



# Organizational Structure, Policy Learning, and Economic Performance: Evidence from the Chinese Commune

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## Abstract

Using original county-level panel data on Chinese communes over two decades, 1958 to 1979, this article builds upon existing theories about the influence of organizational size and structure on institutional performance. We found a consistent and robust interaction effect among the size of the commune (i.e., the coordination level) and its subunits, the brigade (i.e., the supervisory level) and production teams (i.e., the working level), on agricultural productivity. Future work on the relationship between organizational performance and size would likely benefit from including such interaction variables. We also provide evidence that to create a more productive institution, county-level officials learned from their most productive neighbors and adjusted the size of their communes accordingly. This work explains the role of organizational structure as a driver of economic performance and how policy diffusion occurred during China's Maoist era—a period generally treated as a monolith rather than a period of institutional change.

## Keywords

agriculture, productivity, organization, China, learning

## Introduction

China's People's Commune (from here on *the commune*) was the largest, long-lasting, high-modernist experiment in history. Just before China's post-Mao leadership began to dismantle the institution in 1979 it had more than 800 million members; in Henan alone communes were home to 63.7 million people—93.4 percent of the province's population. The commune was created in 1958, and after the devastating Great Leap Forward (GLF) famine (1959–1961) its organizational structure was substantially altered to increase its productivity. These reforms altered its size and introduced two levels of administrative subunits—the production brigade and the production team. In the decade after collectivization, the size of the commune and its subordinate units was continuously adjusted in accordance with the expressed policy of the central government. This article examines these structural changes and their effects on productivity.

We find that during the commune era (1958–1979) the size of the institution and its subunits was a strong and significant determinant of the temporal and geographic variations observed in agricultural output. Taken together, the relative size of the commune (i.e., the number of brigades per commune) and its subordinate production teams (i.e., the

number of households per team) were significant determinants of the institution's ability to grow crops. Although we do not find strong evidence that commune relative size per se had an effect on agricultural output, we did find a sizable and significant interaction effect between commune size and team size. Commune relative size exhibits a strong influence on the effect of team size, such that when average commune relative size is small, smaller teams have higher agricultural output; however, as the average commune size increases (to the medium level), the effect is mitigated and even reversed. The size of teams was set between 1961 and 1962 and thereafter grew apace with population growth. Given the difficulties in adjusting team size, which are explained below, from 1962 to 1966 county-level officials increased commune size

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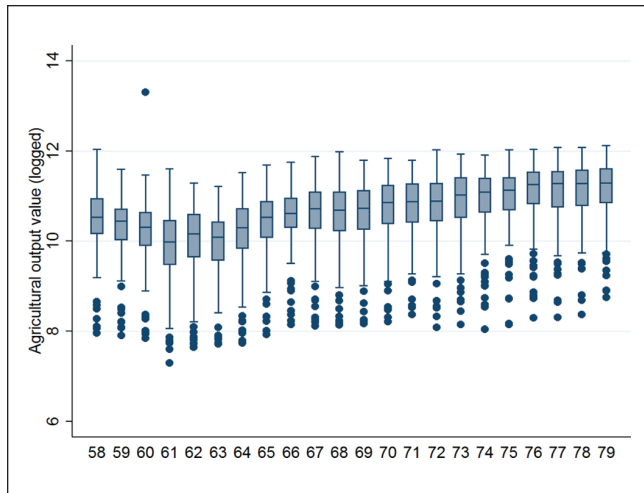
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**Figure 1.** Distribution of agricultural total output across Henan counties, 1958–1979.

to enhance productivity. The increased efficiency gains from economies of scale in larger communes mitigated the negative effect of lax supervision in larger teams.

We also identified a social learning mechanism, whereby county-level leaders adjusted the size of the communes under their jurisdiction to conform with those in more economically productive neighboring counties. Sociological studies suggest that people draw lessons from members of their networks (Axelrod 1997; Coleman et al. 1966; Marsden 1981; Rogers 1995). Our work demonstrates how credible evidence of a policy's (i.e., larger communes) efficacy increased the propensity of similarly motivated county officials under similar local conditions to adopt similar approaches (Dobbin, Simmons, and Garrett 2007:462).

Our conclusions are based on empirical models that use data from the commune and its subunits including all the counties of Henan province between 1958 and 1979. These models include various determinants that affect agricultural productivity, but unlike agricultural economists, our ultimate goal was not to quantify the contribution of agricultural inputs (e.g., land, fertilizers, and agricultural machines) on productivity levels. Instead, we sought to isolate the independent effects of structural variables in order to focus on an important question for policymakers: How did variations in the size of the organization and its subunits over time and space affect its economic performance?

Over the course of the commune era agricultural output exhibited considerable temporal and regional variations. The boxplots in Figure 1 plot the distribution of total agricultural output of counties against years. The median county-level output declined from 1958 to 1961 but increased thereafter. The whisker length of the boxplots, which indicates heterogeneity of agricultural output among Henan counties for each year, changed as well. From 1961 to 1965, the within-year variation is larger than from 1970 to 1979.

To interpret the magnitudes of the marginal effect of changes in team size (see Figure 4) imagine that there are two similar counties that differ only in the relative size of their communes: County A has a smaller average commune relative size, at the 5th percentile of the sample, while County B's commune relative size is at the 95th percentile of the sample. In County A, enlarging team size by 10.0 percent will decrease per capita crop production by 0.9 percent. In County B, by contrast, the marginal effect of team size is positive, 0.06, and not statistically significant. This implies that larger communes mitigate the negative effect of big teams.

By examining the interaction effects between communes and teams and their influence on agricultural productivity over the course of two decades, this article both applies and tests existing theories about the influence of organizational size and structure on institutional effectiveness. It also expands our knowledge of the relationship between changes in organizational structure and agricultural productivity during the commune era, a period researchers have generally treated as a monolith rather than a time of institutional change.

The structure of this article is as follows: First, we begin with a brief institutional history of the commune. Second, we lay out the theoretical arguments in the existing literature about how and why organizational size and the size of subunits influences economic performance. Third, we discuss how those arguments have been applied to the Chinese commune. Fourth, we generate hypotheses about how we suspect changes in the size of the commune and its subunits affected agricultural productivity. Fifth, we develop a model that uses our data to test these hypotheses. Sixth, we present our findings and conduct a series of robustness checks. Seventh, to help explain our findings, we provide evidence that county-level officials learned from their successful neighbors how to adjust commune and team size to enhance commune productivity.

## Institutional Overview: What Was the Chinese Commune?

In the early 1950s China began agricultural collectivization with the implementation of a nationwide land-to-the-tiller program. Next, Beijing encouraged Mutual Aid Teams (1953–1955) based on traditional kin-based labor-sharing schemes, then created Agricultural Producer Cooperatives (1956–1957), the countryside's first collective economic institution. In 1958, the cooperatives were merged to form large communes, and their mandate was expanded to include political and military aspects.<sup>1</sup> Over the course of the Mao

<sup>1</sup>See Bai and Kung (2014) for a review of Chinese agricultural collectivization.

era, collective agriculture evolved from simple, traditional, economic forms into a complex, multitiered institution with control over all local economic, political, and security affairs: the commune.

Throughout the first half of its more than two-decades-long institutional life the commune was continually reformed. Most important, beginning in 1961, in response to the GLF famine, the institution's size was reduced considerably.<sup>2</sup> Its single-level administration was expanded into a three-level organizational structure that included the commune, the production brigade, and the production team, with the latter as the "principle accounting unit" responsible for the vast majority of agricultural production and household remuneration.

Economically, the commune level coordinated agricultural production planning among its subunits and mobilized labor for the construction of large-scale capital and infrastructure projects. The brigade's primary responsibility was to oversee its subordinate teams in agricultural production. It also handled small-scale capital construction and farm machine ownership and repairs, elementary education, veterinary services, basic health care and population control, and so forth. The teams assigned jobs, monitored work performance, and compensated households based primarily on the number of members per household and their labor contribution. The efficient coordination of collective responsibilities among these three administrative levels was among the primary determinants of the institution's economic productivity. The relative size of each commune's subunits influenced its capacity for resource extraction, the scope of capital investment, and its capacity for worker supervision and remuneration.<sup>3</sup>

### Organization and Subunit Size and Economic Performance

Below we use heretofore unavailable data to test the assumption that the size of an organization and its subunits affects its economic performance. Several studies have found that an organization's size (measured in terms of the number of workers) is positively correlated with absolute levels of organizational performance, for example, total profits (Evers, Bohlan, and Warren 1976; Perényi and Yukhanaev 2016; Weiner and Mahoney 1981). Economists and organizational theorists have identified a positive relationship between organizational performance and economies of scale (Aldrich 1979; Mintzberg 1979; Sawyer 1981; Shepherd 1979). Because larger organizations are more likely than smaller ones to possess munificent discretionary resources

they have the wherewithal to make investments that improve productivity. Larger organizations' greater resources make it possible to acquire control over the "environmental entities that mediate critical resources," Gooding and Wagner (1985) explained. "Thus, larger organizations might be more able to produce a degree of resource certainty that insures continued productive viability" (Gooding and Wagner 1985:462–63).

