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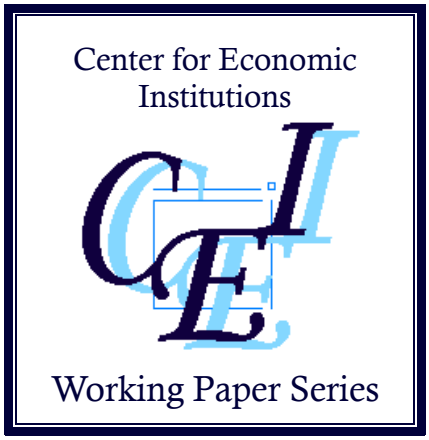

Institute of Economic Research
Hitotsubashi University
2-1 Naka, Kunitachi, Tokyo, 186-8603 JAPAN
http://cei.ier.hit-u.ac.jp/English/index.html
Tel:+81-42-580-8405/Fax:+81-42-580-8333

Evaluating Efficiency Gains from Tenancy Reform Targeting a Heterogeneous Group of Sharecroppers: Evidence from India

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Takashi Kurosaki[a] Rasyad Parinduri[b] Saumik Paul[c]

Abstract

This paper reevaluates the effect of a tenancy reform, popularly known as *Operation Barga*, on agricultural productivity in West Bengal, India. We employ a transparent empirical strategy based on synthetic control. We focus on the varying intensity of *Operation Barga* across West Bengal districts by comparing the districts' agricultural productivity with that of counterfactual districts using the synthetic control approach. Concerns over agro-climatic diversity and the recorded history of land reforms were also addressed while creating counterfactual districts. We find robust empirical evidence of a negligible effect on agricultural productivity growth. Next, we consider a theoretical framework to estimate the potential gains from *Operation Barga* in light of several types of sharecroppers. Consistent with the empirical findings, we conclude that the capacity of *Operation Barga* to enhance agricultural productivity is heavily constrained by the heterogeneity of sharecroppers in terms of wealth and livelihood structure.

Keywords: land reform, agricultural productivity, synthetic control, India
JEL code: D60, O4, Q1, R11

[a,c] Institute of Economic Research, Hitotsubashi University; [b] Nottingham University, Malaysia Campus.

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1. Introduction

Institutions are important in shaping long-run economic performance in terms of both efficiency and equity (e.g., Acemoglu and Robinson, 2012). Much attention has been paid to the relationship between property rights and efficiency (Otsuka, 2007). Theoretically, drastic reforms, such as shifting a tenancy contract from sharecropping to a fixed-rent system or converting occupancy tenants to owner-farmers could lead to a significant discontinuity in the existing institutional set-up. In such cases, evaluations through the identification of institutional changes appear straightforward. In modern states, however, these types of reforms are less frequent due to socio–political constraints, which have limited the scope of empirical research on moderate reforms. For example, reforms are often targeted at enhancing sharecroppers' occupancy rights. However, evaluating the impact of such a moderate reformist policy is inherently difficult. In this paper, we reevaluate the effect of the celebrated tenancy reform program known as *Operation Barga* implemented in West Bengal, India.[1] Under this reform, sharecroppers were given secure rights over land and a part of the residual surplus. Several empirical studies have argued that the program enhanced efficiency and equity (e.g., Banerjee, Gertler, and Ghatak, 2002; Bardhan and Mookherjee, 2007; Ghatak and Roy, 2007). However, the components of *Operation Barga* show that this is a rather moderate reformist policy on land institutions. We therefore ask whether *Operation Barga* was plagued by the inherent limitations of a reformist measure.

West Bengal, an eastern state of India, was under the institution of *zamindari* (landlordism) during the colonial era, resulting in low productivity after independence (a negative colonial legacy; see Banerjee and Iyer [2005]). While sharecropping had existed in Bengal since ancient times, it became widespread during the colonial era under *zamindari*, especially in the 1920s and 1930s. After India gained independence in 1947, the *zamindari* system was abolished, but many of the sharecroppers continued to be a significant part of the agrarian proletariat with no formal occupancy rights. The Left Front government, which came to power in West Bengal in 1977,

[1] India, an agrarian economy with an acute level of land inequality, has witnessed land reform as a top development policy priority since its independence in 1947 (see Ghatak and Roy [2007] and Shaban [1987] for a comprehensive summary).

introduced a package of land reforms and implemented it intensively until the late 1980s. In 1978, among its land reform policies, *Operation Barga* was initiated with the goal of registering sharecroppers in order to enhance their rights. Though many studies have evaluated the impact of *Operation Barga,* our understanding of its efficiency is highly limited. The literature remains inconclusive about the extent to which *Operation Barga* improved agricultural productivity in West Bengal.

Banerjee, Gertler, and Ghatak (2002) serve as the baseline study on *Operation Barga.* Using district-level data, they find that the program improved rice yields by almost 20% and attribute the improvement to a reduction of Marshall–Mill sharecropping distortions. More recent research indicates a number of shortcomings in this study. Bardhan and Mookherjee (2007), using a more disaggregated study at the farm level (which they claim is subject to less measurement error), find only a quarter of the size of the effect documented by Banerjee, Gertler, and Ghatak (2002).[2] They contend that the supply of agricultural inputs and a village-level general equilibrium effect had a much larger effect on rice productivity than on land reform. Among other controls, they also include *Gram Panchayat*-level programs to address the possible endogeneity between land reform and the supply of inputs. In another study, Bardhan, Mookherjee and Kumar (2012) use farm-level panel data from 1982 to 1995 and show that falling groundwater costs (with the spread of investments in private irrigation facilities such as tube wells) is significantly correlated with growth in value added per acre for farms. This was partly stimulated by the tenancy registration program through investments in minor irrigations. This indicates spillover benefits to non-tenant farms and highlights the complementarity between private investment incentives and state-led institutional reforms.

