandria city.

For latitude and longitude we used maps from the 1930s to determine which counties were contiguous to each other; the largest number of contiguous neighbors for a single county was 14. When developing the inverse distance spatial weighting scheme, we used the ICPSR data set 8159 created by Robert Sechrist. We found a number of errors in the latitudes and longitudes in ICPSR data set, which were corrected: Dutchess, NY latitude 41.45, Greene, PA longitude 80.12, Moultrie, IL latitude 39.35, Fulton IN latitude 41.07 longitude 86.15, Rock Nebraska longitude 99.32, Butte, SD latitude 44.38,

Campbell, SD latitude 45.44, McCook SD latitude 43.39, Webster, GA latitude 32.04, Greene, NC latitude 35.28, longitude 77.45, Sampson NC latitude 35.0; Wake, NC latitude 35.45; Rains, TX latitude 32.52; Fulton, KY latitude 36.33; Custer, OK longitude 98.57; Carbon, MT longitude 109.2; Santa Fe, NM latitude 35.4; Mendocino, CA latitude 39.09, longitude 123.12; Multnomah, OR longitude 122.4.

We developed a series of variables to describe the elevation range and maximum elevation and information on the number of bays, lakes, beaches, etc., as reported in the USGS's Geographic Names Information System. The information was downloaded from http://geonames.usgs.gov/stategaz/index.html (August 2003). The data set describes features noted on small-scale topographical maps, including mouths of streams, lakes, valleys, summits, cliffs, bayous, beaches, etc.[22] The Geographic Names Information System (GNIS) contains name and location information about almost 2 million physical and cultural features located throughout the United States and its Territories.GNIS was developed by the U.S.Geological Survey in cooperation with the U.S. Board on Geographic Names (BGN) to promote the standardization of feature names. GNIS is being compiled in phases. The first phase is complete for the entire U.S., and entailed the collection of names from Federal sources including large-scale USGS topographic maps, Office of Coast Survey charts, U.S. Forest Service maps, and digital datasets distributed by the Federal Communications Commission, the Federal Aviation Administration, and the U.S. Army Corps of Engineers. The second phase of data collection is complete or in progress for about 90% of the U.S., and captures names from State, locally, and other

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[22] See Fishback, Horrace, and Kantor (2004, Appendix 1) for a more complete discussion of the creation of the geography variables and of our handling of county boundary changes since the New Deal.

published current and historical maps, charts, and texts.   The information was downloaded in August 2003 from http://geonames.usgs.gov/stategaz/index.html.

The data set describes features noted on small-scale topographical maps, including mouths of streams, lakes, valleys, summits, cliffs, bayous, beaches, etc. Elevation was listed for a significant number of features in each county. We used this information to determine the maximum and minimum elevation listed and the range between the two figures. We did not try to calculate an average elevation because many of the features did not include information on elevation. Because of the lack of full coverage there may be some measurement error, but our sense from spot checks around the country is that the maximum and minimum elevations are reasonable depictions of those figures.

From the data set we calculated the number of summits and valleys to get a sense of the degree to which there were fluctuations in terrain. The original database includes the number of airports, arches, areas, arroyos, bars, basins, bays, beaches, benchs, bends, buildings, canals, capes, cemeterys, churchs, civils, cliffs, craters, crossings, dams, falls, flats, forests, gaps, guts, harbors, hospitals, islands, lakes, locales, militarys, mines, oilfields, parks, pillars, plains, postoffs, populated places, ranges, rapids, reserves, reservoirs, ridges, schools, springs, mouths of streams, summits, swamps, towers, trails, tunnels, valleys, wells, woods. For the purposes of our research we sought to avoid using man-made features, so we used only summits, bays, lakes, summits, valleys, mouths of streams, swamps, beaches, forests, and woods. Even in these cases there may have been

changes wrought since the 1930s, so there is likely to be some measurement error for the natural features as they stood in the 1930s.