Simply put, organizations with more discretionary resources can use them to make investments (e.g., irrigation networks) that can mitigate their environmental resource constraints (e.g., water scarcity) and thus increase productivity. Yet there appear to be limits on an organization's ability to increase its productivity through enlargement. Gooding and Wagner argue that "diseconomies of scale associated with increasing workforce size might consume other scale economies ... resulting in diminishing net returns on size-related economies of scale" (Gooding and Wagner 1985:477). They find, in sharp contrast to other economists' and organizational theorists' assumptions, that "any positive size-related economies of scale in organizational performance to be absorbed by counteracting diseconomies" (Gooding and Wagner 1985:478). This may explain why some studies have found a curvilinear relationship, such that medium-sized organizations outperformed both larger and smaller ones (Dalton et al. 1980; Indik 1963). Constraints on the positive relationship between organizational size and productivity may also help explain the failure of China's large GLF communes.

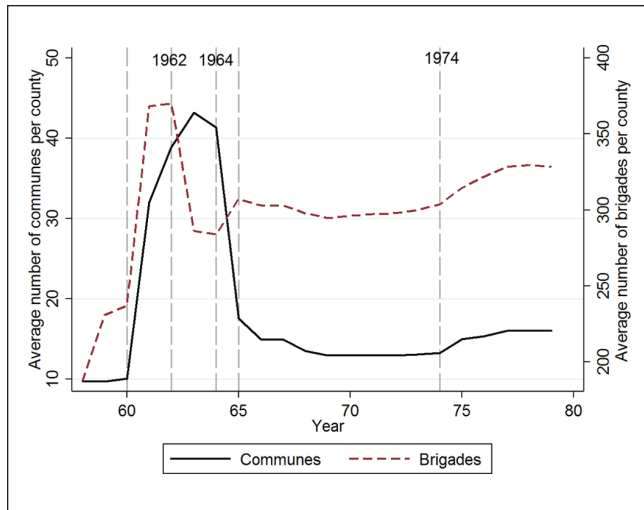
Social psychologists who have studied the relationship between group size and group performance have generally found an insignificant or negative relationship between larger subunit size and economic performance (Fleishman 1980; Katzell, Barrett, and Parker 1961; Marriott 1949; Steiner 1966). After analyzing a sample of 234 regional metropolitan branches of a large financial services organization in the United States, Carillo and Kopelman found that "by keeping units to a small size, productivity may be enhanced" (Carillo and Kopelman 1991:55). Specifically, they found that smaller subunits increased overall productivity by 17 percent, because workers in smaller subunits

- (a) are more accountable because they cannot hide or pass the buck; (b) are more resourceful, given lower organizational slack; (c) have greater psychological ownership and commitment; (d) are more creative, risk accepting, and decisive; (e) have greater information, because sharing information is easier; (f) have a feeling of control and empowerment; and (g) are more motivated and fast acting. (Carillo and Kopelman 1991:57)

Numerous theorists have attributed the loss of productivity associated with larger subunits to members' opportunistic behavior, that is, "free riding" or "loafing" (Gooding and Wagner 1985:475; also see Buchanan 1968; Jones 1984; Latane 1981; Olson 1971; Williamson 1975). Others have

<sup>2</sup>Dikötter (2010) and Lin (1990) examined the Great Leap Forward agricultural crisis.

<sup>3</sup>See Stavits (1974) for a summary of the roles of the commune and its subunits.



**Figure 2.** Average numbers of communes and brigades in Henan counties, 1958–1979.

identified a positive correlation between organization size and worker absenteeism (e.g., Bridges and Hallinan 1978; Revans 1958). Free riding is characterized as the single-minded pursuit of outcomes that are selectively allocated, that is, personally received and consumed. Simply put, free-riding opportunists slack off and avoid contributing to the acquisition of shared “public goods” (Albanese and Van Fleet 1985; Olson 1982:18).

In larger subunits, the greater number of workers serves as a “behavioral mask” by making undesirable behavior harder to detect and punish (Fleishman 1980). Moreover, the problem is likely to grow worse as fellow workers observe the subunit leaders’ inability to sanction slackers (Olson 1971). As an increasing number of workers become free riders, the subunit’s total productivity is further reduced (Kerr and Bruun 1983). A lack of oversight in larger subunit size thus increases the likelihood that workers will free ride and, in turn, lowers collective productivity.

Researchers have tended to discount the possibility that some members might value the well-being of their group and thus might “irrationally” work hard even under conditions of larger group size (Buchanan 1968; Olson 1971). Yet Gooding and Wagner observed that “‘irrational’ contributions to the acquisition of public goods can occur to a modest extent in large groups” (Gooding and Wagner 1985:476). This finding is substantiated by anecdotal evidence that pervasive collectivist ideologies (e.g., Maoism) induce workers to work hard despite a lack of material compensation.

In sum, the existing literature suggests that through economies of scale larger organizations are able to improve overall economic performance. Yet at the subunit level, there is evidence of an inverse relationship between size and performance because smaller work groups help mitigate free rider problems (Dalton et al. 1980:53).

To understand the full implications of size on organizational performance, Kimberly (1976) recognized it as a multidimensional construct dependent on the “operationalization of size.” Dalton et al. (1980) also called for researchers to identify the “level of analysis” when conducting assessments of the productivity of organizations and their subunits. As Gooding and Wagner (1985:484) explain: “Defining size as the number of employees or the log of the number of employees might reflect the degree to which the availability of human resources facilitates or constrains performance.”<sup>4</sup>

### Hypotheses about the Relationship between the Size of Commune Subunits and Agricultural Productivity

The GLF’s failure taught Chinese policymakers a bitter lesson about the close relationship between commune size and agricultural productivity. In response to the famine, they moved quickly to drastically shrink the communes’ size and introduce subunits.<sup>5</sup> First promulgated in April 1961, *Working Regulations of Rural People’s Communes* (*Nongchun renmin gongshe gongzuo tiaoli*), also known as *The Sixty Articles in Agriculture* (*Nongye liushi tiao*), was adopted in September 1962 by the China’s People’s Commune Central Committee and remained the commune’s legal working guidelines until decollectivization. Article 5 mandated that the size of the commune and its subunits be decided primarily to increase productivity:

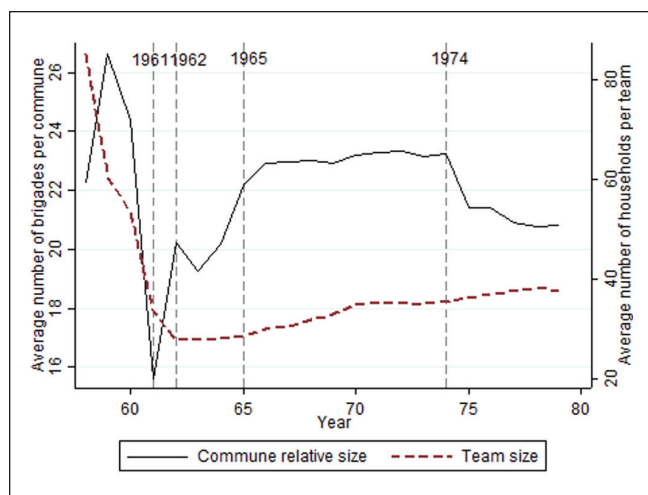
The size of the various levels of a people’s commune should be decided ... to benefit the various levels of a people’s commune in production, management, and unity. In deciding the size of a production team, it is necessary to consider the area of its land, the distance between plots, the density or scattering of residential quarters, its labor force, the balance between its draft animals and farm implements, conditions for developing diversified undertakings and so on. (Liu 1979:94)

In keeping with these instructions, cadres in Henan adjusted their communes’ size extensively throughout the early to mid 1960s. Figure 2 shows that after the failure of the excessively large GLF communes in 1958–1959, between 1960 and 1963 the average number of communes per county in Henan rose dramatically—from 10 in 1960, to 32 in 1961, to 39 in

<sup>4</sup>Studies that use the number of employees include Marriott (1949) and Glisson and Martin (1980). Evers, Bohlen, and Warren (1976) use the log number of employees.