In a related study, Bardhan, Luca, Mookherjee, and Pino (2014) examine the effectiveness of *Operation Barga* in reducing land inequality, incorporating its indirect effect

[2] In a simple exercise assuming that rice yield is homogenous across all types of land, with about 20% of the cultivated land under sharecropping, an increase of 20% rice yields (based on Banerjee, Gertler and Ghatak [2002]) indicates an almost 100% increase in rice yield from the sharecropped land due to *Operation Barga*. Even the findings of Bardhan and Mukherjee (2007) indicate an almost 25% increase in yield. Both results seem highly unlikely given the vast literature on the effect of tenancy reforms on yields (Otsuka, 2007).

through induced household division, migration, and land market transactions. Their main findings suggest that the tenancy reform lowered land inequality through its effects on household divisions and land market transactions but that its effect was quantitatively dominated by the inequality-raising effects of population growth. Finally, investigating long-term effects, Deininger, Jin, and Yadav (2013) use data from a sample of 96,000 households from 200 villages to find that strong disincentives to investment in soil fertility and irrigation exacerbated the continued inefficiency of sharecropping, which suggests efficiency losses of almost 25% from such arrangements. A recent study by Fujita (2014) aptly summarizes the findings so far. He asserts that *Operation Barga* did not contribute to agriculture output growth but did contribute to the overall economic growth of West Bengal by creating a more egalitarian distribution of assets and income and by preventing marginal farmers from becoming a landless proletariat. Using a finer classification of paddy crops, he further contends that the agricultural growth during the 1980s occurred mainly because of the expansion of irrigated area through private tube wells and the associated expansion of dry season paddy, as well as the gradual dissemination of high-yield variety seeds in other seasons.

We now turn to the earlier and less-known literature that discussed the limitations of *Operation Barga* as a reformist measure. In one early contribution, Dutta (1981) stated that, while *Operation Barga* made the poorer among the rural population more conscious of their rights, the policy was misdirected on several levels. According to him, it was not clear how much bargaining power the sharecropper would enjoy in the communal ownership of land. If the government actually intended to develop a small peasant proprietary economy, it had to provide a support system such as by establishing producers' cooperatives, but such support was totally lacking. Khasnobis (2001) voiced similar concerns and added that the program induced only a slight rearrangement of property relations, with the old landowning classes retaining basic rights over land. Another paper, Mukhopadhyaya (1979), stressed that some plots under *Operation Barga* ended up having multiple sharecroppers registered, who cultivated on the same plot but in different harvesting periods. This created political tensions in many areas, as *Operation Barga* became the hotbed of violent factional politics. Rogaly's (1999) study on contractual arrangements associated with seasonal migration also casts doubt on the efficacy of *Operation*

Barga in providing land use rights to sharecroppers-cum-migrants. Finally, Rudra (1981) observed that the most oppressed segment of the rural masses was bound to be neglected if the Left-Front Government aimed at majority support through such reformist measures. In this sense, the question of equity also comes under scrutiny, in addition to efficiency.

While the early literature on *Operation Barga* points out the potential limitations inherent in the measure, the arguments are at best sporadic and lack a systematic structure. In this paper, we pay close attention to the history of land relations in West Bengal and develop a platform with which to analyze the limitations of *Operation Barga*. We do this in three steps. First, after carefully examining the rich history of land reforms in West Bengal, we conclude that *Operation Barga*, the Left Front's landmark initiative, had many predecessors (of a similar kind). In this sense, the agricultural output growth of the 1980s could be simply the cumulative effect of reforms undertaken since the early 1950s. Second, we apply a synthetic control method (Abadie, Diamond, and Hainmueller, 2010) to obtain transparent and data-driven estimates of the reform's impact.[3] We create counterfactual West Bengal districts from a pool of 271 districts from 12 other states in India based on a number of observable characteristics for the period from 1967 to 1977. We pay particular attention to the varying intensity of *Operation Barga* across West Bengal districts as well as agro-climatic diversity; the recorded history of land reforms is also addressed while creating the counterfactual districts. We find robust empirical evidence of a negligible effect on agricultural productivity growth.[4] A number of placebo test outcomes confirm the empirical findings.