When we were working with the geography measures and the river measures, there were some county boundary changes between 1940 and 2000. In situations where new counties were carved from older counties, we have merged the new county information back in with the older counties. La Paz in Arizona was merged back in to Yuma county and Cibola county in New Mexico was merged back into from Valencia. [Broomfield, Colorado was formed in 2001 but had no streams listed.] Virginia developed a new set of independent cities and their information was merged back into the county/city combinations that we developed for the New Deal. We did not pay close attention to situations where parts of some counties were annexed to others, but we do not believe this to be a serious problem. In South Dakota Washabaugh county had been combined into Jackson county and Washington County had been combined into Shannon after 1940. To determine the geographic features for Washabaugh we used any features above latitude of 4.372694 from Jackson county. This may overstate some features in Washabaugh. For Shannon we took all features in Shannon county below latitude 43.30139. Information on county boundary changes since 1970 comes from http://www.census.gov/geo/www/tiger/ctychng.html#1970.

The various measures of soil quality in the database are from the 1990s from the State Soil Geographic (STATSGO) Data Base for the Conterminous United at http://water.usgs.gov/lookup/getspatial?ussoils. Mickey Lynn Reed and Todd Sorensen at the University of Arizona converted the information to county data by using ARC-GIS mapping software to layer county boundaries over the basic data set of 78,518 polygonal

land areas and create averages weighted by land area..   When a county boundary split a polygon, they were able to determine the area of that polygon within each county. For each county they then developed weighted averages of the variables with the land area as the weight. This is modern data and there have been some mergers and additions of new counties since 1940. We merged new counties back into their original counties during the 1930s. Three counties in South Dakota, Armstrong, Washabaugh, and Washington had been merged into other counties. In those cases we gave Armstrong, Washabaugh and Washington the values of the counties into which they had been merged.

According to the U.S. Natural Resources Conservation Service, AWC is "the volume of water released from the soil between the time the soil is at field capacity (the maximum water held in soil against the pull of gravity) until the time it is at the wilting point (the amount of water held too tightly in soil for commonly grown crops to extract). Loamy soils and soils high in organic matter have the highest AWC." Clay is the percent of soil consisting of clay (in percent of material less than 2mm in size). Kffact is the actual k factor used in the universal soil loss equation to calculate soil loss by water. LL is the liquid limit of the soil layer (in percent moisture by weight).   OM is the organic material in the soil (in percent by weight). Perm is the permeability of the soil (in inches per hour). Thick is the depth of soil layers (in inches). Hygrp is a code identifying the hydrologic characteristics of the soil, converted into a numeric code by Bill Battaglin's methods, where 1 is high infiltration, deep soils, well drained to excessively drained sands and gravels, 2 is moderate infiltration rates, deep and moderately deep, moderately well and well drained soils with moderately coarse textures, 3 is slow infiltration rates, soils with layers impeding downward movement of water, or soils with moderately fine

or fine textures, 4 is very slow infiltration rates, soils are clayey, have a high water table, or are shallow to an impervious layer. Battaglin subselected certain areas and assign values for hygrp based on the area type. Miscellaneous areas labeled as Dumps, and Gullied Land are assigned the hygrp = 2.5 if the hydgrp value is missing. Areas denoted as Pits, Rock Outcrops, Terrace Escarpments, and Urban land with missing hydgrp are assigned a hygrp of 4. See the documentation of the SAS program "setussoils.sas" at http://water.usgs.gov/lookup/getspatial?ussoils for additional details. The transformed data are averaged across components using the component percentage as weights.

Float is a code identifying the quality of soil drainage, where 1 is excessive, 2 is somewhat excessive, 3 is well drained, 4 is moderately drained, 5 is somewhat poorly drained, 6 is poorly drained, 7 is very poorly drained. Slope is the slope of the map unit in percent. Ifhydric is the shre of the map unit with hydric soils, where 1 means the entire map unit has hydric soils). Afldfreq is the annual flood frequency code, where 1 is greater than 50%, 2 is 5% to 50%, 3 is 0% to 5%, and 4 is flood. In all cases the values for each variable are averaged across components using the component percentage as weights. See http://soils.usda.gov/sqi/soil_quality/what_is/glossary.html for more detail.

Appendix II

A Model of a Representative Farmer

To develop the equation for estimating the impact of the New Deal programs on the number of tractors, we develop a theoretical model of a representative farmer. The model does not lead to unambiguous comparative statics but does have implications for what types of variables should be included in the estimation equation.