<sup>5</sup>The assumption that commune cadres adjusted subunit size in response to economic stimuli is not universally accepted. Kate Xiao Zhou argues that “cadres organized farming on a commune, brigade, or team basis, regardless of the implications for productivity” (Zhou 1996:3).





**Figure 3.** Average commune relative size and average team size in Henan counties, 1958–1979.

Note: Commune relative size is measured by the number of brigades per commune; team size is measured by the number of households per production term.

1962—and peaked at 43 in 1963. This change, which was accompanied by a drastic reduction in average commune relative size from 24 brigades per commune in 1960 to 19 in 1963, appears to have been an overcorrection that was redressed by a sharp increase between 1964 and 1965 followed by a gradual increase until commune size plateaued at around 23 brigades per commune from 1966–1974 (see Figure 3). Team size, by contrast, was stabilized after 1962, and thereafter the gradual increase in the number of households per team reflects population growth.

But do these changes in the size of the commune and its subunits actually help explain the temporal and regional variations in agricultural productivity observed in Figure 1? *The Sixty Articles* and the theoretical literature about the relationship between organization and subunit size and economic performance both suggest they do, as did Dali Yang (1998:80). Yet due to a paucity of systematic data it has not been possible to test whether variations in organizational size (either independently or in concert) actually affect agricultural productivity. To answer this question, we developed four hypotheses, which we expressed—in accordance with Dalton et al.’s (1980) suggestion—in terms of the organization’s three relevant “levels of analysis”: the commune, brigade, and team.

### Commune Size

**Hypothesis 1:** *As commune size increases, capital investment increases, causing agricultural production to rise.* The commune system used coercive household income extraction to fund investments in agricultural, physical, and human capital—a system known as the Dazhai development model (Baum 1975). The commune level coordinated the construction of

infrastructure projects that were beyond the capacity and geographic jurisdiction of a single brigade. Larger communes had a greater capacity than small ones to invest in what Lippit called “self-reliant industrialization projects,” allowing them to better mitigate environmental and resource constraints (Lippit 1977:248). Water-management systems and hydropower generation, for instance, reduced the stochastic influence of weather patterns on agriculture, thus improving yields (Bai and Kung 2014; Kerkvliet and Selden 1998; Lippit 1977; O’Leary and Watson 1982). A larger commune could also take advantage of economies of scale in the purchase and maintenance of agricultural equipment or fertilizer production via its numerous subinstitutions and enterprises. According to Lynn T. White III, agricultural modernization (e.g., advances in farm mechanization, seeds, fertilizer) freed up large quantities of surplus rural labor to work in rural industry and increased factor mobility (White 1998:85–93; also see Bramall 2007:145; Naughton 2007:253). Bramall (2004) argues that the positive effect of Chinese decollectivization reform in the early 1980s has been overstated compared to investments made under the commune. Rural China’s widespread undercapitalization and overpopulation meant that extensive local investment could produce an extended period without decreasing returns to capital (Lewis 1954).

The commune’s capacity to harness workers to construct productivity-enhancing infrastructure was determined by the size of the labor force under its jurisdiction. Like large firms, larger communes could deploy both skilled and unskilled labor across a larger geographic area and spread staffing costs across more subunits, thus increasing the scope of benefits while reducing the burden on each subunit. Increased agricultural production, expanded basic education, and improved health care services under the commune had dramatic results: In 1964 average life expectancy in China was 49, but by 1978 it was older than 65—compared with 51 in India, 52 in Indonesia, 49 in Pakistan, and 47 in Bangladesh (Putterman 1993:15).

### Brigade Size

**Hypothesis 2:** *As brigade size falls, supervision of teams improves, causing agricultural production to rise.* The brigade was responsible for monitoring its teams’ policy implementation and reporting economic performance—related data up to the commune. Brigade leaders were at the crossroads of a complex web of interdependent and competing team-level problems, objectives, and interests (Butler 1978:33–34). Every project or policy—whether initiated in Beijing or at the commune—required brigade supervision; hence we predict that the more teams a brigade had the harder it was to supervise them. A larger brigade was also more likely to have higher levels of inequality among its production teams, which, according to *The Sixty Articles*, disincentivized the most productive teams.

We hypothesize that the more teams a brigade had, the harder it was to supervise and incentivize them, and thus, all else being equal, smaller brigades had better oversight and less inequality and were more productive. To improve oversight and ensure teams were meeting their production targets the commune could increase the number of brigades, thus reducing the number of teams under each one's jurisdiction. Figure 2 shows that in Henan between 1960 and 1962 there was a sharp increase of the average number of brigades per county from 237 to 370, respectively. After a decline in 1963, the average number of brigades per county rose again from 284 in 1964 to 307 in 1965. One former team leader explained how subdividing brigades—and thus reducing their size—helped improve their supervisory capacity:

There were definite advantages in splitting up the previously large brigade. It was easier to inspect production. Previously it took four or five days to make an inspection, but after splitting the brigade it could be done in one day. It prevented the team from covering up the situation and strengthened the control over the team leadership. Splitting the brigade also had an effect on profiteering: the brigade controlled the team head. Previously even the team head could engage in profiteering. Before splitting the brigade, field management was not controlled as strictly. (Butler 1978:18)

### Team Size

**Hypothesis 3:** *As team size falls, supervision of workers improves, causing agricultural production to rise.* After 1961, the production team was the principal accounting unit of the commune system responsible for nearly all day-to-day field management, worker supervision, evaluation, and income distribution (Lippitt 1977).<sup>6</sup> The team administered the workpoint remuneration system, which required a recording of each worker's contribution to the collective. After the harvest, the team accountant would tally each household's workpoints and exchange them for a portion of the collective agricultural output that remained after all production, management, investment, and welfare costs were deducted.

Some researchers argue that under the commune collective agriculture undermined worker supervision and a lack of incentives prompted workers to engage in excessive free riding, which resulted in low labor productivity and falling agricultural output (Lin 1988; Nolan 1983, 1988). Between 1979 and 1983, the commune was replaced by the Household Responsibility System, which returned rural China to private, household farming.<sup>7</sup> Numerous studies make cross-institution comparisons between collective agriculture under the commune and the Household Responsibility System

(e.g., Fei 1989:232–33; He 2015; Lin 1992; McMillan, Whalley, and Zhu 1989; Riskin, 1987:288; Saich 2001:61; Zhang 1982:128; Zhou 1996).<sup>8</sup> Most attribute improved agricultural productivity after decollectivization to economic “rational choice” theories that prioritize conceptions of the self-interested peasant. This view, which is supported by official data that show agricultural output grew rapidly after decollectivization, was succinctly summarized by James Kai-sing Kung:

*Collective agriculture was seen as suffering from problems of labor supervision within the institutional context of a team, which prevented the adoption of payment systems that would sufficiently differentiate and reward farmers' actual contributions to total output, such as the use of piece rates. In the Chinese case, the difficulties of monitoring led to the adoption of a time-based payment system, with a very narrow spread of earnings. While that system was simple to administer, it provided only a tenuous link between effort and reward. This weakness of incentives led to extensive free riding behavior, which was cured only by the eventual replacement of the collectives by family farms.* (Kung 1993:486, emphasis added)

Others argue that informal institutions, such as peer pressure and group sanctioning, successfully mitigated individual shirking (Barnett and Carroll 1995; Freeman and Hannan 1975; Hannan and Freeman 1984). Based on both the general literature on organization size and existing studies on China, we hypothesize that opportunistic free riding was a greater problem among larger teams than smaller ones, and hence smaller team size is correlated with better productivity.

**Hypothesis 4:** *There is an interaction effect among the organizational structure variables (i.e., commune size and brigade size) and team size such that when combined with large communes and/or smaller brigades, large teams are less detrimental to agricultural production.* Hypotheses 1 through 3 hypothesize the independent effects of size for each of the institution's three tiers: team, brigade, and commune. But if, as Kimberly (1976), Dalton et al. (1980), and Gooding and Wagner (1985) seem to suggest, there is an interaction effect among the different-sized organizational subunits, then how does it influence the institution's overall productivity? Changes in the size of the three components may enhance, mitigate, or have no effect each other. Specifically, based on the theoretical literature, we are interested to know whether large commune size and small brigade size will mitigate the negative effect of large teams on productivity. We presume that when commune size is too small to mobilize enough resources to take advantage of the efficiencies generated by economies of

<sup>6</sup>The income and accounting tasks were shifted from communes to brigades in 1959 and to teams in 1961.