Third, we develop a simple theoretical framework to examine the limitations and potential gains from *Operation Barga*, in light of the prevalent agrarian institutions. We consider various classes of farmer, including several types of sharecropper, and rank them according to productivity level in the Marshallian sense. We work out two mechanisms through which

[3] Somewhat related to these issues, Ghatak and Roy (2007) found that average treatment effects can hide a considerable amount of heterogeneity. We try to overcome this problem using a synthetic control approach.
[4] This is in line with the literature showing the inherent inefficiency problem due to various factors such as insufficient wealth among tenants, which causes other means of farming less binding (Ghatak and Roy, 2007)

Operation Barga could have enhanced productivity efficiency. The first is a direct effect on sharecroppers. Using the shares of various sharecropper types, we conclude that a reduction in Marshall–Mill-type sharecropping distortions due to *Operation Barga* may not be sufficient to improve productivity levels. Second, we consider the possibility of structural transformation across farmer classes, such as the transformation of sharecroppers to owner-farmers. We also show, however, that such possibilities are rare due to the prevailing agrarian structure and credit constraints. Overall, we find that the scope of *Operation Barga*'s contribution to agricultural productivity growth was heavily constrained by heterogeneity within the sharecropping class. As a result, it seems reasonable to expect a negligible (or less than moderate) gain in agricultural output accruing through *Operation Barga*.

The rest of the paper is organized as follows. In section 2, we provide a brief history of land reform programs in West Bengal, divided into two periods: pre- and post-*Operation Barga*. Section 3 analyzes the outcomes of baseline and extended models using the synthetic control method. We also discuss the outcomes of placebo tests. In section 4, we provide a theoretical framework to discuss several mechanisms, spelling out the possible relationships between *Operation Barga* and agricultural productivity. Finally, section 5 concludes the paper.

2. A Brief History of Land Reforms in West Bengal

After the independence of India in 1947, various land reform programs were introduced in West Bengal, similar to those adopted in other states of India. Following Besley and Burgess (2000), they can be categorized into four broad groups: 1) abolition of intermediaries; 2) security of cultivation rights for tenants; 3) introduction of ceilings on land ownership and redistribution of surplus land; and 4) consolidation of land. In most states, only the first type was implemented thoroughly; the others were implemented only partially. The state of Punjab was exceptional in implementing the fourth component of land consolidation. In West Bengal, however, the second and third types have been more frequent, especially since 1977, when the Left Front government

came to power. In September 1978, *Operation Barga*[5] was initiated as part of continuing efforts to secure cultivation rights for sharecroppers by registering them. In this section, we adopt an historical perspective and describe the development of land rights and related institutions in West Bengal as a backdrop to our discussion of *Operation Barga*.

2.1. Pre-1977 Period

According to many studies, the origin of land rights in Bengal[6] dates back to 1793, when the British East India Company conferred property rights to *zamindars* (landlords) through the establishment of the Permanent Settlement Act (Chaudhuri, 1975; Bhaduri, 1976). Under this Act, the *zamindars* became hereditary proprietors of land with rights over land transfer; revenue demand was fixed at approximately nine-tenth of the actual rent. The *zamindari* system improved land revenue collection immediately (Saha, 1930). Facing a heightened revenue obligation, landlords opted for a more secure option by which to hedge against the risk of default by transforming resident tenants into rent-receiving intermediaries (Bhaduri, 1976). Over time, this spawned multiple layers of *occupancy raiyats* (resident sub-tenants), each claiming proprietary rights over land and agricultural surplus.[7] Some sub-tenants with relatively large holdings of land formed a group of powerful moneylenders. Frequent land transfers took place from the old *zamindari* estates to newly developed moneyed class consisting of usurers and moneylenders. This made the economic condition of the *raiyats* (tenants) vulnerable, as this new landowners class was driven mainly by pecuniary motives (Ray and Ray, 1975). The share of landless agrarian laborers increased from 3% in 1891 to almost 30% in 1931 (Paul, 2016). A sizable portion of the smallholder cultivators, impoverished by increasing rent obligations, became *bargadars* (sharecroppers) with no ownership rights. While the practice of sharecropping in Bengal had existed since ancient times, it became widespread in the 1920s and 1930s.[8]

Throughout the colonial period (1765–1947), several reforms were enacted, including the 1859 *Rent Act* and the 1885 *Bengal Tenancy Act*, to improve the rights of superior tenants. In

[5] The literal meaning of "*barga*" is "division of output by half." In west Bengal, sharecroppers are also known as *Bargadars*.
[6] The current state of West Bengal was known as "Bengal" in undivided India (i.e., until its 1947 independence).
[7] The number of intermediaries increased by almost 62% between 1921 and 1931 (Bhaduri, 1976).
[8] Cooper (1988) provides a detailed history of sharecropping in Bengal, but accurate statistics are unavailable.

sharp contrast, the question of *bargadars* was largely ignored (Chattopadhyay, 1984). Moreover, in places with more exploitative arrangements, *bargadars* struggled to secure interest-free seed and grain for consumption purposes and protested against illegal exactions (Cooper, 1988). In response to political pressure to improve the wellbeing of such *bargadars*, the Land Revenue Commission conducted a sample survey from 1938 to 1940. The commission report found that about 20% of the arable land was cultivated by *bargadars*, with considerable variation across the Bengal districts. The highest share of *bargadars* was found in the district of Hooghly, while the district of Malda had the lowest share (see Column 1, Table 2.1). Table 2.1 shows the ratio of sharecropped land reported in the 1951 Census and a survey by Basu and Bhattacharya (1963) conducted in 1960–61. While the figures are not comparable due to the different survey designs, the table reveals some broad trends. The prevalence of sharecropping in terms of land was in the range of 20 to 30% in West Bengal, with a large inter-district heterogeneity, and there was no clear decreasing tendency until the 1960s.

