There Will Be Killing: Collectivization and Death of Draft Animals*

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October 9, 2016

Abstract

The elimination of private property rights can lead to inefficient use of productive assets. In China's collectivization movement from 1955 to 1957, instead of transferring draft animals to the ownership of the collectives, peasants slaughtered them to keep the meat and hide. By comparing 1,600 counties that launched the movement in different years, the difference-in-differences estimates suggest that the animal loss during the movement was 12 to 15 percent, or 7.4-9.5 million head. Grain output dropped by seven percent due to lower animal inputs and lower productivity.

Keywords: property rights, collective, agriculture, China, draft animals

JEL: D23, N55, P26, P32, Q15

*Comments are welcome: Chen: cs@fudan.edu.cn; Lan: xhlan@fudan.edu.cn. For helpful comments, we thank two anonymous referees, Jimmy Chan, Jiahua Che, Zhao Chen, Roger Gordon, Yu Hao, James Kung, Shu Lin, Yu Liu, Ming Lu, Yiqing Xu, and Yu Zhou. For excellent research assistance, we thank Yongtao Li, Bo Yang, Zhongyin Gan, Zhentao Jiang, Shuyao Li, Qiri Sa, Yuan Tan, Yulu Tang, Qin Yao, and Zhitao Zhu.

"But a (ownership) conversion process that requires that the animals be killed in order to establish private rights must incur the larger social cost of depleting the stock of animals."

—Alchian and Demsetz (1973, p. 23)

1 Introduction

Between 1955 and 1957, 96 percent of China's 550 million peasants were organized into collectives and deprived of their private ownership of land and draft animals (National Bureau of Statistics, 1980). This was the largest movement from private to communal property rights in history. Collectivization set the stage for the Great Leap Forward (GLF) movement in 1958, which in turn led to the worst famine in human history that killed 17-45 million people (Meng, Qian, and Yared, 2015). Collective land ownership has shaped the lives of Chinese peasants for generations, and it remains in place today.[1]

The response of peasants to the collectivization movement was a poignant example of the power of incentives.[2] Peasants were required to turn over their land to the collective without compensation, and sell their draft animals to the collective at a low price. In the collectives, which were called advanced cooperatives, all the rent payments for land and draft animals were eliminated and income was distributed only in the form of wages. Faced with the prospect of losing the animals' future output, and unwilling to accept the low price paid in installments that might never materialize, peasants chose to slaughter their animals to keep the meat and hide. Historians (Shue, 1980; Hinton, 1983; and Friedman, Pickowicz, and Selden, 1991) and contemporary government documents (Huang, 1992; Ye, 2006) provide anecdotal accounts of such slaughter.

There have been no appropriate data to estimate the animal loss caused by collectivization. We use a novel data set of yearly inventories of draft animals in 1,600 Chinese counties from 1952 to 1957, collected from many recently declassified government files. The sample covers 71 percent of all Chinese

[1] For an introduction to collectives and China's urban-rural divide, see Naughton (2007).

[2] We thank a referee for highlighting this point.

counties and 77 percent of the rural population. Some counties started to collectivize in 1955 and others did so in 1956, and our identification explores this variation in timing. The difference-in-differences estimates show that collectivization reduced annual animal inventory by 4-5 percent, and the total animal loss during the movement was 12-15 percent, or 7.4-9.5 million head.

The use of farming machines cannot explain the loss, nor can a shift in the demand for draft animals after collectivization caused by the economy of scale or a shift in crop types. The loss occurred immediately during the transition to collectives, and therefore cannot be explained by the overuse or mistreatment of animals in the collectives. Our hypothesis is that peasants did not want to keep draft animals as productive assets without holding the rights to claim their future output, so they slaughter the animals to keep the meat and hide. This hypothesis has two testable implications. First, more animals would be slaughtered if their owners were assigned into a large collective with more members, because their resulting share of the animals' output would be smaller.[3] Indeed, we find that the animal inventory declined more in counties with larger cooperatives. Second, more animals would be slaughtered in counties in which private property rights had been better protected prior to collectivization. We use the ratio of so-called "middle peasant" households in the rural population to measure the level of protection of private property. China finished a land reform movement three years prior to collectivization, in which the properties of landlords and rich peasants were confiscated and given to poor peasants. Only the property of the officially recognized middle peasants remained. Because the middle peasants owned more land and animals than the others, they were unwilling to join a cooperative and share the output based only on labor input, although they were forced to do so (Du, 2002; Ye, 2006). We find that the animal inventory declined more in counties with more middle peasants.

[3]As articulated in Coase (1960), Demsetz (1967), and Alchian and Demsetz (1973), the main allocative function of property rights is the internalization of externalities. When the products are shared, joint ownership of the productive asset may or may not dominate private ownership, depending on whether the output produced using the asset is a public or private good (Besley and Ghatak, 2010).

Collectivization reduced the annual grain output by seven percent, due to both lower animal inputs and lower total factor productivity. Productivity in counties with larger cooperatives was as low as in counties with smaller cooperatives. These results do not support the hypothesis that the collectives managed to reduce the demand for draft animals by pooling resources and taking advantage of the economy of scale.

Most empirical works related to property rights test whether secure private rights increase investment.[4] The Chinese collectivization movement allows us to examine how the removal of private rights affect existing productive assets. Without private rights, productive assets (draft animals) were used much less efficiently (as meat and hide). Lower output followed.

Economists have intensively studied the GLF movement of 1958 and the Great Famine of 1959-61, but they have paid less attention to the collectivization movement of 1955-57.[5] Compared with the disastrous loss during the GLF and the famine, the loss caused by collectivization seems relatively modest. However, it was through collectivization that the government firmly controlled grain production and procurement, which laid the foundation for the GLF and the excessive grain procurement that led to the famine. While Lin (1990) emphasizes the change in work incentives brought by the GLF, we describe how, even before the GLF, collectivization had already disincentivized peasants from maintaining productive assets.

The phenomenon discussed in this paper is not unique to China. Historians have documented a similar mass loss of draft animals during the collectivization movement in the Soviet Union in 1929-33 (Conquest, 1987; Fitzpatrick, 1996). The purpose of the Soviet movement was also to control the

[4]For microeconomic evidence, see Besley (1995), Banerjee, Getler, and Ghatak (2002), Jacoby, Li, and Rozelle (2002), Johnson, McMillan, and Woodruff (2002), Goldstein and Udry (2008), Hornbeck (2010), Galiani and Schargrodsky (2010), and Fenske (2011). For cross country studies, see Svensson (1998) and Acemoglu, Johnson, and Robinson (2001). Secure property rights could also increase labor supply and migration (Field, 2007; De Janvry et al., 2015). Besley and Ghatak (2010) summarize the literature.

[5]For the research on the GLF movement and the famine, see Lin (1990), Li and Yang (2005), King and Chen (2011), Meng, Qian, and Yared (2015), and references therein. Wen (1993) and Lin (1990) note the lower total factor productivity in Chinese agricultural production in 1956 and 1957, but it is not the focus of their papers.

rural economy and peasantry, but the process was much more violent. It was launched simultaneously with the eradication of kulaks (rich peasants), the famine-genocide in Ukraine, and the forced settlement of nomadic Kazakhs. These violent measures led to uprisings and revolts as well as a mass loss of human life and loss of livestock, all of which confounded the effect of economic incentives related to collectivization. In contrast, the collectivization movement in China was carried out smoothly and was not accompanied by major social unrest. Thus, for the first time, we are able to identify the causal effects of collectivization and explore the heterogeneity in economic incentives across counties.

2 China's Collectivization in the 1950s

With the founding of the People's Republic of China in 1949, a three-year land reform movement was launched, and land and draft animals were redistributed from landlords to poor peasants. In 1952, the government adopted a Stalinist heavy-industry-oriented development strategy. To fund this rapid industrialization, more resources needed to be extracted from the agricultural sector (Lin, 1990; Li and Yang, 2005). Given the lack of new technologies capable of raising agricultural productivity, the government resorted to transforming the way the peasantry was organized.

1952 to 1955. In 1952, the Communist Party of China (CPC) started to press for establishing Mutual Aid Teams (MAT). An average MAT consisted of seven households (National Bureau of Statistics, 1957), which were usually comprised of relatives or neighbors. At the peak of the MAT movement in 1954, 58 percent of rural households joined about 10 million MATs (Figure 1). Within a MAT, draft animals were either jointly owned, or rented from their owners to the other members in exchange for grain, fodder, or labor. One day's ox labor was typically equivalent to two days' man labor (Shue, 1980).

The national movement from MATs towards elementary production cooperatives began in late 1953. A typical elementary cooperative included 20 or more households (National Bureau of Statistics, 1957). In contrast to the oc-

casional reciprocal aid in a MAT, members of an elementary cooperative put their land and other means of production at the disposal of the cooperative, and organized production under unified management. Members' income was based on rent payments for their land and animals, and wage payments for their labor. According to a survey of 26,733 elementary cooperatives throughout China (National Bureau of Statistics, 1956), the annual rent payment for a draft animal was about 40 RMB (in 2014 dollars, about $43), and the annual wage of an able-bodied man was 86 RMB. As William Hinton (1983) observed in some elementary cooperatives, "a peasant who owned two good draft animals could get by without working at all. "

Unexpected Collectivization. By 1955 the CPC leaders had come to believe that tractors and other modern agricultural equipment were prerequisites for large collective farms, without which the economy of scale would not be realized. Therefore, collectivization should be gradual, and accompanied by industrialization (Ye, 2006). In the summer of 1955, Mao Zedong changed his mind and declared that rapid agricultural collectivization could boost agricultural productivity and supply more resources for industrialization. He condemned the conservative policy and pressed other leaders to accelerate the pace of collectivization. From August to October of that year, the other top leaders came to endorse rapid collectivization (Lin, 2009).

As a result of the new emphasis on rapid collectivization, local cadres rushed to create new collectives of a fully socialist nature, called advanced cooperatives. In the middle of 1955 there were only 500 advanced cooperatives nationwide, but the number surged to 17,000 by the end of the year, covering four percent of all rural households (Figure 1).[6] After only two years, by the end of 1957, 96 percent of rural households had been organized into advanced cooperatives. In such a fast and sweeping movement, forced participation or even violence against distressed peasants was not uncommon (Huang, 1992; Ye, 2006).

[6]In 1953, there were only 15 advanced cooperatives nationwide, which were conducted as voluntary experiments. In 1954, the number was about 200 (National Bureau of Statistics, 1957). We ignore these special cases in the following analysis.

In the advanced cooperatives, rent payments for land and draft animals were eliminated. Income was distributed only in the form of wages, according to the "work points" earned by each member. Peasants had to turn over their land to the cooperative without compensation, and sell their draft animals to the cooperative, accepting payment in installments made over three to five years. The prices set for the animals were usually very low. A high price would be a burden for the majority of members, who were too poor to own a draft animal and had to pay off the installments with their labor. Thus, the owners of draft animals essentially had to subsidize other members and accept the risk that the installment payments might never be made.

Unwilling to turn over their valuable animals in exchange for a meager cash payment of one-third or even one-fifth of a price that was already very low, many peasants instead chose to slaughter their animals.[7] According to statistics from the Ministry of Agriculture (1990), Figure 2A shows an abrupt decline in the national inventory of draft animals during collectivization from 1955 to 1957, decreasing by 3.6 million head compared to the 1954 level. The animal loss was indeed the result of mass slaughter. Figure 2B shows a spike in the trade volume of cowhides during collectivization. The abnormal increase in cowhides was higher than the cumulative animal loss, as many calves, females, and even milk cows were slaughtered as well.

The slaughter also reflected the fact that selling draft animals was difficult during collectivization.[8] With the establishment of the centrally planned economy, official marketing cooperatives had replaced the traditional markets of draft animals (State Council, 1955). These poorly managed institutes failed to organize animal trade, and the trade halted completely in most places (State Council, 1957). However, trade in animals as a source of meat was still active. Banning the sale of draft animals to butchers was unlikely to succeed because

[7]For anecdotal accounts of such slaughter in government reports, see Huang (1992) and Ye (2006). For observations from historians, in both northern and southern China, see Shue (1980), Hinton (1983), and Friedman, Pickowicz, and Selden (1991).

[8]In the 1950s, peasants were tied to the land allocated to them by the land reform movement. Relocating to another village in response to collectivization was not a feasible option.

it was almost impossible to differentiate draft animals from meat animals. Instead, the government lowered the purchase price of both beef cattle and cowhide in 1955 and 1956 to mitigate the animal loss, until they completed the process of collectivization in 1957 (Figure 2C).