<sup>7</sup>By 1984, 99 percent of teams had adopted the Household Responsibility System (Lin 1992:38).

<sup>8</sup>McMillan, Whalley, and Zhu (1989), for instance, attributed about 78 percent of productivity gains between 1978 and 1984 to economic reforms associated with decollectivization.

scale, the disadvantage of large teams is more evident. However, as commune size increases enough to benefit from economies of scale, the favorable macro-level production environment produced by capital investments improves aggregate economic performance, thus reducing the need for intensive worker supervision at the team level. As worker supervision becomes a less powerful determinant of economic performance, there is, in turn, less pressure to maintain a small team; thus, as commune size grows we predict the productivity gap will shrink between big teams and small teams. In sum, we hypothesize that larger communes increase productivity because they mitigate the negative effect of large teams.

We apply the same logic to brigade size. When brigade size is too large to effectively supervise and/or incentivize teams, we hypothesize that large team size had a stronger negative effect on production. Smaller brigades, by contrast, provide increased supervision and better incentives and thus reduce the negative effect of large teams on productivity.

Hypothesis 3 predicts that smaller team size helps improve agricultural productivity. This may help explain the decline of team size in Henan between 1961 and 1962 (see Figure 3). After 1962, however, the size of production teams remained stable in Henan, though across counties there remained wide-ranging variation.<sup>9</sup> In counties where teams were larger than economically ideal the interaction effects imply that commune size could be enlarged and/or brigade size could be reduced to mitigate the negative effect of large teams.

Despite the economic benefits of small team size, there were good reasons that team sizes' generally remained fixed after 1962. More than any other subunit, team size was exogenously determined. Teams were usually based on natural villages, so members' households were often neighbors for generations. Subdivision would have disturbed local social networks and the rhythms of daily life (Zhang 1998). Team subdivision also meant the partition of land and labor, changes that would have abruptly altered workpoint values and thus each household's income. Politically, the collectivist ethos of Maoism favored large work units as more "socialist," thus making subdivision politically incorrect (Zhang 1998). Huaiyin Li (2016) found that increases in team size weakened the shared sense of identity among workers.

In sum, when and where commune size is small—which hinders capital investment (hypothesis 1)—or brigade is large—which hinders team supervision (hypothesis 2)—the relatively poor production environment highlights smaller teams' ability to better supervise workers. Conversely, when

and where commune size is large enough and/or brigade size is small enough, we predict the negative effects of large team size were mitigated. Such interaction effects, which we demonstrate below, also informed their search for a more productive commune structure.

## Empirical Strategy

Below we test our four hypotheses and examine how differences in the average size of communes and their subunits among Henan counties affected their agricultural productivity. To do this we present heretofore-unavailable data on the often-overlooked county level, that is, the level just above the commune. Using *Henan Agricultural Statistics, 1949–1979* (*Jianguo sanshinian Henan sheng nongye tongji ziliao*) we constructed a balanced county-level panel data set (with missing observations) including county-level data on agricultural input and output for all 117 counties in the province's 10 prefectures covering the years 1958 to 1979.<sup>10</sup>

We chose Henan, first, because it is an agricultural province located in the center of China with a large and dense rural population of 66 million people in 1980. These attributes allowed us to minimize variations in climate, soil type, topography, and population density and focus on the product that the commune specialized in: grain.

Second, in Henan we observed considerable variation on both our dependent and independent variables. During the 1959–1961 GLF famine, several Henan counties experienced a drastic decline in agricultural output. Yang (1998) argues that in areas where the famine was particularly severe in the early 1960s local officials adopted measures—including adjusting the size of communes and their subunits—to revive productivity. Between 1960 and 1979, amid rapid population growth, total agricultural output in Henan increased by 155 percent, and per capita agricultural output increased by 67 percent. Moreover, as noted above, Henan counties also exhibited large variation in the size of communes and their subunits over both time and geographic space. These variations made it easier to observe whether changes in organizational size can explain such rapid productivity growth.

We conducted a county-level analysis for three reasons. First, we wanted to quantify how changes in the average size of communes and their subunits affected agricultural output across Henan. County-level (as opposed to prefectural-, provincial-, or national-level) data provide the granularity necessary to reveal the regional and temporal variations required to explain how these changes affected economic performance.

<sup>9</sup>The number of teams in Henan remained relatively stable from 364,628 in 1962 to 333,657 in 1978. Between 1963 and 1979, the within-year standard deviation of the average number of households per team across counties ranged from 5.1 to 11.5. This observation was made anecdotally by Lippit (1977:232). Also see Zhang (1998:260).

<sup>10</sup>The 10 prefectures are Anyang, Xinxiang, Shangqiu, Kaifeng, Luoyang, Xuchang, Zhoukou, Zhu Madian, Nanyang, and Xinyang.



Second, according to official regulations the size of communes was determined at the county level.<sup>11</sup> County leaders could increase the size of a commune by adding or subdividing brigades, or it could shrink the commune by combining brigades or removing them and adding them to an adjacent commune.

Third, examining the agricultural sector from the middle of the Mao era governance structure—rather than from a top-down or bottom-up perspective—has distinct advantages. Communes in some counties performed much better than others. Given the consistency of national policy under *The Sixty Articles* until 1979, if we hold economic inputs—land, labor, and capital—constant, we should be able to observe how variations in the size of communes and their subunits helped account for changes in economic performance across counties and over time.

## Variables

**Dependent variable.** Throughout this article, unless otherwise stated, the dependent variable is the natural logarithm of the value of each county's per capita annual crop production, expressed in thousands of renminbi and in 1970 prices. To check the robustness of our operationalization, we also tested the model using the total value of agricultural production (rural per capita), including crop, livestock, forestry, fishery, and sideline production, as an alternative dependent variable. The alternative measure yielded similar results (see Appendix Table B).

**Independent variables.** We measured the effect of commune, brigade, and team size and their interaction on agricultural production. The average size of commune variable combines commune and brigade size into a single measure. It is calculated by dividing the number of brigades for each county in each year by the number of communes in that county, which is equal to a ratio of average commune size over average brigade size in a county (shown in equation 1). We then take a natural log to reduce the skewness. The average team size variable is measured with logged average number of households per team for each county in each year.

$$\frac{\#brigades}{\#communes} = \frac{\frac{\#teams}{\#communes}}{\frac{\#teams}{\#brigades}} = \frac{\text{average commune size}}{\text{average brigade size}} \quad (1)$$

<sup>11</sup>See, for instance, article 2 of *CPC Central Committee's Resolution on the Establishment of People's Communes in Rural Area* (Zhonggong zhongyang guan yu zai nongcun jianli renmin gongshe wenti de jueyi), August 29, 1958. Available at <http://cpc.people.com.cn/GB/64184/64186/66665/4493238.html> (accessed July 15, 2016).

We used the relative size of communes rather than the absolute size of communes and brigades because there is a strong correlation among the absolute variables.<sup>12</sup> Our relative size of communes variable both mitigates this multicollinearity problem and allows us to study the interaction effects among the commune's three levels. After the transformation, the correlation between commune relative size and team size decreases to  $-.03$  ( $p$  value = .19; see Appendix Figure A for the scatterplot).

The commune relative size measure took a large value if there are many brigades per commune in a given county for a given year. Because large communes benefit from economies of scale, we anticipated a positive effect of commune size on production. When the interaction between commune relative size and team size is included in the regression, we expect the interaction coefficient will be positive because large communes combined with small brigades mitigate the disadvantage of big production teams (hypothesis 4).

Finally, we were concerned that our findings might result from our specific measure of commune relative size or by overfitting of the data. To address these concerns, we conducted additional robustness checks that separately measured commune size and brigade size and used a machine learning method to penalize overfitting of the data. These tests all yield similar findings.

## Econometric Method

We used a two-way fixed-effect model, which includes both county fixed effects and year fixed effects. This model can rule out the influence of time-invariant county-specific factors, such as culture and natural endowment, and year-specific factors, such as national or provincial policies, which affected all counties.

$$\begin{aligned} \text{output}_{i,t} = & a_i + c_1 MCcommune_{i,t} + c_2 MCteam_{i,t} \\ & + c_3 MCcommune_{i,t} \times MCteam_{i,t} \\ & + X'_{i,t-1} b + d_t + e_{i,t}. \end{aligned} \quad (2)$$

In this model,  $i$  denotes counties while  $t$  denotes years. The dependent variable *output* is the natural logarithm of the value of crop production in each county for each year.