[Table 2.1 is about here]

India gained independence in 1947. In 1953, the West Bengal States Acquisition Act was passed abolishing the Bengal Tenancy Act of 1885. Under this Act, the lowest-tier of occupancy *raiyat* was given highly protected land occupancy rights, and all intermediaries above them (with *zamindars* at the top) were abolished (i.e., they lost the right of land ownership after being compensated for the loss). Provisions were made for a systematic recording of *bargadars*, but they were rarely implemented. Ceilings on land ownership were introduced, but, as they were defined on an individual basis, within-family transfers of nominal ownership made the ceilings ineffective for the surplus land redistribution. To overcome such irregularities, the Land Reform Act of 1955 was subsequently adopted. Under this new Act, the occupancy rights of the lowest-tier occupancy *raiyat* were strengthened to the extent that they were regarded as full ownership rights. Several provisions were introduced to improve the conditions of *bargadars* in terms of restrictions on land rent share or eviction. However, without a proper recording of *bargadars*, the impacts of these provisions on sharecropping arrangements were limited.

The issue of land ceilings was finally addressed in the revised Land Reform Act of 1972. The ceilings on land ownership were redefined on a household basis with strict conditions on "self-cultivation," and the ceiling was reduced. The 1972 Act also revised provisions regarding sharecropping arrangements in favor of *bargadars*; the ceiling on the land rent share was further reduced to 25%, for example. Had this provision been effective, *bargadars* would have needed their name changed, as the share was no longer *barga* (i.e., a half). The sharecroppers' occupancy rights were also made inheritable under the 1972 Act. To make these provisions more effective, a preliminary attempt to register *bargadars* was initiated in November 1972 in five districts: Bankura, Darjeeling, Hooghly, Murshidabad, and West Dinajpur. This attempt was expanded to 10 other districts (except in Purulia) in April 1974. However, by June 1977, when the Left Front government came to power, only 350 thousand *bargadars* were recorded in West Bengal (Bandyopadhyay, 1980). This was much smaller than the estimated number of *bargadars* in the state, which was in the range of two to three million (see also column [2] in Table 2.2). Under the 1972 Land Reform Act, land over the ceilings was appropriated by the state government and redistributed to landless households in West Bengal. By September 1975, 570 thousand acres of such "surplus land" was redistributed to 815 thousand beneficiaries (Gupta, 1977). This number was not negligible, but the land distributed per beneficiary was a meager 0.7 acre. Moreover, the land quality was often inferior to the state average.

2.2. Post-1977 Period

After coming to power in 1977, the Left Front government paid special attention to the protection of *bargadars*' rights and the redistribution of surplus land. However, it is important to note that most of the legal provisions necessary for the two measures already existed in West Bengal before the Left Front came to power. According to government documents (Bandyopadhyay, 1980), the Left Front's agrarian reforms comprised 10 pillars: 1) *Operation Barga* to protect *bargadars*' rights and improve their tenancy terms; 2) redistribution of surplus land to landless farmers and laborers; 3) increased appropriation of surplus land with help from Village Panchayats and farmers' organizations; 4) credit provisions to beneficiaries of 1) and 2); 5) giving house ownership to rural artisans, laborers, and fishermen; 6) irrigation expansion; 7) agricultural subsidies; 8) a new tax on agrarian assets; 9) returning land to the original owners if

the land was lost due to usury; and 10) an expansion of the "Food for Work" program. As is clear from this list, only the first three were land reform policies according to the standard definition, while the last seven were rural development policies complementing the three land reform policies. This indicates that the Left Front government considered that land reform policies would be ineffective if they were not accompanied by complementary policies.

[Figure 2.1 is about here]

2.2.1. Registration of sharecroppers through *Operation Barga*

Operation Barga was initiated in September 1978 by dividing the entire state of West Bengal into two regions. The main goal was to hasten the recording of *bargadars* through camps in a sequential manner across the regions. The number of registered *bargadars* saw an unprecedented growth (see Figure 2.1). In two years' time, from June 1978 to August 1980, about 0.45 million new *bargadars* were recorded under the *Operation Barga* program. As shown in Figure 2.1, the registration peaked around 1979 and 1980 and then receded in the mid-1990s. By November 2010, approximately 1.538 million *bargadars* had been registered (see Table 2.2). According to Census 1981, the estimated population of *bargadars* was 2.31 million, which is about 27% of the agricultural population. The final registration number thus corresponds to 66.6% of the estimate. These figures are consistent with the literature if we consider the different phases. Sengupta (1981) estimated that *Operation Barga* was successful in reaching almost 35% of the targeted people in late 1970s. Banerjee et al (2002) find that registered sharecroppers during *Operation Barga* accounted for about 48% of all sharecroppers in the 1990s, whereas Bardhan and Mukherjee (2011) estimate the same to be around 65% in the 2000s. However, by 2010, the population of *bargadars* could have grown as well, at a rate that is not available from Census 2011. As the number of workers involved in agriculture grew by a factor of approximately 1.4 between 1980 and 2010, the registration rate of 66.6% could be an overestimate.[9] Furthermore,

[9] The dominant view is, however, that the population growth rate of *bargadars* was lower than that of other types of agricultural population (see Dasgupta, n.d., for example). Therefore, dividing the percentage in column (7), Table 2.2 could be an underestimate as well.

as Fujita (2014) contends, almost 15% of sharecroppers lost their registered land over the 15-year period after *Operation Barga* began.