A risk averse farmer chooses the number of tractors and other farm inputs to maximize expected utility in a one period problem.[23] The farmer makes the input choices at the beginning of the period and does not discover the prices or harvest outcomes until the period has ended. We assume the farmer is risk averse in making decisions about farm inputs. We have couched the analysis in terms of numerical values, yet some features of Clarke's analysis based on the non-cash part of the farm economy are easily incorporated. Her focus on non-cash opportunity costs might also be incorporated in the model based on whether cash or non-cash opportunity costs are considered to be the more relevant factor. Clarke strongly emphasizes that lowering interest rates and giving farmers more access to cash credit would make them more likely to accept risk. Obviously, if labor and capital are substitutes on the farm, lowering the rental rate of capital should increase demand for capital. However, if Clarke's argument about risk aversion is correct, one should be able to find that a lower interest rate will increase demand for tractors without making any assumptions about the substitution patterns between labor and capital on the farm.

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[23]Manuelli and Seshadri (2004) have developed a neoclassical dynamic model of the farmer's decision but do not incorporate the risk factors emphasized by Clarke.

We treat the choice of all farm inputs as endogenous in this model, which is consistent with Olmstead and Rhode's (2001) findings that tractors and farm size were simultaneously chosen.[24] We can alter this assumption within the model by fixing the land size or adding credit constraints. Farmers are risk averse and have strictly monotonic preferences with diminishing marginal utility over income:

(1) $U^{`}(\cdot) > 0, U^{``}(\cdot) < 0$

Assume that the farmer traditionally produced one crop, the AAA designated crop. A farmer's profits can be represented as follows:

(2) • $(N_A, N,, T, CL) = s\ P_A\ Q^A(N_A, T, L_T - L_R, q)\ +\ s\ P_B\ Q^B\ (N - N_A, T,\ L_R, q)$

$$-\ w\ \ N\ -\ p_T\ \ r\ \ T -\ p_L\ \ r\ \ L_T\ +\ s\ \ n\ L_R\ .$$

The farmer chooses the quantity of labor used in the production of the AAA designated crop (N_A), the total labor hired or used during the year (N), the total acreage of land the farmer chooses to cultivate (L_T), and the number of tractors (T).[25] Exogenous land quality is measured with q; we do not focus on investments in land quality to

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[24] Alan Olmstead and Paul Rhode (2001) examined the diffusion of the tractor between 1910 and 1960 using a panel of state level data for the Census years. The key assumption that they challenged in the threshold model was the treatment of farm size as exogenous in the decision process. Farm size might be treated as exogenous during the growing season, or within time frame of a year or two if the individual farmer faces a borrowing constraint, the farmer can't move, or he is unable to expand because he is at the limit of his current farmable acreage and cannot find land to rent or purchase close enough to expand. In their state level panel study of Ag Census years they allow for both farm size and tractor choice to be endogenous and find that larger farm sizes contribute to more adoption of tractors but also that the adoption of the tractor leads farmers to choose larger farm sizes.

[25] The choice was often a choice of zero or one tractors since the vast majority of farms owned only one tractor.

simplify the analysis, although we do incorporate it in the discussion of benefits from

alternative crops below. L_R is the amount of land that the farmer removes from

production of the AAA crop when he signs a AAA contract and n is the benefit payment

per acre removed. We treat L_R as exogenous because the AAA only offered a single

contract option. Our data allows us to look at only cross-sectional comparisons, so we do

not include parameters showing the improvement of the quality of tractors over time.

Under the AAA program the farmer was offered an all-or-nothing contract that

specified both the benefit payment and the amount of land nL_R. The benefit payment

varied geographically based on the crop and the prior productivity per acre of the land

while the number of acres was determined by historical usage of the land relative to the

national target quotas. P_A represents the price of the AAA designated crop, P_B is the

benefit of the alternative crop that the farmer switches to with the land taken out of

production of the AAA crop. The benefit of the alternative crop (P_B) might come in

several forms. In the South, where the farmer could not switch to a cash crop, it might

come in the form of a non-market value of feed or food produced or the anticipated future

value of higher productivity of the soil. In the Midwest, the value also could include cash

prices for the alternative crop. Since the farmers had not been using the land to produce

the alternative crop prior to the AAA, our sense is that the long-term average benefits

from the alternative use was lower than for the AAA crop ($P_A > P_B$). To account for the

impact of tenancy and cropping, s is the share of the crop received by the farmer. The

share is one for owners and fixed rent tenants and less than one for share tenants and

lower still for croppers. We assume that the share croppers and tenants also get the

appropriate shares of the AAA payments. This can be reconsidered later in light of the

problems tenants and croppers faced in the South in obtaining the appropriate share.