To examine the coefficient of team size when commune relative size is fixed at its average level, and commune relative size when team size is fixed at its average level, we

<sup>12</sup>If the absolute size number of teams per commune and teams per brigade are added into the regression, neither the variables per se nor their interactions with team size are statistically significant. The correlation between commune and brigade absolute size is .43 ( $p$  value = .000), the correlation between commune absolute size and team size is  $-.29$  ( $p$  value = .000), and the correlation between brigade absolute size and team size is  $-.36$  ( $p$  value = .000).



**Table 1.** Commune Dynamics and Agricultural Output (Baseline Results).

Variable	Value of Crops		Value of Crops per Capita	
	(1)	(2)	(3)	(4)
<b>Institutional structure</b>				
MC commune relative size	−0.035 (0.024)	−0.036 (0.025)	−0.046* (0.027)	−0.047* (0.027)
MC team size	−0.037 (0.045)	−0.012 (0.047)	−0.033 (0.042)	−0.006 (0.048)
MC Commune Relative Size × MC Team Size		0.100** (0.039)		0.108** (0.043)
<b>Conventional input</b>				
Land	0.251** (0.123)	0.247** (0.121)	0.271** (0.123)	0.267** (0.121)
Machine power	0.035* (0.020)	0.035* (0.020)	0.038* (0.020)	0.038* (0.020)
Labor	0.185 (0.138)	0.179 (0.137)	0.166 (0.137)	0.160 (0.136)
Fertilizer	0.020* (0.011)	0.021* (0.011)	0.022* (0.011)	0.022* (0.011)
Rural population	0.072 (0.266)	0.090 (0.270)	−0.687*** (0.229)	−0.668*** (0.232)
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	2,030	2,030	2,030	2,030
R <sup>2</sup> (within)	.653	.654	.429	.432
Number of counties	117	117	117	117

Note: MC = mean-centered. Dependent and all independent variables are logged; the constant is included in the model but not reported here; robust standard errors, in parentheses, are clustered at the county level. \* $p < .10$ . \*\* $p < .05$ . \*\*\* $p < .01$ .

rescaled both variables by subtracting their sample means.<sup>13</sup> Thus, the mean-centered commune relative size variable (*MCcommune*) measures the deviation from mean logged average relative size of communes of the sample, and mean-centered team size (*MCteam*) is the deviation from mean logged average size of teams in the sample; both are measured in each county for each year. To test the interaction effect, we also included an interaction term between these two variables.

The control variables (*X*) include conventional inputs, for example, area of planted land (logged), total agricultural machine horsepower (logged), commune labor (logged), and metric tons of fertilizer per hectare of planted land (logged). For a more precise definition of these variables see Appendix Table A. We also controlled for the size of rural population (logged). To mitigate the problem of reverse causality, the conventional inputs and the rural population are lagged to the

previous year (though regressions without lags generated almost the same results). We did not lag the commune relative size variable and team size variable because in the early 1960s they exhibited drastic changes from year to year, and a lag cannot capture such an immediate effect. Although this approach may enhance endogeneity, we conducted additional robustness checks below.

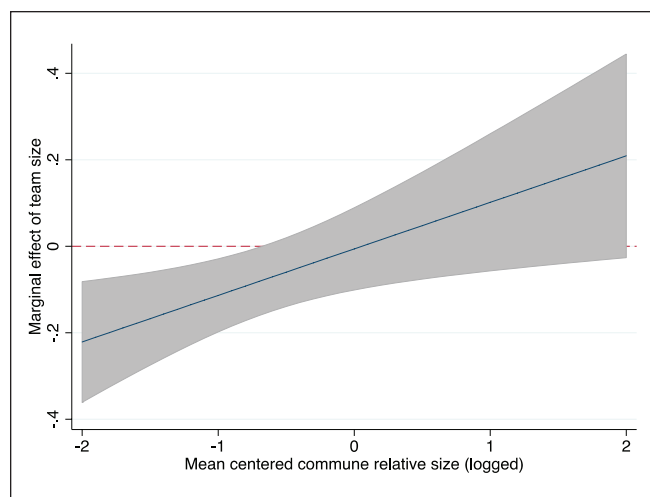
We included county fixed effects ( $a_i$ ) in the specification to capture time-invariant county characteristics that may be related to both changes of size of commune and subordinate units and agricultural output; we also include year fixed effect ( $d_t$ ) to capture provincial or nationwide policy changes, which may simultaneously affect commune sizes and agricultural output.  $e_{it}$  is the disturbance term, and the disturbances are allowed to be correlated across years for the same county.

## Empirical Findings

Table 1 summarizes our findings. First, in the absence of the interaction variable, we did not find strong evidence supporting hypothesis 1, hypothesis 2, or hypothesis 3. In columns 1 and 3, coefficients of both commune relative size and team size are negative, and the estimates are not statistically significant at the conventional confidence level. More than 16 of the 20 year dummies are statistically significant individually, and a joint F test for their significance resoundingly rejects the hypothesis that they are zero. The statistical significance of the year dummies implies that national or provincial policies that vary over time but affect all counties have a significant effect on agricultural production outcomes. These results corroborate notions in the aforementioned literature that interactions among organizational subunits should be considered in evaluating the impact of commune size on agricultural production.

Second, we found strong evidence to support the interaction effect postulated in hypothesis 4. In columns 2 and 4, when the interaction between commune relative size and team size is introduced, the marginal effect of team size diverges conditional on differences in commune relative size. Because both commune relative size and team size are mean centered, the coefficients of commune relative size suggest that when team size is fixed at the average level, commune relative size does not strongly affect agricultural production. Similarly, the coefficients of team size indicate that when commune relative size is fixed at the sample average, team size does not have a statistically significant effect on agricultural production. The interaction variable's positive and statistically significant coefficients, however, reveal that if two identical counties both exhibit small average commune relative size, the one with smaller average teams will outperform the one with larger average teams. But if both counties' communes are relatively large, the negative association between team size and agricultural production will be weaker, and if they are very large, there is a weak positive association between team size and agricultural production.

<sup>13</sup>Mean centering does not change the coefficient of the interaction term between commune relative size and team size.



**Figure 4.** Marginal effect of team size conditional on mean-centered commune relative size.

Note: Estimated based on column 4 of Table 1. The gray area indicates the 95 percent confidence interval of estimated marginal effect of team size.

Figure 4 plots the marginal effects of team size against commune's relative size based on Table 1, column 4, with the x-axis ranging from the minimum to the maximum values of the commune's mean-centered relative size in the sample. When commune relative size takes the value of  $-0.78$ , fifth percentile of the sample, team size's marginal effect on agricultural output is  $-0.09$  ( $-0.006 + [-0.78] \times 0.108 = -0.09$ ;  $p$  value = .029): Increasing average team size by 10.0 percent decreases crop production per capita by 0.9 percent. Thus, when the interaction term is included, hypothesis 3 is partially supported because when commune relative size is small, team size is negatively correlated with agricultural production (see Figure 4). As the relative commune size increases, however, the detrimental effects of large teams on production are mitigated. When commune relative size is in the 95th percentile (0.61), the effect of team size is 0.06 ( $-0.006 + 0.61 \times 0.108 = 0.06$ ;  $p$  value = .37), and the estimate is not statistically significant.

In sum, our empirical evidence does not support hypothesis 1 or hypothesis 2. When the interaction term is included the negative correlation between team size and agricultural production conditional on small commune relative size (see Figure 4) means that there is partial support for hypothesis 3. Most importantly, there is strong and robust evidence for the existence of the interaction effect postulated in hypothesis 4. Next, we present some robustness checks that further substantiate this finding.

## Robustness and Falsification Analysis

### Control for Higher-level Policy Changes

Among the potential confounding factors in our analysis, we are particularly concerned with "policy winds" and policy adjustments at the higher administration levels (i.e., national,

provincial, and prefecture) that could influence both the size variables and agricultural production (Zweig 1989). As noted, to mitigate the endogeneity problem we used a two-way fixed-effects model to rule out the influence of county-specific time-invariant factors and year-specific county-invariant factors. Thus, county-specific factors such as culture and natural endowment are less likely to bias the estimation. Moreover, since Henan is the only province in the sample, the provincial or national policies' effect will be absorbed by year fixed effects and will not bias the estimation.