[Table 2.2 is about here]

There is some heterogeneity in the number of registered *bargadars* across districts, which could be partially due to the sequential order of registration. Looking at the registration rate by November 2010, some districts had significantly more registered *bargadars* than the average—for example, in Birbhum (112%) and Bankura (104%)—whereas, for some other districts, it remained in the vicinity of 30 to 40 % (e.g., Jalpaiguri and Darjeeling). *Operation Barga* gave the tenant a choice of registration with the land-revenue bureaucracy; this was to establish the legal standing of a tenant, tenancy contracts being predominantly oral at that time. A registered tenant could not be evicted provided they paid a legally stipulated share of output to the landlord. However, as tenant protection provisions were guaranteed by overall rural development policies under the Left Front government, registered *bargadars* under *Operation Barga* were very different from the *bargadars* registered before *Operation Barga*. While the registration rates reported in Table 2.2 appear impressive, in terms of the acreage share, the actual achievement of *Operation Barga* was modest. Sharecropped land operated by the 1.538 million registered *bargadars* totaled 0.456 million ha (or 1.128 million acres), which was about 8.3% of the net cultivated area in West Bengal. The district-level heterogeneity is shown in Table 2.3, with Birbhum and Jalpaiguri showing the highest ratio and Purulia, Nadia, and Midnapore the lowest.[10] Table 2.3 also shows that, on average, the sharecropped land per registered *bargadar* was as small as 0.3 ha (0.7 acre). With this size of land holding, viable farming could be difficult.

[Table 2.3 is about here]

[10] Darjeeling's ratio was not mentioned in the text, as the district showed large changes in net cultivated area depending on the period; Table 2.3 indicates that the rate was among the highest, but, if we use the average in 2001–03, the rate was among the lowest. For all other districts, the rates were robust regardless of the years for which the net cultivated area data were taken.

2.2.2. Redistribution of Surplus Land

Another pillar of the land reform policies of the Left Front government was the redistribution of surplus land over the ceilings to landless households. According to Left Front government statistics, 0.613 million acres of land was redistributed to 0.963 million beneficiaries by December 1978, 0.807 million acres of land to 1.611 million beneficiaries by June 1985, and 1.131 million acres of land to 3.023 million beneficiaries (Government of West Bengal, *Economic Review*, various issues). The last number (1.131 million acres) corresponds to about 8.3% of the net cultivated area, almost the same amount as the sharecropped land under registered *bargadars*. This is not very impressive but is also not ignorable. However, for the purpose of this paper, we do not consider any evaluation of the productivity impact of the Left Front's land redistribution at the district level, for two reasons.[11] First, the statistics shown above are accumulated numbers, which include achievements before the Left Front came to power. Out of the 1.131 million acres mentioned above, approximately half were distributed before 1978. The discontinuity with the arrival of the Left Front government was not as sharp as was the case with *Operation Barga.* Second, the amount of land distributed per family dropped substantially during the Left Front period due to a rapid increase in the number of beneficiaries. For instance, between December 1978 and June 1985, the average size of the redistributed land was only 0.30 acre. As the land quality was more likely to be lower than the average and as landless households without previous experience of farm management were unlikely to become efficient, land redistribution is unlikely to affect overall agricultural productivity at the district level.

2.3. Implications for Empirical Analysis

As *Operation Barga* brought about a significant discontinuity in land reform implementation in West Bengal and the number of *bargadars* registered under the program was large relative to the estimated total, it is worth investigating its impact on agricultural productivity at the district level. Since land under sharecropping arrangements is usually of good quality, the 8.3%

[11] A similar view was provided by Gazdar and Sengupta (1997) and Dasgupta (n.d.) as well.

incidence rate for West Bengal's total land cannot be ignored. The enhanced cultivation rights under *Operation Barga* might have led to an improvement in production efficiency on sharecropped land. It is undeniable that West Bengal witnessed a major surge in agricultural productivity in the 1980s and early 1990s, which was preceded by *Operation Barga* (Bose, 1999; Gazdar and Sengupta, 1999). This spur in agricultural growth could have been due to *Operation Barga*, or other concurrent policy reforms, such as private investments in new technology (Bardhan and Mukherjee, 2011; Fujita, 2014). We make a novel application of the data-driven synthetic control statistical method to evaluate the effect of *Operation Barga* on district-level agricultural productivity (section 3).

3. Empirical Analysis

We use the synthetic control approach of Abadie and Gardeazabal (2003) to examine the effect of *Operation Barga* on productivity in West Bengal's districts.[12] We compare each district (treated unit) in West Bengal and a district in another state (untreated unit) whose rice yield trend before intervention resembles that of the treated unit. Such an untreated unit usually does not exist, however. The solution offered by Abadie and Gardeazabal (2003) is 1) to find a synthetic unit, a combination or weighted average of all untreated units, such that the trend of rice yield and the characteristics of this synthetic unit resemble that of the treated unit; and 2) to consider the status of the synthetic unit after the intervention as the counterfactual to estimate the effects of *Operation Barga*.

3.1. The model

Suppose the sample has $J + 1$ districts—the first is a West Bengal district and the remaining J are districts in all other states. The government of West Bengal introduced Operation Barga in 1978; no other state introduced tenancy reforms as extensive as Operation Barga. The first district is therefore a treated unit, while the others form a donor pool from which we create a synthetic control unit.