The government tried to ban intentional slaughter but inevitably failed. Peasants could slaughter an animal and claim that it was old, weak, sick, injured, or stolen. The governmental guideline for punishing alleged intentional slaughter was also vague; it stated that the peasant should be "seriously criticized and educated" (State Council, 1955). The problem of how to deal with private slaughter was left to the discretion of local officials, which we discuss in Section 4.3.

3 Data

We assemble a novel data set of yearly inventories of draft animals, grain output, land use, and population in 1,720 counties from 1952 to 1957. The sample covers 77 percent of Chinese counties and 80 percent of the rural population.[9] The statistics are from a wide variety of official sources, including declassified government files, recently released compilations of statistics, and county gazetteers. Appendix reports the data sources and documentation in details.

Our identification strategy explores variation across counties in the year that advanced cooperatives were introduced: 1955, 1956, and later or never. Figure 3 shows the three groups of counties, based on the information in county gazetteers. We drop the last group of 120 counties because they are special cases. 62 of them are located on the north or northwest pastureland, and most of their inhabitants in the 1950s were nomads. Without a fixed residence and grazing area, it was difficult to collectivize their livestock and establish an advanced cooperative. The other 58 counties are mainly in the southwest mountains and forests, and they did not complete the process of land reform until late 1956 or 1957.

[9]In 1957, China had 2,247 counties and a rural population of 54.7 million (National Bureau of Statistics, 2010). According to the 1982 census, about 80 percent of rural residents lived in the counties included in our data.

Our final sample includes 1,600 counties that introduced advanced cooperatives either in 1955 (569 counties) or in 1956 (1,031 counties). The key dependent variable is the year-end inventory of draft animals: cows, horses, donkeys, and mules in the north; and cows and water buffaloes in the south. Table 1 shows that an average county is quite large, comprising 255,100 people, 56,250 hectares of arable land, and 35,820 animals.[10] The summary statistics are consistent with the national statistics presented in Li and Yang (2005). In our sample, the average number of animals per peasant is 0.152, the area of arable land per peasant is 0.217 hectares, and the grain output per peasant is 0.322 tons. In their paper, the three figures are 0.159, 0.213, and 0.347, respectively.[11]

Our analysis controls for the effects of floods and droughts on animal inventory and grain output. The historical local weather data are based on records from 267 weather stations (State Meteorological Society, 1981). We assign the records to their closest counties and define two separate binary indicators for exceptional floods and exceptional droughts (the details are presented in Appendix). Table 1 shows that floods occurred more frequently than droughts, owing to the 1954 Yangtze River floods, some of the worst that occurred in 20th century China. Panel B lists county characteristics that may affect the influences of collectivization, which we discuss in Section 4.3.

[10]The total number of draft animals is somewhat larger than the national inventory in Figure 2A, because most counties only report the total number of large livestock, including females and calves. We use this broader category of animals to be consistent across counties.

[11]Li and Yang (2005) report national grain output and draft animals for each year from 1952 to 1957, and we divide these numbers by the national rural population. They only report the area sown with grain, which is larger than the area of arable land because grain could be sown multiple times within a year. To compare their figures with ours, we obtain data on the national area of arable land from the same data source, i.e. Ministry of Agriculture (1989).

4 Results

4.1 The Declined Inventory of Draft Animals

The counties that started to collectivize in 1955 saw an immediate loss in draft animals, but the other counties did so only after they started to collectivize in 1956, as shown in Figure 4. We use the following general difference-in-differences specification to estimate the effect of collectivization on the inventory of draft animals:

$$log(animal)_{it} = \beta * collect_{it} + year_t + c_i + X_{it} + \varepsilon_{it} \quad (1)$$

For county i in year t, $collect_{it}$ is a dummy variable equal to 1 for the year that a county started to introduce an advanced cooperative and for the years after. In most counties, collectivization was conducted village by village and was not completed until late 1956 or 1957. Thus β, the coefficient of interest, captures the average change in the animal stock during the process of collectivization. A set of year dummies $year_t$ and county dummies c_i capture the differences fixed over years and across counties. Other control variables that change across counties and over time, X_{it}, include the log of rural population and the log of arable land, which may affect the demand for draft animals. Also included are two separate indicators for exceptional floods and droughts. We report robust standard errors clustered at the county level.

Table 2 reports the results. In columns 1 and 2, the estimates of $\hat{\beta}$ indicate that the animal stock drops by five percent during collectivization, with or without adding control variables. In column 3, we control for the interaction terms of province and year dummies, and the robust results suggest that the effects of collectivization are not driven by specific provinces. In column 4, we relax the common trend assumption by adding county-specific trends, $c_i * t$, and the results are still robust. In columns 5 and 6, we restrict the sample to the counties that are close to each other, i.e. within 100 kilometers to the provincial capital, and the results barely change.

4.2 The Assumption of A Common Trend

Our identification strategy assumes that the timing of collectivization is not related to other potential factors that could also affect the inventory of draft animals. The collectivization movement was launched in the fall of 1955, and most counties waited until the winter to avoid disrupting the harvest. Since the winter spanned from late 1955 to early 1956, we divide these counties into two years, though the gap in the timing was only a few months. The division matches our data, in which all the main variables, including the animal inventory, are drawn from year-end statistics. Many counties, mostly in the south (Figure 2), waited until after the summer harvest in 1956 to collectivize. These counties were not seized by the CPC in the civil war until late 1949 or early 1950, one year later than the north. Because of "later liberation" and "a weaker base of collectivization," their delay in collectivization was permitted (Ye, 2006).[12] The delay, however, seems unrelated to agricultural production. First, the main results suggest that the timing of collectivization was not related to the factors that were important to agricultural production and to the inventory of draft animals. In columns 1 and 2 of Table 2, adding these factors as control variables does not change the estimated effect of collectivization on animal inventory. Second, Appendix Table A1 shows that the timing of collectivization was not related to any significant change in the size of rural population or arable land. Third, in the years prior to collectivization, the animal inventory followed a common trend in the two groups of counties that started to collectivize in 1955 or in 1956, as did the rural population and the size of arable land. To demonstrate this, we use the following specification:

$$log(animal)_{it} = \sum_k \beta_k * I(CY_{it} = k) + \sum_k \lambda_k * L_i * I(CY_{it} = k) + c_i + e_{it} \quad (2)$$

[12]For example, according to the *People's Daily* on October 28, 1956 (Huang, 1992), only 40 percent of rural households in Guangdong province, 31 percent in Sichuan province, 28 percent in Yunnan province, and 50 percent in Guizhou province had joined an advanced cooperative.

A set of dummy variables $I(CY_{it} = k)$ indicates the k_{th} year of collectivization: $CY_{it} = 0$ is the first year of collectivization, $CY_{it} = 1$ the second year, and $CY_{it} = -1$ the year before the movement, and so forth. L_i is a dummy for counties that started to collectivize in 1956, and c_i are county dummies. While β_ks capture the average year-by-year changes in the group of counties that started in 1955, λ_ks capture the relative changes of the 1956 group in the same normalized year. Since we only have two groups, all the changes over years are absorbed in the specification, and a separate set of calendar year dummies will not be identified. If $\hat{\lambda_k}$s are zero for all $k < 0$, we cannot reject the hypothesis of a common trend.

Column 1 of Table 3 shows $\hat{\lambda_k}$ for the two years prior to collectivization, compared to the base year $k = -3$. The coefficients are neither economically nor statistically significantly different from zero. Columns 2 and 3 show that $log(rural\_population)_{it}$ and $log(arable\_land)_{it}$ in the two groups follow a common trend as well. In an extended sample in which we have data as far back as 1949 for some counties, columns 4-6 show that the common trend assumption still holds in the six years prior to collectivization. Except for the very first two years, 1950 and 1951, the areas of arable land grew faster in the "late" group of counties. Many counties in this group were in the south and were seized by the CPC in the civil war later than the north, and the faster growth of arable land was likely to reflect the later recovery of land abandoned during the wartime.

The common trend in the animal inventory suggests that peasants in the "late" counties did not start to slaughter their animals in advance of the collectivization movement. Peasants were unlikely to hear of advanced cooperatives until they were imposed, because information traveled slowly in the vast rural areas during the 1950s, where most peasants were illiterate. For those who had heard of collectivization, it would have seemed irrational to slaughter their valuable animals before knowing the exact amount of compensation offered by the collective. The compensation was generally very low, as discussed in Section 2, but it could vary across counties and the rate available in a given collective would have only been revealed once collectivization had

begun.[13] Now we turn to the local factors that could affect the negotiation between peasants and officials, the specifics of collectives, and the subsequent animal loss.

4.3 Interpretations and County Heterogeneity

The undeveloped economy of China in the 1950s precludes the possibility that agricultural machinery replaced draft animals. In 1957, for 550 million peasants, the entire country had only 14,674 tractors, 1,789 combine harvesters, and 4,084 trucks for agricultural use. Only 2.4 percent of the tilled areas were tilled with machines (National Bureau of Statistics, 1980). By comparison, in 1957 the Soviet Union had 924,000 tractors, 483,000 combine harvesters, and 660,000 trucks for agricultural use, for only 110 million peasants, and 98 percent of their collective farms were tilled with machines (Li, 1981). Using statistics from the National Bureau of Statistics (1980), we split our sample into two groups. In one group of 24 provinces, the percentages of areas tilled with machines were all lower than four percent; and in the other group of five provinces, the percentages ranged from 10 to 21 percent. Appendix Table A2 re-estimates Equation (1) in each group, and the effects of collectivization on the animal inventory are almost identical. The use of farming machinery cannot explain our results.

Compared to individual peasants, cooperatives might plant more grain rather than cash crops such as cotton, or vice versa, which might shift the demand for draft animals. Appendix Figure A1 shows that this hypothesis is also unlikely to explain our results. From 1950 to 1957, among all the sown land, the ratio allocated to grain continuously decreased, but the decline was modest, from 0.89 to 0.85. The decline was neither accelerated nor reversed in the years following collectivization. Appendix Table A2 shows that the effect of collectivization does not change with the ratio.

[13] In a village in Hebei Province, the villagers slaughtered their animals despite being promised relatively decent compensation, because they "could see there was no money for such payments" (Friedman, Pickowicz, and Selden, 1991). In a village in Shanxi Province, the leaders managed to convince some CPC members to sell their animals to the collective at a low price, which set the benchmark price for other villagers (Hinton, 1983).

Our interpretation of the animal loss is that weakened private property rights suppressed peasants' motivation to maintain the animals. Since peasants could not claim most of the future output of the animals, they slaughtered them to sell or consume the meat and hide. Two testable implications follow. First, collectivization would incur greater animal losses in counties in which private rights had been better protected prior to collectivization. Second, in counties with larger cooperatives, more draft animals would be slaughtered because the owners' share of the animals' output would be lower in such cooperatives.

Property Rights Prior to Collectivization. Prior to collectivization, private property rights were better protected in some counties than in the others. By 1952, the CPC had completed land reform. In this program of "land to the tiller," the property belonging to millions of landlords and rich peasants, including their land and draft animals, were confiscated and given to poor peasants and landless laborers. According to the National Bureau of Statistics (1980), landlords and rich peasants owned 53 percent of land before the reform, but only 8.6 percent after, as shown in Appendix Figure A2. Thus their rights to most of their property had been lost prior to collectivization. The windfall gains for poor peasants and landless laborers were too new to be justified as their own property.[14] Only the property of "middle peasants," who had a long tradition of planting their own land and raising their own animals, survived the reform.[15] The CPC believed that a firm alliance with the middle peasants was a key to success in the revolution and the reform. The land reform policies concerning the middle peasants were unequivocal: *under no circumstances were their lands or their interests to be harmed* (Hinton, 1966). Following the land reform, middle peasants, who accounted for about 37 percent of all rural households, owned 44 percent of the land and 52 percent of the draft animals (Appendix Figure A2). Thus, they stood to become worse

[14]Historians have documented that some poor peasants returned their newly assigned valuables to the original owners (Hinton, 1966; Shue, 1980).

[15]The official CPC definition of middle peasants was *"those who have land, plow animals, and farm implements, who labor themselves and do not exploit others, or do so only slightly—these are the middle peasants."* (Hinton, 1966).

off in an advanced cooperative in which output was shared only based on labor input. It was no wonder that they were unwilling to join such cooperatives voluntarily, although they were ultimately forced to do so (Du, 2002; Ye, 2006).