There is a possibility, however, that the prefectural government may have instructed counties under its jurisdiction to implement agricultural policies that could influence the size of communes and their subunits and/or agricultural output and that such policies could vary across prefectures and years. Since systematic prefectural-level data on policy changes are unavailable, we controlled for the annual mean per capita crop production for neighboring counties in the same prefecture, which served as a proxy for time-varying prefecture-wide policies. As shown in column 1 of Table 2, including this additional control variable does not change the results.<sup>14</sup>

### Lagged Effect of Size Variables

In the main analysis reported in Table 1 we did not use lagged measures to capture the contemporaneous effect of the size variables. But do changes in commune relative size and team size have an immediate effect on crop production, or is there a lagged response? To address this question, Table 2, column 2, includes the mean-centered size variables with one-year lags as additional control variables. The results lend more credence to our previous estimation: The lagged size variables are not statistically significant while the main results remain unchanged. Moreover, in a test not shown here, when including only lagged size variables, neither the two size variables per se or their interaction term were statistically significant. In sum, changes in commune relative size and team size are more likely to cause immediate changes in crop production, and the contemporaneous size measures are more likely than the lagged ones to capture these effects.

### Excluding GLF and Famine

Another concern is whether our empirical findings across the whole commune period might be driven largely by the drastic fall in productivity associated with GLF and famine years. To check whether this occurred, we drop the years before 1962 in column 3 of Table 2. The salient results remain unchanged, and the magnitude of the interaction coefficient gets even larger, suggesting that our conclusions are not biased by the first "catastrophic" years (1958–1961) of the commune era.

<sup>14</sup>Including the annual change of the mean per capita crop production in neighboring counties as an additional control variable yielded similar results.

**Table 2.** Robustness and Falsification Analysis.

Variable	DV: Crop per Capita			DV: Crop per Capita in Previous Year
	Additional Control Variable		Excluding Great Leap Forward and Famine	Falsification Test
	(1)	(2)	(3)	(4)
Mean per capita crop production in neighboring counties	0.276* (0.159)			
Institutional structure				
MC commune relative size	-0.050* (0.026)	-0.042* (0.025)	0.001 (0.034)	-0.043* (0.026)
MC team size	0.020 (0.055)	0.011 (0.050)	0.124 (0.109)	0.023 (0.073)
MC Commune Relative Size × MC Team Size	0.094** (0.045)	0.104** (0.040)	0.319** (0.153)	0.073 (0.055)
MC commune relative size (lag = 1)		-0.010 (0.022)		
MC team size (lag = 1)		-0.020 (0.035)		
MC Commune Relative Size (lag = 1) × MC Team Size (lag = 1)		0.002 (0.033)		
Conventional input				
Land	0.220** (0.100)	0.273** (0.122)	0.288* (0.167)	0.163 (0.104)
Machine power	0.041* (0.021)	0.039* (0.021)	0.045 (0.027)	0.038* (0.020)
Labor	0.116 (0.136)	0.162 (0.137)	0.194 (0.153)	0.219* (0.128)
Fertilizer	0.012 (0.008)	0.023** (0.011)	0.018 (0.012)	0.022** (0.011)
Rural population	-0.600*** (0.208)	-0.678*** (0.238)	-0.603** (0.268)	-0.550*** (0.207)
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	2,030	2,004	1,731	2,006
R <sup>2</sup> (within)	.451	.432	.360	.423
Number of counties	117	117	117	117

Note: DV = dependent variable; MC = mean-centered. Neighboring counties are defined as other counties under the jurisdiction of the same prefecture; dependent and independent variables are logged; the constant is included in the model but not reported; robust standard errors, in parentheses, are clustered at the county level.

\* $p < .10$ . \*\* $p < .05$ . \*\*\* $p < .01$ .

### Falsification Test

To evaluate the validity of our results we employed a falsification test using the previous year's crop production as the dependent variable. Because commune relative size, team size, and their interaction should not affect crop production in the previous year, we expect a null effect of the three variables on previous crop production. If any statistical association is found between them it suggests an opposite causal direction, that is, agricultural performance affects commune relative size and team size, rather than vice versa.

In column 4, we conducted this falsification test using the size variables and the interaction term of one year and the

previous year's crop production value as the dependent variable. As expected, none of the three coefficients are statistically significant at the 95 percent confidence level. Although the falsification test per se is not evidence for causation, its results are consistent with our findings.

### Alternative Measures and Estimation Strategy

Using linear regression models, we have identified a consistent pattern that larger commune relative size mitigates the negative effect of big production teams. But there is a possibility that our results were driven by overfitting the data by adding interaction terms, or by the particular measure of

**Table 3.** Pointwise Marginal Effects Estimated with Kernel-based Regularized Least Squares.

Variable	Average (1)	SE (2)	t (3)	P > t (4)	P <sub>25</sub> (5)	P <sub>50</sub> (6)	P <sub>75</sub> (7)
Commune size (mean centered)	-0.016	0.036	-0.452	0.651	-0.218	-0.035	0.147
Brigade size (mean centered)	0.028	0.036	0.770	0.442	-0.201	0.018	0.282
Team size (mean centered)	-0.327 <sup>†</sup>	0.068	-4.823	0.000	-0.809	-0.260	0.195
Land	0.038	0.030	1.292	0.197	-0.073	0.044	0.166
Machine power	0.201 <sup>†</sup>	0.020	10.266	0.000	0.037	0.182	0.367
Labor	0.388 <sup>†</sup>	0.100	3.899	0.000	-0.310	0.357	1.004
Fertilizer	0.030 <sup>†</sup>	0.007	4.241	0.000	-0.043	0.015	0.088
Rural population	-0.065	0.040	-1.621	0.105	-0.313	-0.081	0.120

N = 2,010;  $\lambda = 1.078$ ;  $\sigma = 8$ ;  $R^2 = .452$ .

Note: Commune size and brigade size are measured with the average logged number of production teams per commune and per brigade, respectively, in each county for each year; similarly, team size is measured with the average logged number of households per team in each county for each year. We conducted the kernel-based regularized least squares estimation after parceling out the year and county fixed effects. Column 1 reports the average pointwise marginal effect of each variable; columns 2 through 4 report the standard error, *t* statistic and *p* value for each estimate, respectively; and columns 5 through 7 report the first quartile, median, and the third quartile of the pointwise marginal effect of each variable.

<sup>†</sup>*p* < .001.

commune relative size that we designed to capture the joint effect of commune and brigade, while alleviating multicollinearity problems. To check, we measure commune and brigade size separately, that is, without combining them into the single measure of commune relative size, and replicate our results using the kernel-based regularized least squares (KRLS). KRLS is a machine-learning method designed to tackle regression problems without parametric assumptions while simultaneously preventing overfitting the data by explicitly penalizing complex functions (Ferwerda, Hainmueller, and Hazlett 2017; Hainmueller and Hazlett 2014). Thus, rather than including the interaction term in the regression model, KRLS allows the data to decide whether the interaction exists.

KRLS's strength is that—unlike many other machine learning methods that provide less interpretable results—it provides close-form solutions for many quantities of interest by generating a pointwise estimate of marginal effect of each variable for each observation. To test hypothesis 1, 2, and 3, we use KRLS to estimate the average effect of each of the three size variables. Next, we estimate the derived pointwise marginal effect of team size as the dependent variable to examine whether, as predicted by hypothesis 4, it remains positively associated with commune size and negatively associated with brigade size.

Table 3 summarizes the average effect of all variables. As before, we do not find significant effects of commune and brigade size per se. Interestingly, however, team size is negatively associated with agricultural productivity, and the average marginal effect of team size is statistically significant at  $-.33$ . This negative average effect provides even *stronger* support for hypothesis 3 than our initial linear regression analysis.

Moreover, while on average team size's effect is negative, a closer look reveals considerable variation in different counties and across years (see Appendix Figure B). The KRLS

estimation regression 1 and Appendix Figure C provide strong support for hypothesis 4, that is, increasing commune size indeed mitigates the negative effect of large teams, and larger brigades worsen the negative effect of big teams.

*Regression 1: Marginal effect of team size*

$$= -0.35 + 0.28 \times \text{Commune size} - 0.32 \times \text{Brigade size}$$

Regression 2, which combines the two separate measures of commune and brigade sizes into a single measure of commune relative size as we have done in the linear regressions, also provides evidence to support hypothesis 4.

*Regression 2: Marginal effect of team size*

$$= -0.33 + 0.29 \times \text{Commune relative size}$$

The adjusted  $R^2$ s are .0217 and .0220 for regressions 1 and 2, respectively. The nearly identical explanatory power indicated by the adjusted  $R^2$ s suggests that combining commune size and brigade size into a single measure does equally well in explaining variations in the effect of team size.