12 See also Abadie, Diamond, and Hainmueller (2010). Recent papers that use this approach include Billmeier and Nannicini (2013) and Cavallo et al. (2013).

Let Y_{it}^1 and Y_{it}^0 be the rice yield in district i at time t for district $i = 1, \dots, J$, and time periods $t = 1, \dots T$ if the district did and did not (respectively) introduce Operation Barga. Let T_0 be the number of periods before Operation Barga was introduced, where $1 \leq T_0 \leq T$, so that the first district had Operation Barga from period $T_0 + 1$ to T. Assume Operation Barga did not affect rice yields in India before it was introduced (a plausible assumption because tenants' rights improved only after T_0), so that $Y_{it}^1 = Y_{it}^0$ for $i = 1, \dots, J$, and time periods $t = 1, \dots T$. Assume also that Operation Barga did not affect any district in the donor pool.[13]

Define $\alpha_{it} = Y_{it}^1 - Y_{it}^0$ as the effect of Operation Barga in district i at time t; the lead-specific causal effect of Operation Barga is

$$\alpha_{1t} = Y_{1t}^1 - Y_{1t}^0 = Y_{1t} - Y_{1t}^0 \tag{3-1}$$

for $t = T_{0+1}, \dots T$. We observe Y_{1t} but not Y_{1t}^0. Therefore, to obtain α_{1t}, we need to estimate Y_{1t}^0 using a weighted average of districts in the donor pool.

Consider a $(J \times 1)$ vector of weights $W = (w_2, \dots, w_T)'$, such that $w_j \geq 0$ for $j = 2, \dots, J + 1$ and $w_2 + w_3 + \cdots + w_{J+1} = 1$, with each element the weight of a district in the donor pool. Let also Z_i be an $(r \times 1)$ vector of the observed predictors of rice yield.

Abadie et al. (2010) suggest that, if $W^* = \left(w_2^*, \dots, w_{J+1}^*\right)$ exists such that

$$\sum_{j=2}^{J+1} w_j^* Y_{jt} = Y_{1t} \tag{3-2}$$

$$\sum_{j=2}^{J+1} w_j^* Z_j = Z_1 \tag{3-3}$$

for $t = 1, \dots, T_0$, then we can use

$$\widehat{\alpha_{1t}} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{3-4}$$

[13] This assumption of no interference between districts is analogous to the stable unit-treatment value assumption (Rosenbaum, 2007).

as an estimator of α_{1t}.

3.2. Implementation

Let $X_1 = \left(Z_1'; \overline{Y}_1^{K_1}, \ldots, \overline{Y}_1^{K_M}\right)'$ be the vector pre-intervention characteristics and linear combinations of rice yield of a treated district and $X_0 = \left(Z_j'; \overline{Y}_j^{K_1}, \ldots, \overline{Y}_j^{K_M}\right)'$ be a matrix of the same variables for districts in the donor pool. We want to minimize the distance between X_1 and a weighted average of X_0, $\|X_1 - X_0 W\|$. In particular, we minimize

$$\|X_1 - X_0 W\| V = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$$

where V is a diagonal matrix whose elements reflects the importance of the predictors of rice yield.

First, we estimate W and V using observations in the first half of the pre-intervention period. We use the first half as the "training period" of the model—which allows us to see how a good rice yield in the synthetic unit tracks that in the treated district. Then, we extrapolate this model to the second half of the pre-intervention period and, to obtain estimates of Y_{1t}^0, beyond. The difference between the rice yield in the treated district and its synthetic unit for each of the years in the post-intervention period is $\widehat{\alpha_{1t}}$, the effects of the tenancy reform.

To estimate the average effects, Cavallo et al. (2013) suggest averaging the effect across all treated districts as follows:

$$\overline{\alpha} = \left(\overline{\alpha}_{T_{0+1}}, \ldots, \overline{\alpha}_T\right) = \frac{1}{G} \sum_{g=1}^{G} \left(\hat{\alpha}_{g,T_{0+1}}, \ldots, \hat{\alpha}_{g,T}\right)$$

where G is the number of treated districts, and $\overline{\alpha}_t$ is the average effects at time t in the post-intervention period.

3.3. Data

We use India agriculture and climate data (from ICRISAT, World Bank) and the annual district-level agricultural, climatological, edaphic, and geographical variables of 271 districts in 13 major states in India over a period of 30 years from 1957–58 to 1986–87.[14] The unit of analysis is the district based on the 1965 boundaries. We include time periods from 1960 to 1987. We start in 1960, long before the West Bengal government introduced *Operation Barga* in 1978. We stop in 1987 because that is the last year the dataset covers; besides, a decade-long period is sufficiently long to examine the effects of the tenancy reform. Because 10 districts lack complete observations for some variables, we drop these districts from the sample, resulting in a total of 271 districts. During the period of our analysis, West Bengal had 16 districts, but the urban district of Calcutta is excluded from our analysis. We therefore have 15 West Bengal districts[15] as treated units and 246 districts in the donor pool.

The intervention, the treatment variable, is *Operation Barga*. Because the West Bengal government introduced the tenancy reform in September 1978, the period from 1960 to 1978 is the pre-intervention period, and 1979 to 1987 is the post-intervention period. The treatment variable equals 1 in 1979 or later and zero otherwise.