The ratio of middle peasants in rural households indicates the degree to which private rights had been secured prior to collectivization. We find such a ratio in 895 county gazetteers. The ratio varies from 0.07 to 0.89 across counties, with a mean of 0.32. If the ratio increases by 0.1, the animal loss caused by collectivization would increase by one percent (column 1 of Table 4).

The Size of an Advanced Cooperative. The animal loss should be larger in counties with larger cooperatives, as the owner's share of their animals' output would be smaller in such cooperatives. In 1,276 county gazetteers, we find the number of advanced cooperatives at the time when collectivization was completed, mostly in 1957. We divide the rural population by this number to calculate the average size of a cooperative, which is about 1,154 people or 250 households. These numbers are close to a survey of 289,268 advanced cooperatives across 24 provinces, conducted in 1956 by the National Bureau of Statistics (1957b), which found that an average cooperative included 1,082 people or 246 households.

Column 2 of Table 4 shows that doubling the cooperative size (or an increase of 0.7 log points) would further increase the animal loss caused by collectivization by two percent. Unlike the ratio of middle peasants, which was pre-determined prior to collectivization, the cooperative size could be affected by animal loss. In fact, to mitigate the impact of collectivization and the challenges of managing large cooperatives, many local governments downsized their cooperatives in 1957 (Ye, 2006). If the cooperatives shrank in response to animal loss, then the effects of the cooperative size would be underestimated.

Political Influence and Ethnic Minorities. Both private slaughter and sales to butchers were hard to monitor and regulate, as discussed in Section 2. While local officials were busy establishing more advanced cooperatives to meet the target number before the deadline (Lin, 2009), it was unclear how much effort they made to identify and punish intentional slaughter. It was also

unclear how peasants perceived the risk of penalty. Here we try to evaluate some local characteristics that would affect this hide and seek game.

First, we calculate a county's distance to the provincial capital. Political zeal might decrease with distance from the political center, and local officials might ignore or disregard animal slaughter. Column 4 of Table 4 shows that in counties further from the provincial capital, collectivization causes a greater animal loss. Second, we create an indicator for counties that are officially recognized as a "revolutionary base," which accounts for 10 percent of the counties in our sample, based on a list from the Ministry of Agriculture (1989). In counties with a revolutionary legacy, local officials might be more tolerant of animal slaughter among local people who had been longtime supporters and allies of the CPC. Meanwhile, peasants in these areas might be more likely to support the CPC's collectivization movement and turn over their animals to the collectives. Column 4 shows that a revolutionary legacy does not alter the effect of collectivization on animal loss. Third, we calculate the ratio of ethnic minorities in a county's population using data from the 1982 census, the earliest census available. In counties with a large population of ethnic minorities, officials could offer a higher price for draft animals in order to avoid ethnic conflict. These counties were also more likely to receive subsidies or enjoy favorable policies (Huang, 1992). Column 4 shows a lower animal loss in counties with more ethnic minorities. Column 5 shows that once we add the ratio of middle peasants and the size of cooperatives, the effects of the other county characteristics become insignificant.

The Tragedy of the Commons. The estimated effects of collectivization on animal loss are likely to result from two types of behavior, both related to weak private property rights: animals could be slaughtered by their owners, or they could die from being overused and mistreated in the collective, the well-known tragedy of the commons. This latter cause of animal loss could only happen after the collectives took charge of the animals. The consequences of overuse and mistreatment should also result in more gradual decline in the inventory of draft animals compared to rapid slaughter following collectivization. To highlight the immediate loss caused by intentional slaughter, we drop

the observations in 1956 and 1957 for counties that started to collectivize in 1955, and the observations in 1957 for counties that started in 1956. Appendix Table A3 re-estimates Equation (1) with this truncated sample, and the results are similar: collectivization reduces the animal inventory by five percent, with a greater loss in counties with more middle peasants or with larger cooperatives.

4.4 The Dynamic Effects and The Total Loss in Animals

The coefficient β in Equation (1) summarizes the mean shift in the annual animal inventory after launching the collectivization movement. It underestimates the total animal loss, because the inventory keeps declining as the movement spreads to more villages and counties. Had the inventory continued growing at the same rate as in the early 1950s without disruption, what would it have been by the end of collectivization? Using this counterfactual as the benchmark, we can evaluate the total loss caused by collectivization.

We estimate the year-on-year change in the growth rate of the animal inventory, $\triangle log(animal\_inventory)_{it}$, both before and after collectivization:

$$\triangle log(animal)_{it} = \sum_k \beta_k * I(CY_{it} = k) + year_t + X_{it} + e_{it} \quad (3)$$

$\triangle log(animal\_inventory)_{it}$ filters out the county fixed effects c_i in Equation (1). A set of dummy variables $I(CY_{it} = k)$ indicates the k_{th} year of collectivization: $CY_{it} = 0$ is the first year of collectivization, $CY_{it} = 1$ the second year, and $CY_{it} = -1$ the year before collectivization, and so forth. We use the earliest year as the base year. If the inventory grows at a constant rate prior to collectivization, $\hat{\beta}_k$ should be zero for all $k < 0$. $\hat{\beta}_0$ and $\hat{\beta}_1$ should be negative, which captures the decline from the previous growth rate in the first two years of collectivization. X_{it} includes $\triangle log(rural\_population)_{it}$, $\triangle log(arable\_land)_{it}$, and two dummies for floods and droughts.

Panel A of Figure 5 shows the estimated $\hat{\beta}_{-1}$, $\hat{\beta}_0$, and $\hat{\beta}_1$, with the 95 percent confidence intervals.[16] For some counties, we have data as far back as

[16] Appendix Table A4 reports the estimated $\hat{\beta}_k$s in Equation (3). After the first difference,

1949, when the People's Republic of China was founded. With this sample of unbalanced panel data, Panel B extends the graph to the five years before collectivization. Both graphs show that the animal inventory grows at a constant rate in the years prior to collectivization. Then the growth rate drops by seven and eight percentage points in the first two years of collectivization. The two-year cumulative animal loss caused by collectivization is 15 percent, with a lower bound of 12 percent. The loss is also clear in Figure 4. For counties that started to collectivize in 1955, the log of the animal inventory would have increased to 10.57 in 1956 without collectivization, instead of the actual 10.43. Therefore, the two-year change caused by collectivization is -0.14 log points, or 14 percent. If we take 54 million head as the national inventory after two years of collectivization (Figure 2A), the two-year total loss is 7.4-9.5 million head.

4.5 Grain Output

The loss of draft animals could reduce grain output, and collectivization could also reduce output by reducing productivity. People work less in a large collective because individual effort, which is difficult to monitor in agricultural production, can barely change final outcome. Additionally, poor management and low administrative capacity in the collectives could result in mistakes in production plans and misallocation of resources. According to Wen (1993) and Lin (1990), the average total factor productivity in Chinese agricultural production dropped in 1956 and 1957. Their estimates based on aggregate data, however, are not the causal effects of collectivization. We estimate a simple Cobb-Douglas grain production function, using arable land, rural population, and draft animals as the inputs. As in the main difference-in-differences specification, we add a dummy variable that equals 1 for the years after a county started to collectivize. We allow for a one-year lag in the dummy to reflect

we have five years of data. The one-year gap in the timing of collectivization makes the data comparable for *both* groups of counties in only four years: two years before and two years after collectivization. In the regression, $k = -2$ is the base year. Appendix Figure A3 shows a similar graph of yearly changes in $log(animal)$, which is essentially the same as Figure 4.

the fact that most counties started to collectivize after the harvest. Table 5 reports the estimates: collectivization reduces annual grain output by seven percent, five percent through the channel of lower productivity.

The indirect effect of collectivization, through the channel of lower animal inputs, is difficult to evaluate. The coefficients on the inputs could be biased because of endogeneity. Nevertheless, our estimated coefficient of $log(animal)$, 0.22, is very close to 0.245, the estimate from Li and Yang (2005).[17] Using provincial-level data from 1952 to 1977, they argue that the central planner allocated production inputs among the provinces based on past observations, which hardly reflected the up-to-date idiosyncratic shock. Thus, the effects of contemporary inputs on contemporary grain output can be consistently estimated. If we take their number 0.245, and multiply it by -0.04 (the annual loss in animal inventory in Table 2), we conclude that the animal loss caused by collectivization reduces grain output by one percent.

There is no evidence that collectives reduce the use of draft animals as a result of the economy of scale. The estimates in Table 5 suggest a constant return to scale in grain production, and the decreased productivity suggests that collectives failed to use pooled resources more efficiently. Moreover, column 4 shows that in counties with larger cooperatives, productivity is equally low and the economy of scale is not realized.

5 Concluding Remarks

In China's collectivization movement from 1955 to 1957, peasants slaughtered their draft animals for meat and hide rather than giving them to the collectives. By comparing 1,600 counties that started to collectivize in different years, the difference-in-differences estimates suggest that the total animal loss during the movement was 12-15 percent. More animals were slaughtered in counties that had better protections for private property rights prior to collectivization, and in counties with larger collectives in which output had to be shared with more

[17] See the coefficient of $ln(farm\ capital)$ in column 1 of Table 5 in Li and Yang (2005, pp 863). They construct the variable to measure in equivalent power units the sum of farm machines and draft animals, but the number of machines in 1952-57 was negligible.

members. Grain output dropped by seven percent after collectivization.

This study focuses on the incentives of individual peasants faced with the prospect of losing their animals. Our analysis ends in 1957 because by the end of that year, all draft animals had become communal property and any intentional slaughter after the time would have been considered a crime against the collective. In 1958-61, when the agricultural sector collapsed and the famine raged, animal loss accelerated (Appendix Figure A4). By the end of 1961, the national inventory of draft animals was a mere 38 million head, 19 million head (or 35 percent) fewer than in 1954. If we consider the counterfactual growth without disruption, the total loss would be much larger.

The animal loss was even larger during the collectivization movement in the Soviet Union in 1929-33, which was also accompanied by a devastating famine. By 1933 the national inventory of draft animals in the Soviet Union had dropped by 30 million head, or 50 percent, from its level in 1928 (Appendix Figure A5). The huge loss was caused by distorted economic incentives, similar to those discussed in this paper, as well as by the deadly violence waged against kulaks (rich peasants), Ukrainians, and Kazakhs. According to Conquest (1987), 6.5 million people died as a result of Stalin's *dekulakization* movement. To avoid being labeled as a kulak, peasants rushed to get rid of their capital, slaughter their animals, or even burn down their houses and flee their villages. In Ukraine, five million people died in the famine-genocide. In the forced settlement of nomadic Kazakhs, one million people and 5.8 million head livestock died. In contrast, China's collectivization process was much less violent, which provides a rare chance to examine the effects of economic incentives stemming from the shift from private to communal property rights.

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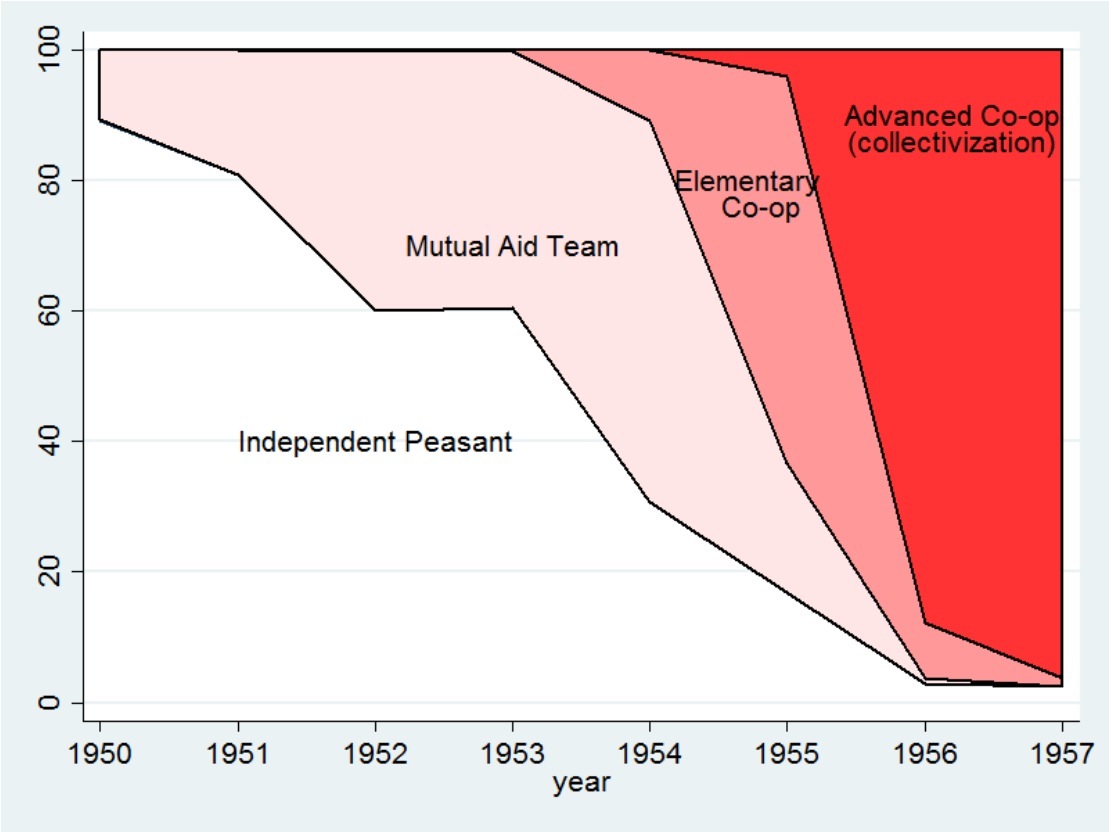
Figure 1 The Percentage of Rural Households Included in Various Organizations



This figure shows the percentage of rural households included in mutually exclusive organizations. From 1950 to 1953, the percentages were recorded in the middle of the year; from 1954 to 1957, they were recorded at the end of the year. For 1955, only the total percentage of independent peasants and mutual aid teams was available.