In sum, the KRLS estimation supports the interaction effect described in hypothesis 4 and provides stronger evidence for hypothesis 3 than does our linear regression analysis. Because this robustness check did not include interaction effects among the size variables, it relieves our concerns that including interaction terms resulted in an overfitting of the data. Finally, and also supporting hypothesis 4, both the separate and combined measures of commune and brigade size yielded similar results, including similar explanatory power on the effect of team size. Simply put, it is unlikely that either our major finding, the affirmation of hypothesis 4, or our



secondary finding, the partial affirmation of hypothesis 3, were spurious.

## Discussion: Adjusting Commune Structure to Improve Productivity

We have demonstrated that increasing commune relative size improves agricultural production by reducing the negative effect of large production teams. Pursuant with *The Sixty Articles*, we expected county-level officials to adjust the relative size of the commune and its subunits in an effort to increase productivity. This tracks with reality as revealed in Figure 3. Average team size declined until 1962, and thereafter, between 1962 and 1966, average commune relative size was gradually increased.

These increases in commune relative size reflect the prioritization of agricultural productivity at both national and local levels. In *The Sixty Articles*, national leaders instructed local officials to adjust the size of communes and their subunits to increase grain output. But higher-level authorities could not choose the optimal commune structure for each county, so county-level officials were made responsible for adjusting their subordinate communes as necessary to increase agricultural grain production.

But how could county officials decide how to adjust their commune structure to enhance productivity? We hypothesize based on the existing social science literature (Axelrod 1997; Coleman et al. 1966; Dobbin et al. 2007; Gale and Kariv 2003; Haas 1980; Kahneman, Tversky, and Slovic 1982; Marsden 1981; Rogers 1995; Volden, Ting, and Carpenter 2008) that they learned which commune relative size was best from their own experience and by watching others around them, or as Levy (1994:287–89) explained in more general terms, they “encoded individually learned inferences from experience into organizational routines.” To see if such policy learning did indeed occur, we tested it using the considerable temporal and cross-county variations in commune relative size and team size. After 1962, when team size could no longer be reduced, we predict that this learning mechanism produced a gradual increase of average commune relative size. This is because, as shown above, larger commune relative size is positively associated with agricultural production because it mitigates the negative effect of larger teams.

To test our prediction, we hypothesize that a county will adjust its communes’ relative size to reflect the size of neighboring counties with high production performance in the past year. Conversely, we also hypothesize that a county will adjust its communes’ relative size away from the relative size of commune subunits in those counties with poor performance in the previous year.

Table 4 provides support for our first prediction, that counties learn from their most productive neighbors. In model 1, the positive and significant coefficient of commune relative size for the best-performing county indicates that counties did bring their commune relative size closer to the county with the best performance in their prefecture in the previous year.

In model 6, the negative coefficient of commune relative size of worst-performing county suggests that counties may have adjusted commune relative size away from that of the worst-performing county in the prefecture in the previous year. But the coefficient is weaker and not statistically significant, suggesting that county leaders learn more from their most successful neighbors.

In models 2–5 and 7–10, we separate the commune’s institutional life into four periods based on whether a major adjustment of commune relative size took place (see Figure 3). Not surprisingly, the learning mechanism for choosing commune relative size was strongest between 1962 and 1966 (i.e., model 3), that is, after team sizes were set.

Why did the learning mechanism weaken after 1966, or put another way, why did growth in commune relative size cease after 1966? One likely reason is that, like team size, commune size was limited by local conditions including population density and land topography as well as social cleavages such as ethnicity, religion, and clan loyalties. Tractorization, which accelerated rapidly in Henan during the 1970s, may have also reduced the impact of the commune size variable over time. Perhaps most important, the outbreak of the Cultural Revolution in 1966 undermined party governance and delayed or halted numerous policy initiatives.

## Conclusion

Using county-level data from Henan province we examined how changes in the size of the commune and its subunits affected the institution’s agricultural productivity. We developed hypotheses about the effects of commune, brigade, and team size on agricultural productivity and tested them using an original data set. Our results reveal that the commune’s institutional structure—its size and the size of its subunits—was a powerful and significant determinant of agricultural productivity. We also identified a policy diffusion mechanism whereby county-level leaders learned from the most successful county in their prefecture how to alter the size of their communes in ways that increased their productivity.

We found strong evidence that the marginal effect of size at the working level (i.e., the production team) varies with the relative size of the institution’s coordination level (i.e., the commune). When commune size is small, smaller teams are more productive; when commune size is large, the negative effect of large teams is mitigated and even reversed. Between 1962 and 1966, to mitigate the effects of suboptimally large teams, county officials learned from their most productive neighboring counties that to increase output they should adjust the size of their communes to take advantage of economic efficiencies generated by economies of scale.

Large communes enhanced public goods provision, which increased the marginal productivity of labor and reduced the importance of close monitoring of workers. Hence, the advantage of smaller teams becomes less obvious, and having fewer, larger teams can simplify agricultural planning

**Table 4.** Learning from Neighbors.

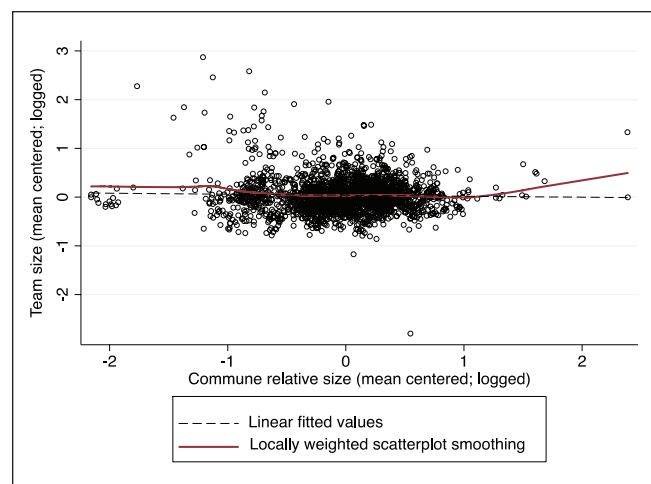
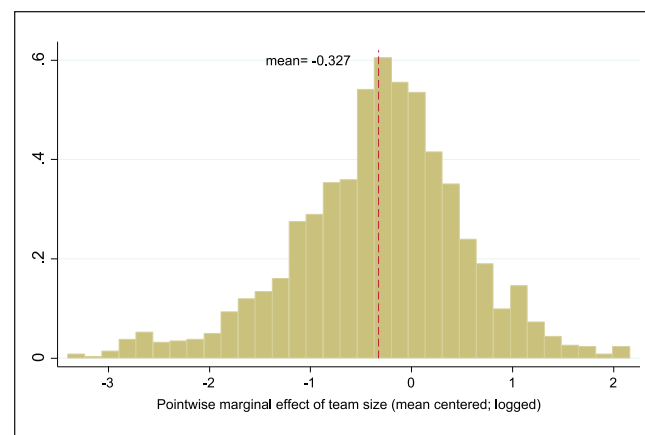
Variable	Dependent Variable: Change of Commune Relative Size from Previous Year				
	Full Sample	59–61	62–66	67–74	75–79
Panel A: learn from counties with “leaders”					
Commune relative size of best-performing county	(1) 0.089 <sup>†</sup> (0.029)	(2) −0.054 (0.151)	(3) 0.286 <sup>†</sup> (0.075)	(4) 0.034 (0.054)	(5) 0.102 (0.078)
Control variables	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	2,020	246	386	805	583
Number of counties	117	89	105	116	117
R <sup>2</sup>	.241	.456	.232	.051	.129
Panel B: learn from counties with “laggards”					
Commune relative size of worst-performing county	(6) −0.020 (0.037)	(7) 0.075 (0.140)	(8) 0.005 (0.086)	(9) −0.010 (0.022)	(10) 0.004 (0.073)
Control variables	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	2,036	228	394	831	583
Number of counties	117	79	105	116	117
R <sup>2</sup>	.206	.424	.139	.049	.118