We use rice yield as a measure of outcome because rice is a major crop in West Bengal. We define it as the ratio of district-level rice production to total rice farm area; the unit is tons per hectare.

We consider agricultural inputs and some measures of the districts' stage of development as well as climatological and edaphic variables as covariates. We do not obtain good matches when we include weather and soil conditions as covariates, however. In the results we present in

[14] The dataset covers more than 85% of India; the areas it does not cover are not major agricultural states (except for Kerala and Assam). We downloaded the data from the ICRISAT/World Bank website in January 2015.
[15] See Table 2.2 for the list of these 15 districts, and see the note to Table 2.2 for their relation to the current districts in West Bengal.

this paper, we include per-hectare numbers of bullocks, tractors, and workers; per-hectare amounts of three types of fertilizer (nitrogen, phosphorus and potassium); access to irrigation; average wages, literacy rates, population density; and lagged rice yields in X_1 and X_0.

3.4. Empirical Results

We perform a synthetic control analysis using three sets of donor pool. First, as the default specification, we include districts in states whose governments did not introduce more than two tenancy reforms from 1960 to 1987. The information on the number of tenancy reforms is taken from Besley and Burgess (2000); some state governments introduced tenancy reforms, but they were not as intensive as *Operation Barga*. We impose a limit of two reforms to make the size of the donor pools sufficiently large. The second and third sets are for a robustness check. We include districts in all states to which we can compare the first set of results or impose the additional restriction on the first set that the donor pool includes districts that fall in the crop zones proposed by Kurosaki and Wada (2015). The additional restriction on the third set makes the districts in the donor pool resemble West Bengal districts more closely; however, as we impose more restrictions, the donor pools become smaller, increasing the likelihood of obtaining worse matches—a point we must consider when interpreting the results.

3.4.1. Main Results

Figure 3.1, in which each panel presents the rice yield trend in one of the 15 treated districts in West Bengal and that in its synthetic district, does not show that *Operation Barga* improves productivity. In the estimation, we use the first donor pool set, which has 204 districts. During the "training period" in the first half of the pre-intervention period (the first half of the period to the left of the vertical dashed line), the rice yield in each synthetic district (the dashed line) closely tracks that in its treated district (the solid line); in the second half of the pre-intervention period, despite the volatility of rice yield (depending on weather), the synthetic districts approximate the treated districts quite well (the mean square prediction errors [MSPE] in the pre-intervention period, the average of the square difference between the rice yield in a treated district and that in its synthetic district, are small—in most cases, smaller than one).

During the post-intervention period, the rice yield in each of the treated districts does not diverge from that in the corresponding synthetic district, except for the few years when West Bengal suffered a severe draught in the early 1980s; in the late 1980s, the trends clearly diverge in only one district, Nadia, one of the smallest rice-producing districts in West Bengal in the late 1970s.

[Figure 3.1, 3.2, and 3.3 are about here]

Figure 3.2, which presents the effects of the tenancy reform (the difference between the rice yield in a treated district and that in its synthetic district), shows the same lack of significant impact. The effects during the pre-intervention period hover around zero, which means that synthetic control approaches provide good a fit for pre-intervention rice yield trends in the treated districts. In the post-intervention period, the effects are more volatile, but they never diverge far from zero; they are well within the bounds of the grey lines (except the effects in Nadia), which show the distribution of the placebo effects of the tenancy reforms in districts whose state governments did not introduce more than two tenancy reforms during the period of analysis. The p-value of the effects for each year during the post-intervention period in each of the treated districts, the likelihood that we would observe such an effect by chance given the distribution of the placebo effects, is large except for the few years when a severe draught hit West Bengal (Panel B and C of Appendix Table A.1). Overall, therefore, there is no evidence that the tenancy reform matters.

We obtain a similar picture when we average the effects of the tenancy reforms in the 15 West Bengal districts. As Panel A of Figure 3.3 shows, the trend of average rice yield in the synthetic districts during the pre-intervention period closely tracks the trend of average rice yield in West Bengal's districts; the same applies to the trend in the post-intervention period; the average effects of the tenancy reform in Panel B also hover close to zero. The p-values of the effects are large for most of the years in the post-intervention period (the last column of Panels B and C of Appendix Table A.1), which means that it is likely that the average effects as large as those seen in Figure 3.3 occur by chance; we do not have evidence that the tenancy reform increases average rice yields in West Bengal.

3.4.2 Robustness Check

As a robustness check, we either expand or limit the donor pool.

[Figure 3.4, 3.5, and 3.6 are about here]

When we include districts in all states in the donor pool (246 districts), we do not find strong evidence that the tenancy reform matters (see Figures 3.4 and 3.5). The trends in the corresponding graphs in Figures 3.1 and 3.4 as well as Figures 3.2 and 3.5 are similar: the MSPEs are small, and the p-values of the effects of tenancy reforms are large in most cases (see Appendix Table A.2). The average effects in Figure 3.6 show a similar picture: the average rice yield trend in the synthetic districts closely tracks that in West Bengal's districts, with the average effects hovering around zero and the p-values of the effects large in most cases (see the last column of Panels B and C of Appendix Table A.2).