Source: National Bureau of Statistics (1957, 1980)

Figure 2A The National Inventory of Draft Animals (million head)

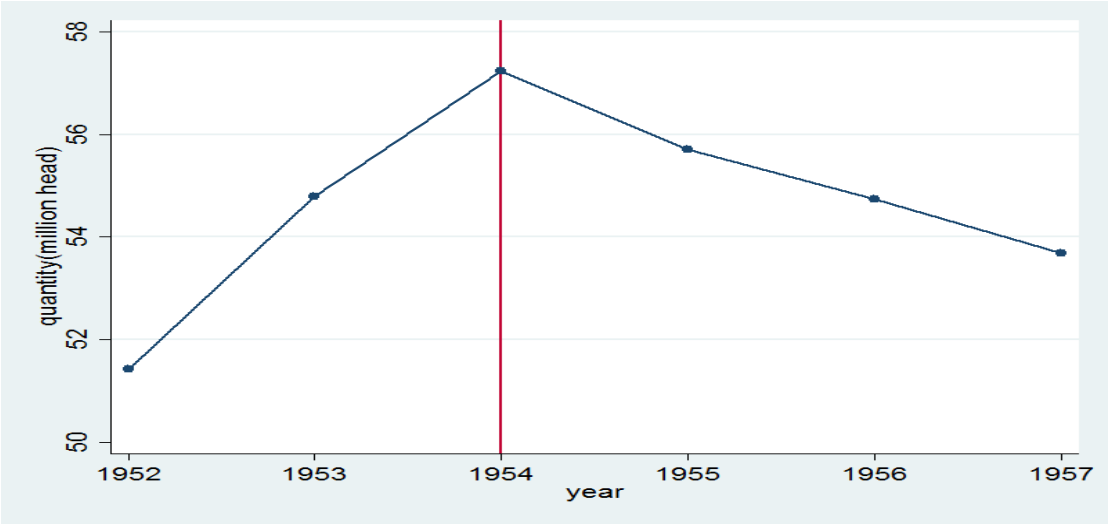


Figure 2B The Quantity of Cowhides Sold Nationwide (million piece)

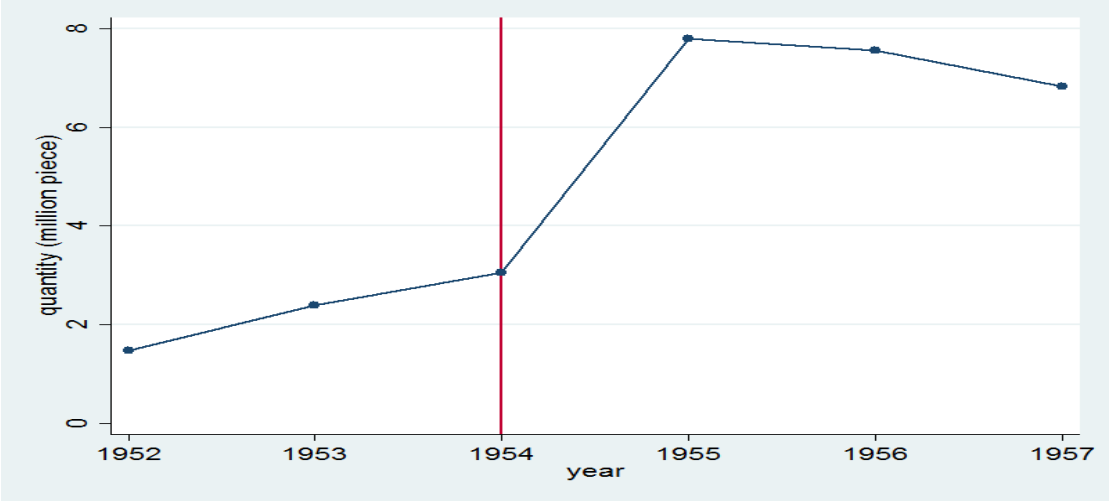
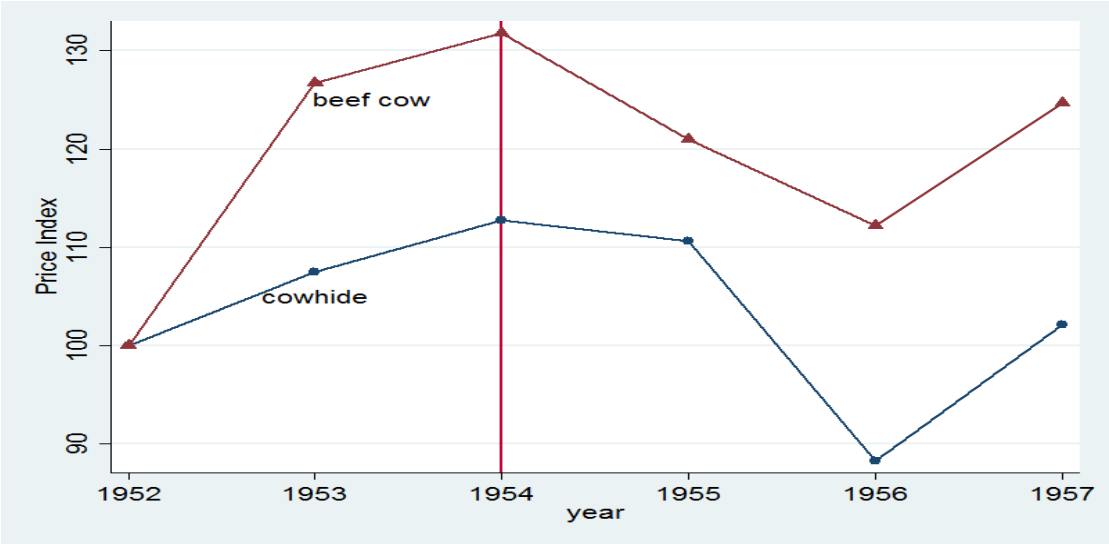
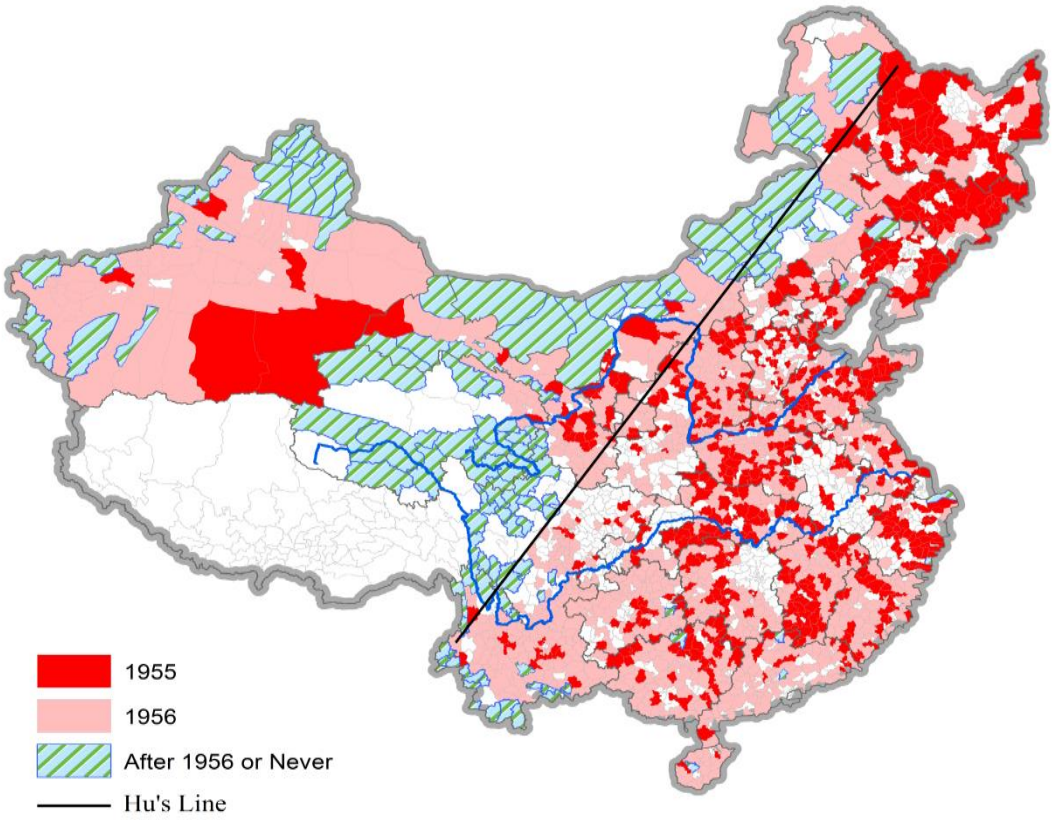


Figure 2C The Price Indices of Beef Cow and Cowhide (1952=100)



Source: Ministry of Agriculture (1990)

Figure 3 The Year of Introduction of Advanced Cooperatives in 1,720 Counties



Note: In our sample of 1,720 counties, 569 began establishing advanced cooperatives in 1955, 1,031 counties began in 1956, while 120 counties began later or never established an advanced cooperative. The majority of these 120 counties are located on the pasturelands of China. Data from Tibet do not exist. The east side of Hu's line includes 43 percent of mainland China's territory and 94 percent of its population.

Source: County gazetteers.