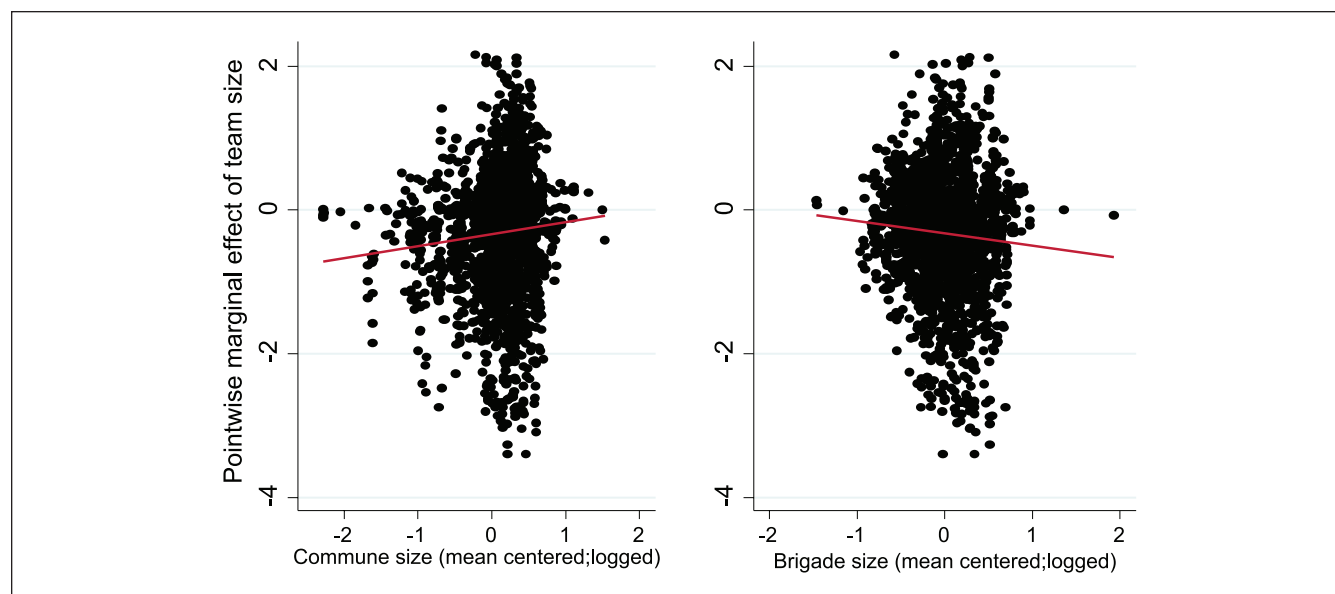
Note: *Commune relative size of best-performing county* refers to the commune relative size of the county with the highest logged per capita crop value within each prefecture in the previous year; similarly, *commune relative size of worst-performing county* refers to that of the county with the lowest logged per capita crop value within each prefecture in the previous year. For each of the 10 regression models organized in panels A and B, we controlled for the county's per capita crop value, average team size, average agricultural population, prefecture-level average per capita crop value, and prefecture-level average commune relative size, all of which were lagged to the previous year. Additionally, year dummies and county-specific fixed effects were included. <sup>†</sup> $p < .001$ .

and the allocation of productive factors. In this way, increased organizational efficiency at the supervisory level helped mitigate the negative effects of the free rider problem at the working level. This finding suggests that future examinations of the structural determinants of organizational

productivity ought to consider the interaction effects among the institution's subunits. Those interested in China, specifically, might consider developing a similar data set for another province or testing our conclusions using prefecture-level data from Henan.

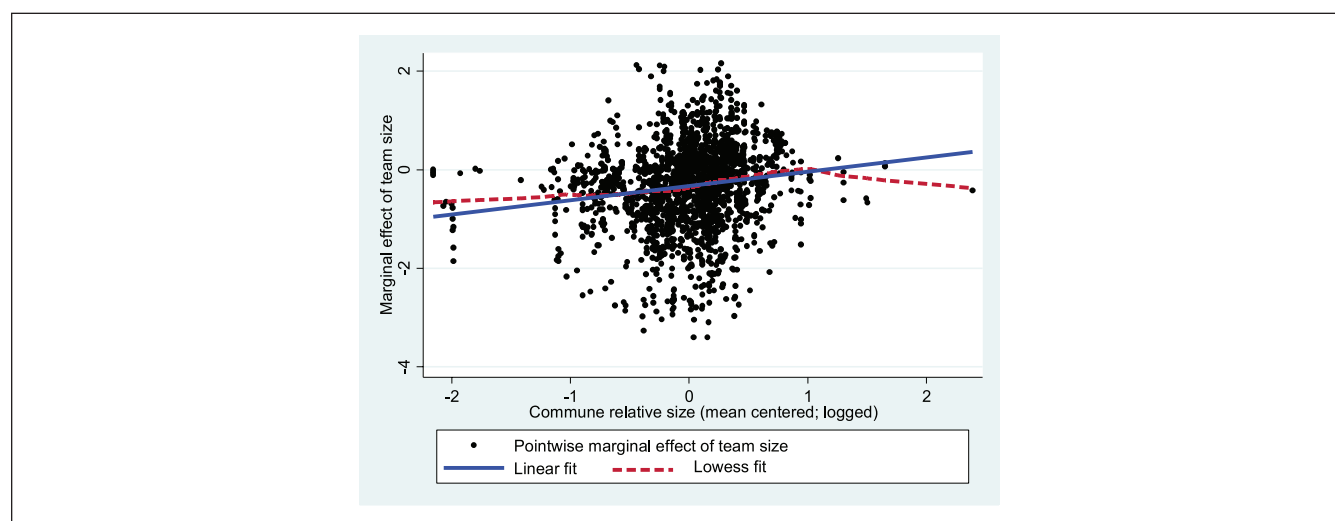
## Appendix

**Figure A.** Scatterplot of team size against commune relative size.**Figure B.** Distribution of pointwise marginal effect of team size. Note: Pointwise marginal effects of team size are estimated using kernel-based regularized least squares, as reported in Table 3.



**Figure C.** Scatterplot of pointwise marginal effect of team size against commune size and brigade size.

Note: Commune size and brigade size refer to the average logged number of teams per commune and per brigade for each county in each year, respectively; pointwise marginal effects of team size are estimated using kernel-based regularized least squares, as reported in Table 3.



**Figure D.** Scatterplot of pointwise marginal effect of team size against commune relative size.

Note: Pointwise marginal effects of team size are estimated using kernel-based regularized least squares, as reported in Table 3.

**Table A.** Summary Statistics.

Variable	Definition	Observations	Mean	Standard Deviation
Crop production	Natural logged value of crop production, expressed in thousands of RMB and in 1970 prices	2,307	10.27	0.91
Crop production per rural capita	Natural logged value of crop production per rural capita, expressed in RMB and in 1970 prices	2,307	4.39	0.58
Total agricultural outputs	Natural logged value of agricultural outputs, expressed in thousands of RMB and in 1970 prices	2,533	10.57	0.85
Total agricultural outputs per rural capita	Natural logged value of agricultural outputs per rural capita, expressed in RMB and in 1970 prices	2,533	4.71	0.51

(continued)

**Table A. (continued)**

Variable	Definition	Observations	Mean	Standard Deviation
Commune relative size	Natural logged average number of brigades per commune	2,473	2.99	0.46
Team size	Natural logged average number of households per production team	2,528	3.55	0.34
Land	Natural logged area of planted land (for grains and oil), in hectares	2,560	11.07	0.87
Powers	Natural logged machine horsepower	2,410	9.37	1.67
Labor	Natural logged average share of labor in rural population	2,529	-0.95	0.14
Fertilizer	Natural logged tons of fertilizers per hectare of planted land	2,574	-2.20	1.78
Rural population	Natural logged rural population, in thousands	2,562	5.86	0.74

Note: RMB = renminbi.

**Table B. Estimation Using Alternative Dependent Variables.**

Variable	Total Output (1)	Total Output per Rural Capita (2)
Institutional structure		
MC commune relative size	-0.030 (0.025)	-0.040 (0.027)
MC team size	-0.032 (0.036)	-0.024 (0.036)
MC Commune Relative Size × MC Team Size	0.096*** (0.035)	0.103*** (0.041)
Conventional inputs		
Land	0.175** (0.082)	0.190** (0.082)
Machine powers	0.029 (0.018)	0.033* (0.018)
Labor	0.433** (0.174)	0.414** (0.171)
Fertilizer	0.019** (0.007)	0.020*** (0.007)
Rural population	0.179 (0.212)	-0.578*** (0.189)
Year fixed effect	Yes	Yes
County fixed effect	Yes	Yes
Observations	2,184	2,184
R <sup>2</sup>	.795	.615
Number of counties	117	117

Note: MC = mean-centered. Dependent and independent variables are logged; the constant is included in the model but not reported here; robust standard errors, in parentheses, are clustered at the county level. \* $p < .10$ . \*\* $p < .05$ . \*\*\* $p < .01$ .


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