$Q^A(.)$ is output of the AAA designated crop and $Q^B(.)$ is the output of the

alternative allowed by the AAA, where both Q functions are strictly increasing at a

decreasing rate in labor (N_A or N - N_A, respectively),the presence of a tractor T, the

amount of land cultivated (L_T – L_R or L_R), and q. On the cost side, w represents the wage

paid to labor, r is the farmer's discount rate, which is strongly influenced by the rate at

which he can borrow, p_T is the purchase price of the tractor, and p_L is the purchase price

of land. The annual rental price of a tractor or land would then be a multiplicative

function of the interest rate and the purchase prices ($r\,p_T$ and $r\,p_L$). For share tenants and

croppers we assume that the contract is written so that ultimately the value of the share of

output going to the owner is equal to the rental value of the land.   We assume that the

output price, wages, rental prices of tractors, and land rent are set in markets over which

the farmer has no control.

Farmers also faced significant uncertainty. Suppose there is a bimodal outcome

in AAA crop production or prices. For example, prices of AAA designated crops can be

either "high" with probability α , or "low" with probability $1-\alpha$, where $0 < \alpha < 1$.[26]

The objective function then becomes

(4)   E[U(N_A, N, T,CL)] = ±(U(Å_H) + (1- ±)(U(Å_L) =

± U(s P_A^H Q^A() + s P_B Q^B() − w N − p_T r T − p_L r L_T + s n L_R) +

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[26] We focus on price fluctuations here to capture some features of Sally Clarke's (1991, 1994) analyses. We could also recast this in a similar way for yield fluctuations.

$$+ (1\text{-}\pm)\, U(s\, P_A{}^L\, Q^A() + s\, P_B\, Q^B() \ -\ w\, N - \ p_T\, r\, T - \ p_L\, r\ L_T + s\, n\, L_R),$$

where $\grave{A}_H$ and $\grave{A}_L$ represent profits in the high and low settings, respectively.   To reduce the number of parameters we assume that there is no variation in the outcomes for the alternative crop.   Thus, the risk for the AAA crop is the greater risk associated with the crop when compared with the alternative.[27]

If we work through the first-order conditions for a maximum in this context, the farmer's choice functions for labor, tractors, and cultivated land will all be functions of the exogenous variables in the equation.

$(5)\quad N_A = N_A\ (\pm, q, s, P_A{}^H, P_A{}^L, P_B, w, r, p_{T,}, p_{L.}\ n, L_R)$

$\qquad N\ =\ N(\pm, q, s, P_A{}^H, P_A{}^L, P_B, w,\ r,\ p_{T,}, p_{L.}\ n, L_R)$

$\qquad L_T\ =\ CL\,(\pm, q, s, P_A{}^H, P_A{}^L, P_B, w, r, p_{T,}, p_{L.}\ n, L_R)$

$\qquad T\ =\ T\,(\pm, q, s, P_A{}^H, P_A{}^L, P_B, w,\ r, p_{T,}, p_{L.}\ n, L_R)$

This combination of choice functions implies that the estimating equation for the number of tractors should be a function of only the exogenous variables, the output prices, the input prices, and the terms of the New Deal programs; therefore, the estimating equations should not include the input choices like farm size.

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[27]Since we do not have CCC loan data we have not explicitly modeled the features of that program. However, we believe it can easily be done by showing the impact of raising the low price, $P_A{}^L$.

The comparative statics from this model turn into an untidy combination of a large number of marginal utilities, prices, and cross products in the productivity functions for the AAA crop (A) and the alternative crop (B). However, we can learn some basic lessons from looking at simplified versions of the model.   For example, Consider a farmer who is risk neutral and can only choose the number of tractors.   The effect of an increase in the AAA offer to remove land from production will be positive if the sign of

$$P_B \, Q^B_{LT} - (\pm \, P^H_A + (1- \pm)P^L_A) \, Q^A_{LT}$$

is negative. The negative sign would result if using tractors raises the expected value of the marginal product of land for the AAA crop more than it raises the value of the marginal product of land for the replacement crop.