Figure 4 Log of the Average Inventory of Draft Animals by the Year of Introduction of Advanced Cooperatives (1955 or 1956)

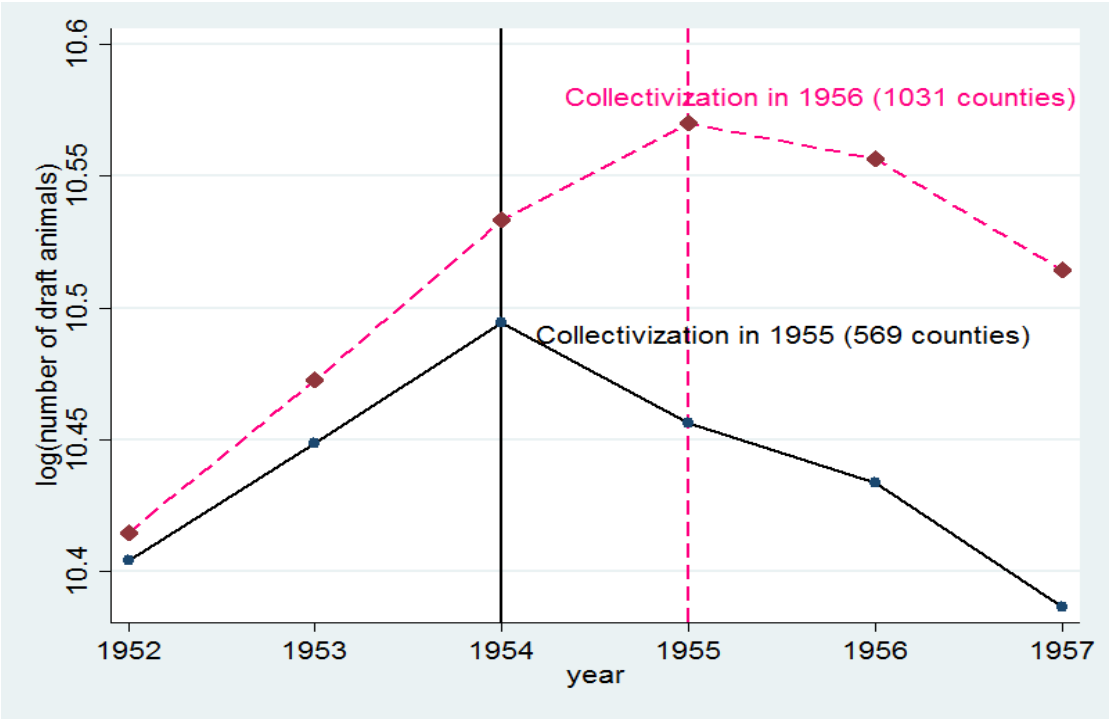
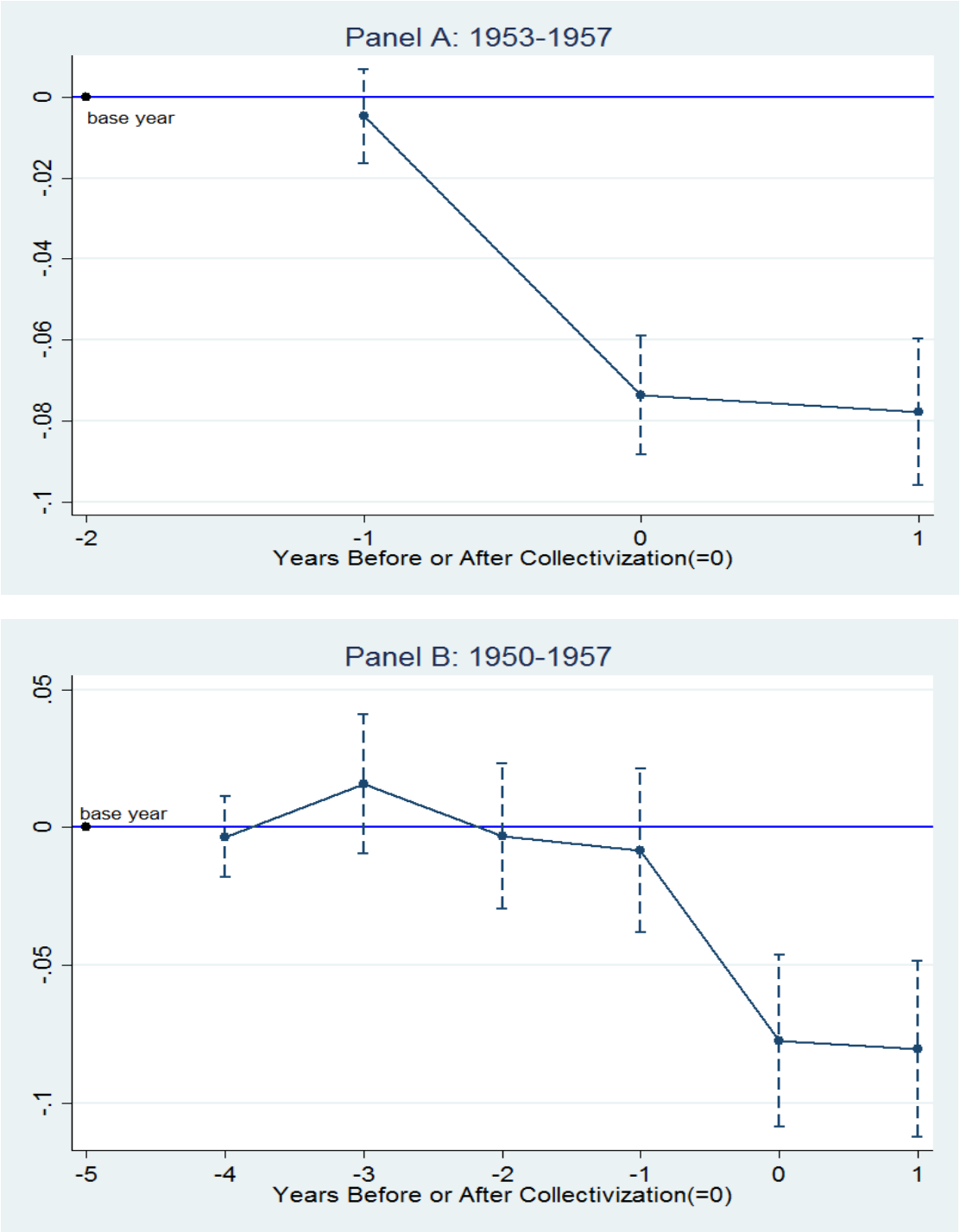


Figure 5 The Dynamic Effects of Collectivization on △log (draft animals)



This figure shows that collectivization, beginning at year 0, changes the growth rate of the animal inventory. We regress △log (draft animals) on a set of normalized year dummies and plot the coefficients. The dotted lines indicate the 95 percent confidence intervals. The reported coefficients reflect the changes in △log (draft animals) relative to the base year. All regressions include Δlog(rural population), Δlog(arable lands), flood, drought, calendar year dummies, and a constant. In Panel B, we use an unbalanced panel data set, in which some counties have data extending back to 1949.

Table 1 Summary Statistics

	N	Mean	S.D.	Min	Max
Panel A: Variables that change across 1,600 counties and over time, 1952-57					
Draft animals (1,000 head)	9600	35.82	25.06	0.59	183.82
Log (draft animals)	9600	10.22	0.8	6.38	12.12
Collectivization	9600	0.39	0.49	0	1
Rural Population (1,000)	8862	255.1	185.9	22.12	1106
Arable land (1,000 hectares)	8699	56.25	44.43	0.66	369.28
Grain output (1,000 tons)	9190	79.23	61.54	0.11	531
Flood	9524	0.19	0.39	0	1
Drought	9524	0.12	0.32	0	1
Panel B: County characteristics that do not change over time					
Ratio of middle peasant households	895	0.32	0.11	0.07	0.89
Number of people included in an advanced cooperative	1276	1154	1395	108	22906
Distance to the provincial capital (km)	1600	187	164	0	1339
Revolutionary base	1600	0.10	0.31	0	1
Ratio of ethnic minorities	1600	0.12	0.24	0	1

Table 2 The Effects of Collectivization on the Inventory of Draft Animals: log (draft animals)

	(1)	(2)	(3)	(4)	(5)	(6)
collectivization	-0.045***	-0.048***	-0.030***	-0.036***	-0.049***	-0.037***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.011)	(0.013)
log(rural population)		-0.002	0.074*	0.052	0.143	0.105
		(0.036)	(0.039)	(0.035)	(0.116)	(0.101)
log(arable lands)		0.319***	0.287***	0.173**	0.311**	0.260
		(0.065)	(0.066)	(0.086)	(0.133)	(0.168)
flood		-0.008**	0.004	-0.014***	-0.025***	-0.028***
		(0.004)	(0.005)	(0.003)	(0.008)	(0.006)
drought		-0.005	-0.002	-0.023***	-0.016**	-0.038***
		(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
constant	10.15***	8.985***	8.864***	8.864***	7.197***	7.845***
	(0.003)	(0.426)	(0.541)	(0.541)	(1.379)	(1.384)
Province FE*year FE	N	N	Y	N	N	N
county FE*trend	N	N	N	Y	N	Y
Distance to Prov. Capital <100km	N	N	N	N	Y	Y
N	9,600	7,997	7,997	7,997	2,410	2,410

Standard errors are clustered at the county level **$p<0.05$, ***$p<0.01$

All regressions include a set of year dummies and county dummies. The collectivization dummy equals 1 for the year that a county started to establish advanced cooperatives and for the years after. In columns (5) and (6), we restrict the sample to counties that are close to each other, i.e. within 100 kilometers of their provincial capital.

Table 3 Test for the Assumption of a Common Trend

	Sample years: 1952-57			Sample years: 1949-57		
	Log(animal)	Log(population)	Log(land)	Log(animal)	Log(population)	Log(land)
	(1)	(2)	(3)	(4)	(5)	(6)
Group56*Five years before collect.				-0.000	-0.012	0.012*
				(0.010)	(0.010)	(0.007)
Group56*Four years before collect.				0.004	-0.001	0.025***
				(0.014)	(0.010)	(0.009)
Group56*Three years before collect.				-0.025	0.001	0.007
				(0.016)	(0.010)	(0.010)
Group56*Two years before collect.	0.007	0.003	-0.000	-0.018	0.004	0.007
	(0.006)	(0.005)	(0.003)	(0.017)	(0.011)	(0.011)
Group56*One year before collect.	0.006	0.002	0.006	-0.019	0.003	0.013
	(0.008)	(0.004)	(0.005)	(0.018)	(0.011)	(0.011)
N	8,000	7,340	7,249	11,344	10,511	10,307

Standard errors are clustered at the county level *$p<0.1$, ***$p<0.01$

We regress log (draft animals), log(rural population), or log(arable land), on a set of normalized year dummies, and their interactions with the dummy for the counties that started to collectivize in 1956. The reported coefficients reflect that, in the years prior to collectivization, the average trend for these "late counties" is the same as the counties that started to collectivize in 1955. In columns (4)-(6), we use an unbalanced panel data set in which some counties have data extending back to 1949. All regressions include county dummies and a constant, see Equation 2.

Table 4 The Effects of Collectivization on log (draft animals), Varied with County Characteristics

	(1)	(2)	(3)	(4)	(5)
Collectivization	-0.024***	-0.029***	-0.021**	-0.040***	-0.025***
	(0.009)	(0.007)	(0.008)	(0.007)	(0.009)
Collectivization*ratio of middle peasant households†	-0.103**		-0.091*		-0.086*
	(0.048)		(0.051)		(0.052)
Collectivization*log(number of people in a co-op)†		-0.033***	-0.031***		-0.032***
		(0.008)	(0.011)		(0.011)
Collectivization*log(distance from the capital city)†				-0.008*	-0.010
				(0.005)	(0.006)
Collectivization*dummy for a revolutionary base				0.011	0.016
				(0.018)	(0.027)
Collectivization*ratio of ethnic minorities				0.036**	0.027
				(0.017)	(0.023)
N	4,490	6,589	4,096	7,997	4,096

Standard errors are clustered at the county level ***p<0.05, ***p<0.01*

The collectivization dummy equals 1 for the year that a county started to establish advanced cooperatives and for the years after. All regressions include log (rural population), log (arable land), flood, drought, year dummies, county dummies, county-specific trends, and a constant.

† The variables are the deviation from their mean. This transformation does not affect the coefficients of the interaction terms, and the coefficients of the collectivization indicator are the effect at the mean level of these variables.

Table 5 The Effects of Collectivization on Log(Grain Output)

	(1)	(2)	(3)	(4)
Collectivization, one-year lag	-0.067***	-0.054***	-0.051***	-0.054***
	(0.012)	(0.012)	(0.013)	(0.015)
log (draft animals)		0.277***	0.220***	0.222***
		(0.031)	(0.048)	(0.058)
log (arable land)		0.616***	0.673**	0.596**
		(0.138)	(0.267)	(0.280)
log (rural population)		0.097*	0.145**	0.136
		(0.057)	(0.057)	(0.115)
flood	-0.081***	-0.071***	-0.086***	-0.090***
	(0.007)	(0.007)	(0.008)	(0.009)
drought	-0.050***	-0.052***	-0.072***	-0.072***
	(0.008)	(0.009)	(0.010)	(0.011)
Collectivization (one year lag)*log(number of people in a co-op)†				-0.012
				(0.016)
county FE*trend	N	N	Y	Y
N	9,114	7,877	7,877	6,491

Standard errors are clustered at the county level *$p<0.1$, **$p<0.05$, ***$p<0.01$

This table reports the difference-in-differences estimates of the effects of collectivization on grain output. We allow for a one-year lag in the effect to reflect the fact that most counties started to collectivize after the harvest. All regressions include year dummies, county dummies, and a constant.

† The variable is the deviation from its mean. This transformation does not affect the coefficient of the interaction term, and the coefficients of the collectivization indicator are the effect at the mean level of the variable.

(For Online Publication)

Appendix: Data Sources

Main Data

Our data sources consist of 20 declassified government files, 15 government reports (both internal and public), seven published compilations of statistics, and 1,720 county gazetteers. Appendix Figure A6 shows some pictures of these declassified files. We collect these documents from the National Library of China, university libraries in both mainland China and Hong Kong, the search engine Duxiu with full-text Chinese books for subscribers, and the Kongfuzi website, the largest online market in China for used or antique books and documents.

For 1,323 counties in 20 provinces, we find complete agricultural statistics compiled by the provincial bureaus of statistics or of agriculture. For a centrally planned economy in the 1950s, these statistics were indispensable to the planning committees and governments. There were three waves of provincial compilations of such statistics. The first wave was in 1958, which summarized the first five-year plan (1953-57). The second wave was in 1978-83, which reviewed the first three decades of the People's Republic of China. The third wave was in 2009, which was compiled to celebrate the 60th anniversary of the republic.

Where provincial compilations are unavailable, we use prefectural compilations of county statistics. A prefecture is an administrative division under a province, and each prefecture consists of several counties. We find 19 prefectural compilations of statistics of 155 counties. When neither provincial nor prefectural compilations are available, we use individual county gazetteers. China has a thousand-year-long tradition of recording local history in gazetteers. The most recent gazetteers were published in the late 1980s and 1990s. Every gazetteer has a section on agriculture that documents relevant policies and some official statistics of agricultural production. Few gazetteers, however, report the annual inventory of draft animals in the 1950s. We find such statistics in 252 county gazetteers.

Below are the data sources, all in Chinese, ordered by provincial administrative division code.

11 Beijing Municipality

The statistics are from county gazetteers.

12 Tianjin Municipality

Historical Yearly Statistics of Animal Husbandry in Tianjin Municipality, the Bureau of Animal Husbandry in Tianjin Municipality, Hebei Science and Technology Press, 1988

Other statistics of agricultural production and population are from county gazetteers.

13 Hebei Province

Historical Agricultural Statistics in Chengde Prefecture: *1949-1978*, the Agricultural Bureau of Hebei Province, the Agricultural Bureau of Chengde Prefecture, 1979

Economic Statistics in Langfang Prefecture: *1949-197*9, the Statistic Bureau of Langfang Prefecture, 1980

Economic Statistics in Qinhuangdao Prefecture: *1949-19*84, the Statistic Bureau of Qinhuangdao Prefecture, 1985

The statistics of other counties are from county gazetteers.

14 Shanxi Province

Shanxi's Economy: Cities and Counties; Shanxi Economy Press, 1992

15 Nei Mongol Autonomous Region

Statistics of Agricultural and Animal Husbandry Production: 1947-1978, Volumes I-IV. the Statistic Bureau of Nei Mongol Autonomous Region, 1983

Brilliant Inner Mongolia: 1947-1999, China Statistics Press, 1999. We use this book for the data of population.

21 Liaoning Province

*One Decade of Economic Achievements of Jinzhou Prefecture 1949-19*58, the Statistics Bureau of Jinzhou Prefecture, 1959

Economic Statistics in Andong Prefecture: *1949-19*62, the Statistics Bureau of Andong Prefecture, 1964

Compendium of Economic Statistics in Benxi Prefecture: *1949-19*71, the Statistics Bureau of Benxi Prefecture, 1975

The statistics of other counties are from county gazetteers.

22 Jilin Province

Jilin Compendium of Statistics of Sixty Years of Agricultural Development: 1949-2009, Jilin Press Group Corporation, 2011

23 Heilongjiang Province

Heilongjiang Compendium of Economic Statistics (Agricultural and Subsidiary Production): 1949-1957, the Statistics Bureau of Heilongjiang Province, 1958

32 Jiangsu Province

Agricultural Statistics in Jiangsu Province: 1949-1975, Volumes I and II, the Agricultural Bureau of the Revolutionary Committee in Jiangsu Province, 1976

33 Zhejing Province

Agricultural Statistics in Hangzhou Prefecture (1949-1973), the Agricultural Bureau of Huzhou Prefecture, 1974

Progressive Huzhou Prefecture: Thirty-five Years of Economic Statistics (1949-1984), the Statistic Bureau of Huzhou Prefecture, 1985

*Vivid Wenzhou Prefecture: Four Decades of Great Economic and Social Achievements (1949-19*88), the Statistic Bureau of Wenzhou Prefecture, 1989

*Four Decades of Zhoushan Prefecture (1949-19*88), the Statistic Bureau of Zhoushan Prefecture, 1989

*Progressive Taizhou Prefecture: 1947-199*0, the Statistics Bureau of Taizhou Prefecture, China Statistics Press, 1994

The statistics of other counties are from county gazetteers.

34 Anhui Province

The statistics are from county gazetteers.

35 Fujian Province

Fujian Compendium of Statistics (the Agricultural Sector): 1950-1957, the Planning Committed of Fujian Province, the Agricultural Bureau of Fujian Province, and the Statistic Bureau of Fujian Province, 1958

36 Jiangxi Province

Jiangxi Compendium of Agricultural Statistics, by Cities and Counties (1949-1965), Volumes I and II, the Bureau of Agriculture, Animal Husbandry, and Fishery in Jiangxi Province, 1989

37 Shandong Province

Statistics of Agricultural Production of Shandong Province during the First Five-Year Plan Period: 1952-1957, the Agricultural Bureau of Shandong Province, and the Statistic Bureau of Shandong Province, 1958

41 Henan Province

Agricultural Statistics in Henan Province in the Three Decades since 1949: 1949-1979, Volumes II-XI, the Agricultural Bureau of Henan Province, and the Statistic Bureau of Henan Province, 1981

42 Hubei Province

Agricultural Statistics in Hubei Province: 1949-1975, Volume II, the Agricultural Bureau of the Revolutionary Committee in Hubei Province, 1979

Agricultural Statistics in Hubei: 1949-1978, the Agricultural Bureau of Hubei Province, 1980

43 Hunan Province

Economic Statistics in Hunan Province (Section 2: Agriculture): 1949-1975, Volumes 3-5, the Statistics Bureau of Hunan Province, 1978

44 Guangdong Province

Agricultural Statistics in Guangdong Province (1949-1981, by Cities and Counties), Statistics Bureau of Guangdong Province, 1982

45 Guangxi Zhuang Autonomous Region

Economic Statistics in Guangxi Zhuang Autonomous Region (Agriculture): 1949-1980, Volumes II and III, the Statistics Bureau of Guangxi Zhuang Autonomous Region , 1985

46 Hainan Province

Agricultural Statistics in Guangdong Province (1949-1981, by Cities and Counties), Statistics Bureau of Guangdong Province, 1982

In 1982, Hainan was still a part of Guangdong province.

50/51 Chongqing Municipality and Sichuan Province

Agricultural Statistics in Wenjiang Prefecture of Sichuan Province: 1949-1979, the Statistic Bureau of Wenjiang Prefecture, 1980

Historical Agricultural Statistics in Leshan Prefecture: *1949-19*86, the Agricultural Bureau of Leshan Prefecture, 1988

Historical Statistics of the Economic and Social Development in the Ethnic Minority Regions in Sichuan Province: *1949-19*85, the Committee of Minorities Affair of Sichuan Province, and the Statistics Bureau of Sichuan Province, 1988

The statistics of other counties are from county gazetteers.

52 Guizhou Province

Economic Statistics of Bijie Prefecture in Guizhou Province: 1949-1959, the Statistics Bureau of Bijie Prefecture, 1960

*Forty Years of Progress in Qiannan Prefecture: 1949-19*88, the Editorial Committee of the Book, and the Statistics Bureau of Qiannan Buyei and Miao Autonomous Prefecture, 1989

Fifty Years of Tongren Prefecture: 1949-2009, the Editorial Committee of the Book, 1999

Sixty Years of Zunyi Prefecture: 1949-2009, the Statistics Bureau of Zunyi, and the Survey Team of Zunyi of the National Bureau of Statistics, 2009

The statistics of other counties are from county gazetteers.

53 Yunan Province

Glorious Sixty Years of Yunan Province, Volumes of Economic Achievements,the Statistics Bureau of Yunnan Province, Yunnan Press Corporation, Yunnan People Press, 2010

61 Shaanxi Province

*Forty Years in Yulin Prefecture: 1949-19*88, the Statistics Bureau of Yulin Prefecture, 1989

*Forty Years in Weinan Prefecture: 1949-19*88, the Statistics Bureau of Weinan Prefecture, 1989

Xi'an Compendium of Historical Statistics: *1949-19*89, Volume I, the Statistics Bureau of Xi'an Prefecture, China Statistics Press, 1995

The statistics of other counties are from county gazetteers.

62 Gansu Province

Statistics in Agriculture, Forestry, Animal Husbandry, Water Conservation, and Weather in Gansu Province: 1949-1957, the Division on Rural Issues of the Committee of Chinese Communist Party of Gansu Province, 1958

63 Qinghai Province

Economic Statistics in Qinghai Province :1949-1979, the Statistics Bureau of Qinghai Province, 1981

64 Ningxia Hui Autonomous Region

Economic Statistics in Ningxia Hui Autonomous Region (Agriculture) :1949-1965, Statistics Bureau of Ningxia Hui Autonomous Region, 1966

65 Xinjiang Uygur Autonomous Region

Agricultural Statistics in Xinjiang Uygur Autonomous Region: 1949-1978, Volumes I and II, the Agricultural Bureau of Xinjiang Uygur Autonomous Region, and the Statistics Bureau of Xinjiang Uygur Autonomous Region; 1980

Animal Husbandry Statistics in Xinjiang Uygur Autonomous Region: 1949-1978, the Animal Husbandry Bureau of Xinjiang Uygur Autonomous Region, and the Statistics Bureau of Xinjiang Uygur Autonomous Region; 1980

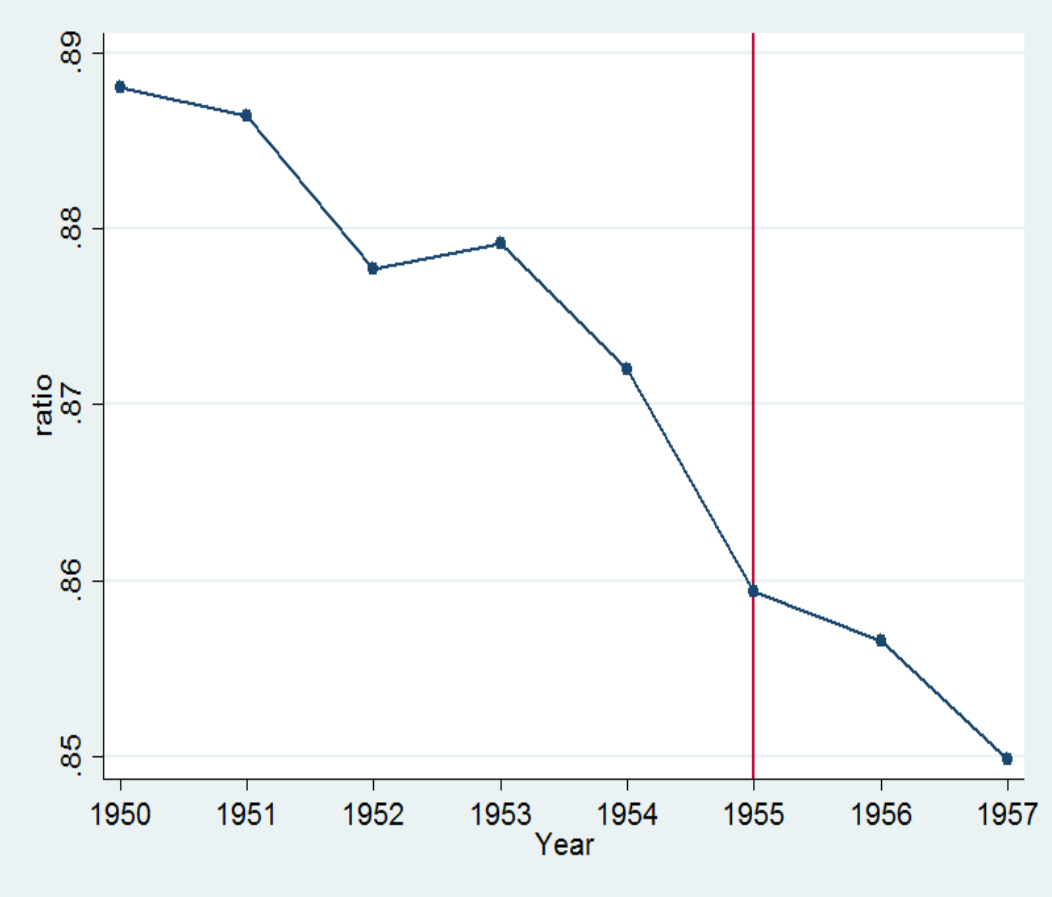
The statistics of population are from county gazetteers.

Weather Data

The historical local weather data are compiled by the State Meteorological Society, recorded in 267 weather stations as well as in county gazetteers. We assign these station records to their closest counties, based on the algorithm of Thiessen polygons. This method creates a polygon around each weather station, and these non-overlapping polygons cover all the counties. The counties closest to a station are the counties within the polygon of the station. The weather data use a discrete variable for rainfall: 1 for exceptional floods, 2 for limited floods, 3 for normal weather, 4 for limited droughts, and 5 for exceptional droughts.[1] We define two separate binary indicators for exceptional floods and exceptional droughts.

[1]The variable is defined according to the descriptions in local gazetteers or the amount of precipitation, when available. Typical descriptions of events categorized as "exceptional floods" are "countless people and animals drowned in floods," or "typhoons and heavy rains flood fields and houses," etc. When the annual amount of precipitation is available, "exceptional floods" are the years in which the amount is higher than a 1.17 standard deviation above the mean.

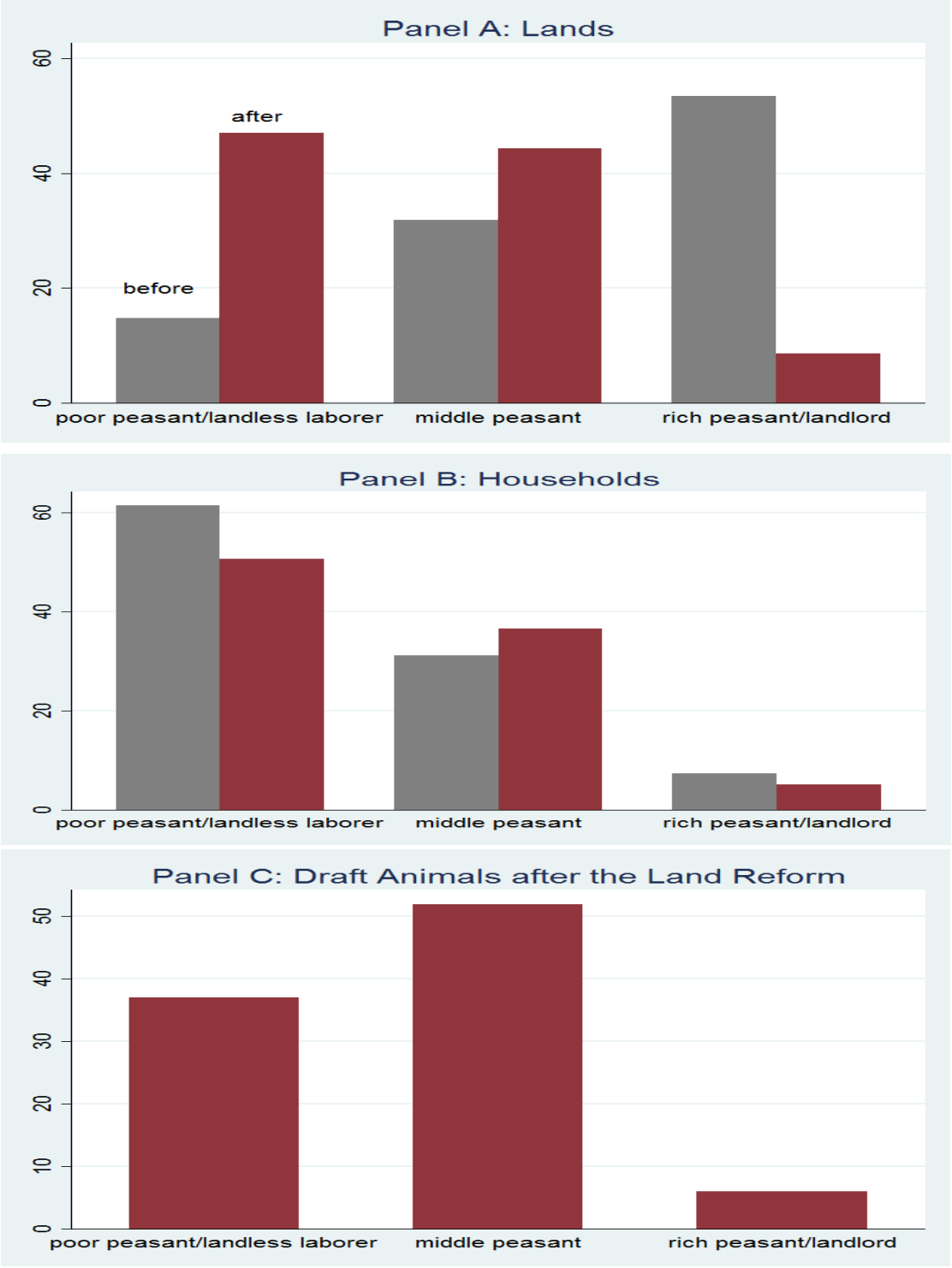
Appendix Figure A1 The Area Sown with Grain as a Proportion of the Area Sown with All Types of Crops



This figure shows that from 1950 to 1957, among all the sown land, the portion allocated to grain decreased continuously. The cumulative decline, however, was modest - less than 4 percentage points. This decline was neither disrupted nor accelerated by collectivization.

Source: National Bureau of Statistics (2010)

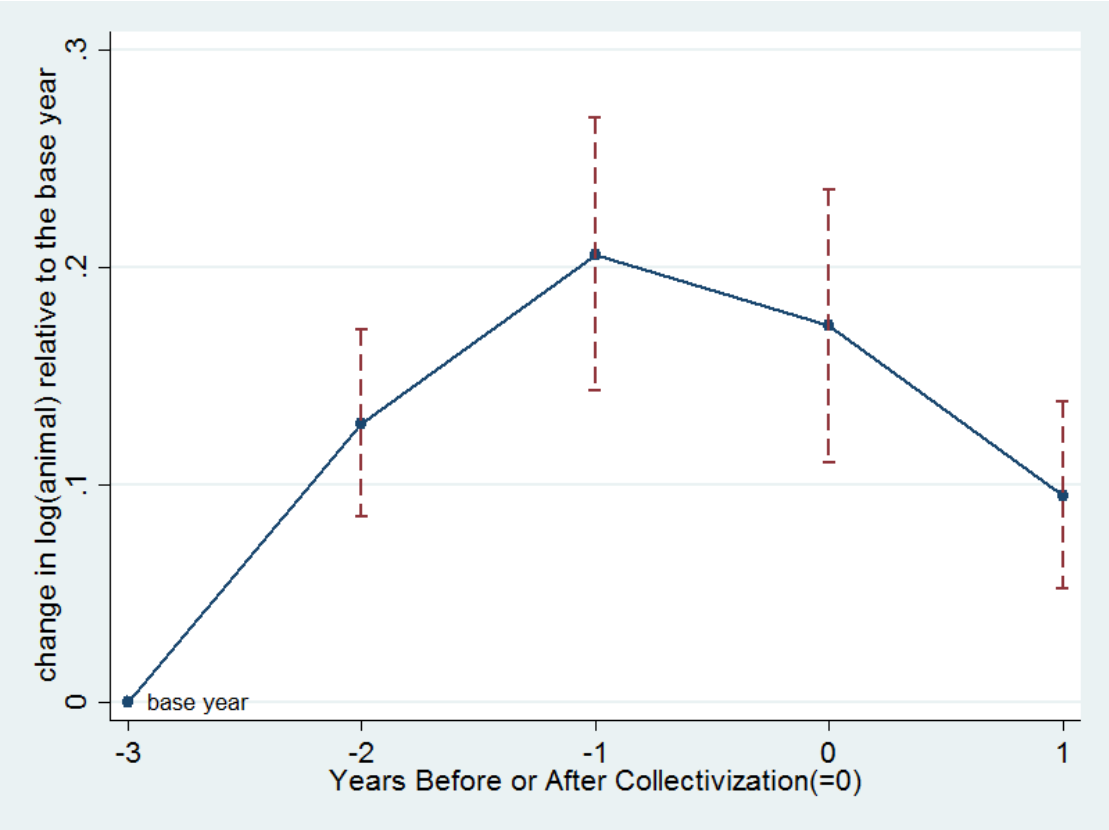
Appendix Figure A2 The Distribution (in percentages) of Lands, Households, and Draft Animals, before and after the Land Reform Movement, by the Classes Assigned



Notes: Panel B shows some slight changes in the ratios before and after land reform. There were typically two or three waves of reform in the same county, with each wave addressing the issues of misclassification in the previous wave. As a result, the ratio of classes was adjusted a bit in each wave. In Panel C, data before the reform are not available.

Source: National Bureau of Statistics (1980)

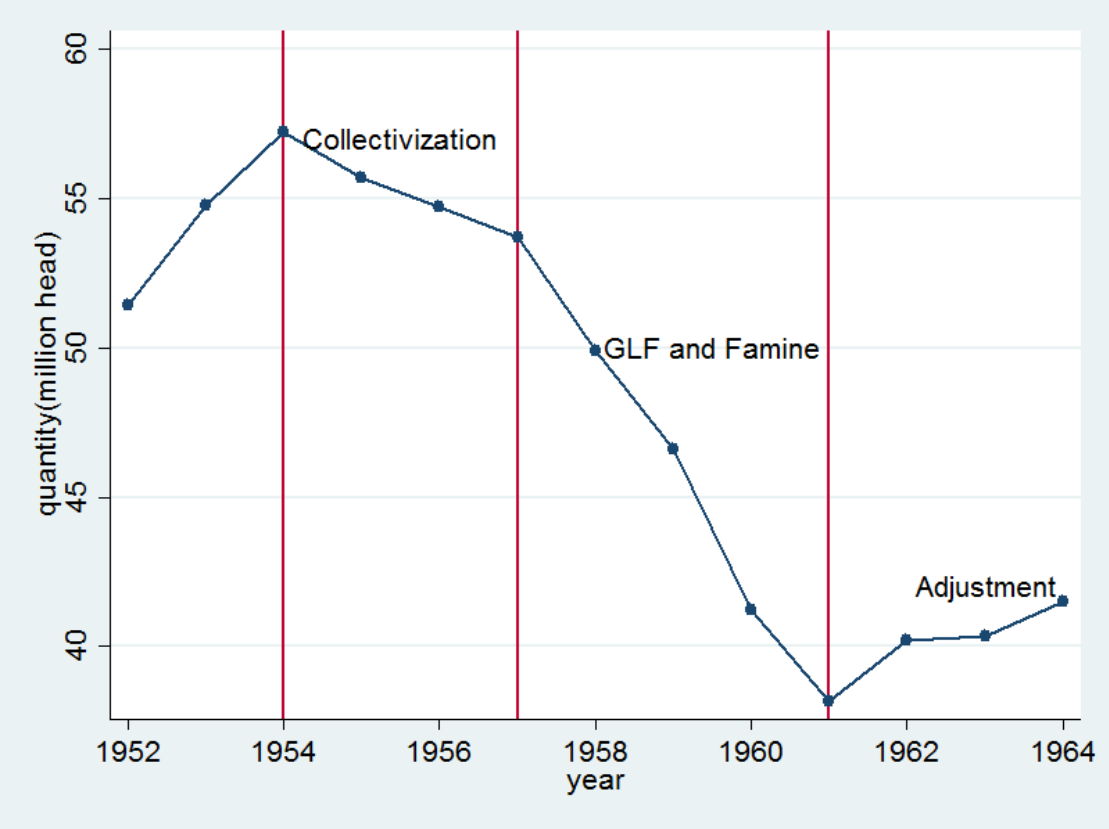
Appendix Figure A3 The Dynamic Effects of Collectivization on log (draft animals)



This figure shows that collectivization, began at year 0, changes the growth pattern in the animal inventory. After two years since collectivization, the animal inventory drops by 10% from its peak in the year before collectivization (x=-1).

We regress log (draft animals) on the normalized year dummies and plot the coefficients. The dotted lines indicate the 95 percent confidence intervals. The reported coefficients reflect the changes in log (draft animals) relative to its level in the base year, the third to last year prior to collectivization. All regressions include log(rural population), log(arable lands), flood, drought, calendar year dummies, county-specific trends, and a constant.

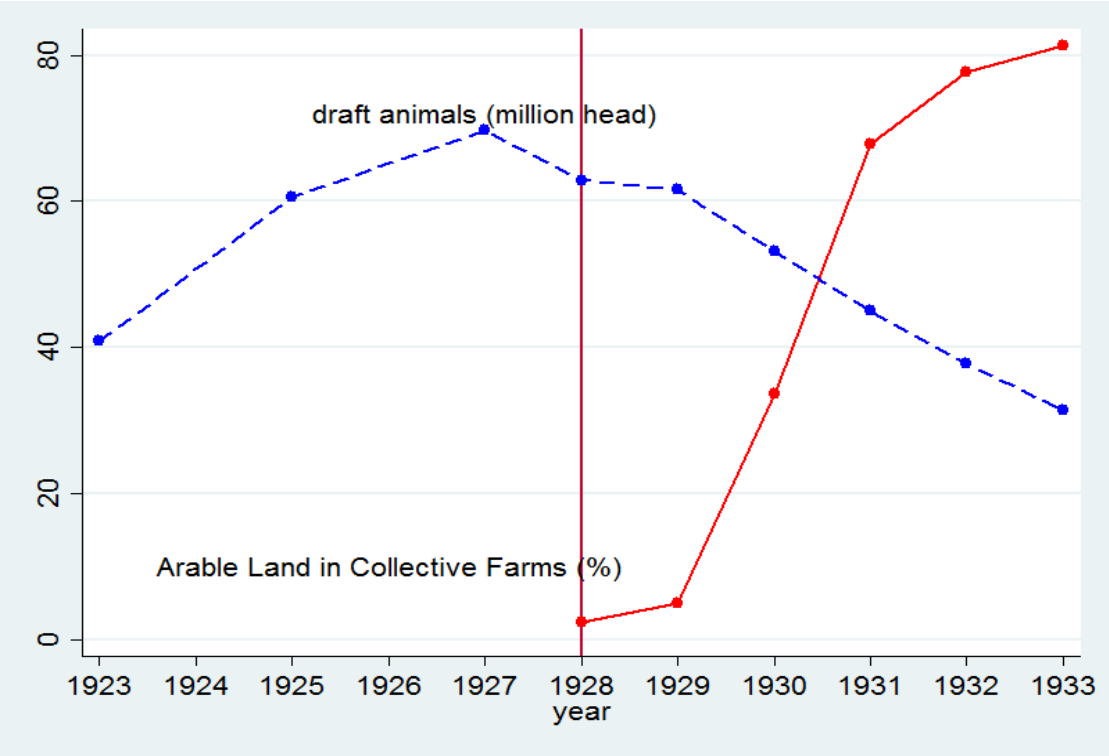
Appendix Figure A4 The National Inventory of Draft Animals (million head)



GLF stands for the Great Leap Forward movement in 1958. "Adjustment" is the three-year "adjustment period" from 1962 to 1964.

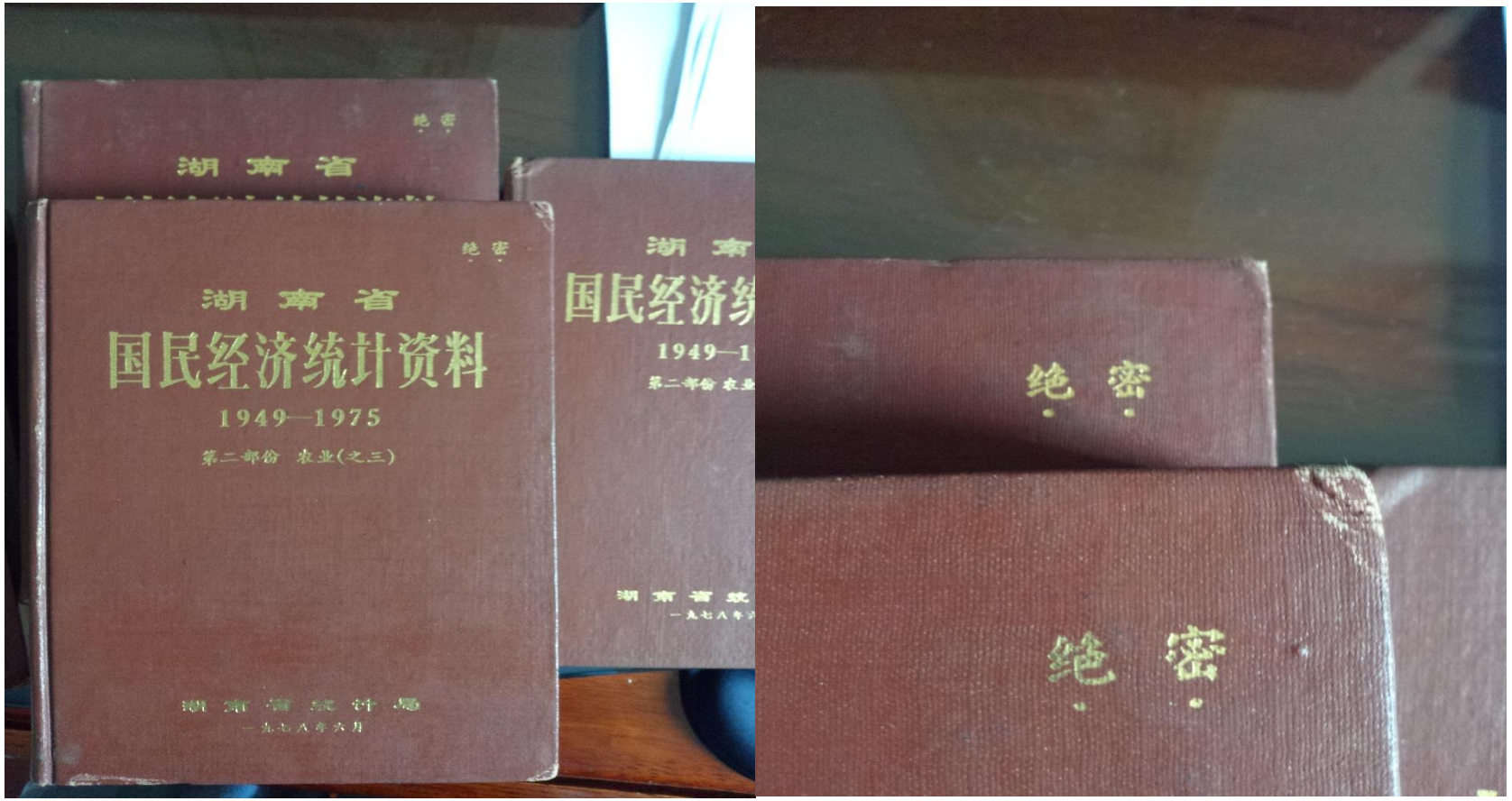
Source: Ministry of Agriculture (1990)

Appendix Figure A5 Collectivization and Draft Animals in the Soviet Union



The collectivization movement in the Soviet Union was between 1929 and 1933. Draft animals include horses and cows, excluding milk cows.
Source: Li (1981)

Appendix Figure A6 Examples of Declassified Government Files



The picture on the left shows the three volumes of the *Economic Statistics in Hunan Province (Section 2: Agriculture): 1949-1975.* The picture on the right highlights the classification level of the file, *Top Secret*, on the front cover.

Appendix Table A1 Placebo Test: The Effects of Collectivization on Rural Population and Arable Land

	log (rural population)		log (arable land)	
	(1)	(2)	(3)	(4)
collectivization	0.001	-0.000	-0.006	-0.001
	(0.002)	(0.003)	(0.004)	(0.004)
flood	-0.008***	-0.002	-0.021***	-0.009***
	(0.003)	(0.002)	(0.002)	(0.003)
drought	-0.001	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
constant	12.105***	12.082***	3.712***	3.701***
	(0.001)	(0.002)	(0.002)	(0.002)
county FE*trend	N	Y	N	Y
N	8,826	8,826	8,623	8,623

Standard errors are clustered at the county level ***$p<0.01$

This table reports the results of a placebo test. It shows the difference-in-differences estimates of the effects of collectivization on log (rural population) and log (arable land). The collectivization dummy equals 1 for the year that a county began to establish advanced cooperatives and for the years after. All regressions include a set of year dummies and county dummies.

Appendix Table A2 The Effects of Collectivization on Log (draft animals): by Two Groups of Provinces

	Agricultural Machinery in 1958		Change of Crop Mix after Collectivization	
	More	Less	>=mean	<mean
	(1)	(2)	(3)	(4)
collectivization	-0.042**	-0.048***	-0.045***	-0.044***
	(0.017)	(0.006)	(0.008)	(0.008)
log(rural population)	-0.067	0.120*	-0.025	0.046
	(0.042)	(0.069)	(0.038)	(0.070)
log(arable lands)	0.550***	0.270***	0.283***	0.441***
	(0.110)	(0.070)	(0.080)	(0.079)
flood	-0.002	-0.012***	0.005	-0.018***
	(0.009)	(0.004)	(0.006)	(0.005)
drought	-0.000	-0.006	-0.017**	-0.000
	(0.013)	(0.005)	(0.007)	(0.006)
N	1,002	6,995	4,416	3,485

Standard errors are clustered at the county level *$p<0.1$, **$p<0.05$, ***$p<0.01$

This table shows that the effects of collectivization on the animal inventory do not vary across two groups of provinces. Columns (1) and (2) divide the provinces according to the extent of their mechanization. According to the National Bureau of Statistics (1980), 21 percent of tilled areas in Beijing were tilled by machines in 1958, 17.4 percent in Heilongjiang, 15.4 percent in Xinjiang, 13.1 percent in Hebei, and 10.4 percent in Qinghai. In all other provinces in column (2), the percentages were lower than 4.2. Columns (3) and (4) divide the provinces according to the changes in the ratio of land sown with grain among all the sown land after collectivization. The changes are modest in all provinces, ranging from -0.04 to 0.01 (National Bureau of Statistics, 2010). The mean change is -0.01. The total number of observations in columns (3) and (4) is smaller than the total number of observations in columns (1) and (2), because data of crop mix are not available in Hainan province and Tianjin municipality. All regressions include year dummies, county dummies, and a constant.

Appendix Table A3 The Effects of Collectivization on Log (draft animals), in a Truncated Sample

	(1)	(2)
Collectivization	-0.051***	-0.037***
	(0.009)	(0.012)
Collectivization*ratio of middle peasant households†		-0.092*
		(0.051)
Collectivization*log(number of people in a co-op)†		-0.028***
		(0.010)
Collectivization*log(distance from the capital city)†		-0.008
		(0.006)
Collectivization*dummy for a revolutionary base		0.009
		(0.027)
Collectivization*ratio of ethnic minorities		0.024
		(0.022)
N	6,144	3,134
Standard errors are clustered at the county level		*$p<0.05$, ***$p<0.01$

These regressions estimate the immediate effect of collectivization. We drop the observations in 1956 and 1957 for counties that started collectivizing in 1955, and the observations in 1957 for counties that started in 1956. All regressions include log(rural population), log(arable land), flood, drought, year dummies, county dummies, county-specific trends, and a constant.

† The variables are the deviation from their mean. This transformation does not affect the coefficients of the interaction terms, and the coefficients of the collectivization indicator are the effect at the mean level of these variables.

Appendix Table A4 The Dynamic Effects of Collectivization on the Annual Growth Rate of Draft Animals: △log (draft animals)

	Sample years: 1952-57	Sample years: 1949-57
Four years prior to collectivization		-0.003
		(0.007)
Three years prior to collectivization		0.016
		(0.013)
Two years prior to collectivization		-0.003
		(0.013)
One year prior to collectivization	-0.005	-0.009
	(0.006)	(0.015)
The year that started collectivization	-0.074***	-0.077***
	(0.007)	(0.016)
The year after collectivization	-0.078***	-0.080***
	(0.009)	(0.016)
N	5,216	7,904

Standard errors are clustered at the county level ***$p<0.01$

This table shows how collectivization affects the growth rate of the animal inventory, year on year. We regress △log (draft animals) on a set of normalized year dummies. The reported coefficients reflect the changes in △log (draft animals) relative to the base year. In the first column, the base year is the second to last year prior to collectivization. In the second column, we use an unbalanced panel data set in which some counties have data extending back to 1949. The base year is the fifth to last year prior to collectivization. All regressions include ∆log(rural population), ∆log(arable land), flood, drought, calendar year dummies, and a constant.