[Figures 3.7, 3.8, and 3.9 are about here]

We find the same evidence of a lack of significant impact when we exclude from the first donor pool those districts in crop zones different from West Bengal districts (the size is very small, only 24 districts). The rice yield trends look more noisy, but the MSPEs remain small, and most p-values are large (see Figures 3.7, 3.8, and 3.9; Appendix Table A.3). Despite the small number of districts in the donor pool, we still find results that are in line with the basic results.

4. Efficiency of *Operation Barga* in Light of Prevailing Agrarian Institutions

The empirical outcomes based on the synthetic control methodology discussed in the previous section suggest a negligible effect of *Operation Barga* on district-level agricultural productivity in West Bengal in the period from 1970 to 1988. This outcome is unsurprising, as a number of studies have questioned the contribution of *Operation Barga* to agricultural productivity (Saha and Saha, 2001; Gazdar and Sengupta, 1999; Webster, 1999; Fujita, 2004; Otsuka, 2007). As argued by many, concurrent private investments in other spheres of production, such as rural credit facilities, irrigation through tube wells, and the adoption of high-yield variety seeds, are

largely responsible for the surge in agricultural output in the 1980s. In section 2, we argued that *Operation Barga* was a continuation of the land reform programs initiated in West Bengal in the early 1950s, and the culmination of agricultural productivity in the 1980s must be understood from a historical perspective. In this section, in light of the evolution of landed institutions documented in historical studies and based on scattered statistical evidence, we reexamine the feasibility of productivity growth resulting from the establishment of secured tenancy through *Operation Barga* in West Bengal.[16]

4.1. A simple analytical framework of the agrarian structure

Building on Ghosh (1986) and Ghosh and Dutt (1977), we develop a simple analytical framework of agrarian classes in West Bengal. With an aim to evaluate the performance of tenancy reforms through *Operation Barga*, we consider only the agents directly employed on agricultural land (i.e., landowners and agricultural laborers of different kinds). Let N be the total number of such agents. N is classified into three broad groups (or classes in the Marxian sense): R (*raiyats* who possess ownership of land and manage a farm using the land); S (sharecroppers who do not possess land but manage a farm using sharecropping land owned by the landlord); and L (landless laborers who do not manage a farm but are employed by others). The *raiyats* are further classified into two groups: R_{OL}, who cultivate their land with own labor, and R_{HL}, who cultivate their land with hired labor. Sharecroppers are further classified into three main categories:[17] S_M, or *mainly sharecroppers* consisting of a group of peasants who depended entirely on sharecropping for subsistence; S_P, or *partially sharecroppers*, mostly middle-income peasants who rent land on the sharecropping arrangement since they have more labor or capital to spare, and they use the rented land to augment their income or secure food consumption needs (Ghosh and Dutt, 1977); and S_L, consisting of *landless sharecroppers*, who are mostly marginal peasants with little capital to conduct farming and depend on wage earnings for their subsistence (hired by R_{HL}) in addition to farm income from sharecropping. Finally, the laborer class L is

[16] There is a voluminous related literature based on both theoretical and empirical work that finds no clear evidence of secured tenant rights on agricultural productivity. See Otsuka (2007) for a detailed discussion of this matter.
[17] Based on several surveys done on the agrarian structure in West Bengal since the 1940s, including a rural survey in 1944 by the Indian Statistical Institute.

composed of two types: L_E, who are hired by R_{HL}, and L_U, who are not regularly employed and remain as a buffer stock of agricultural laborers in the rural sector. We thus have a complete picture of the agrarian structure with agents directly employed on agricultural land. It can be written as $N = R + S + L = R_{OL} + R_{HL} + S_M + S_P + S_L + L_E + L_U$.

While the distribution of agents across these peasant groups varies across districts and time, we provide a tentative distribution using the average figures in Figure 4.1 based on data collected from various sources.[18] The R_{OL} consists of almost 40% of N, followed by R_{HL} (15%), S_L (12%), L_E (11%), L_U (9%), S_M (7%), and S_P (6%). Thus, almost 55% of the population directly dependent on agricultural land (N) is *raiyats*, followed by sharecroppers and agricultural laborers (about 25% and 20% of N, respectively).

There is a social ranking among N broadly correlated with economic wellbeing (or agricultural productivity level): agricultural laborers (L), most of whom are below the poverty line, seek to become sharecroppers (S); similarly, sharecroppers near the poverty line, seek to acquire a piece of land and become *raiyats* (R), who are mostly above the poverty line. At the same time, if a sharecropper is evicted, he regresses to the level of agricultural laborer. In a similar fashion, a small *raiyat* can become a sharecropper by losing his rights over land. The disintegration of both farm and non-farm occupations is evident from Table 4.1. In districts like Howrah and Birbhum, which were more developed than the others were during the colonial period, many families with no prior farming experience took up sharecropping. On the other

[18] For instance, according to the 1944 Rural Survey by the Indian Statistical Institute, we obtain the following table.

	% of sharecropping families to all families	% of sharecroppers to cultivating families only		
		Landless sharecroppers	Mainly sharecroppers	Partly sharecroppers
Midnapore	6.5	12.4	13.3	20.4
Bankura	6.6	18.6	13.9	23.7
Hooghly	27.7	26.7	8.8	34.7
Howrah	17.1	13.6	6.3	9.1
24-Parganas	18.7	10.4	9.8	11.9
Nadia	6.7	7.1	10.6	26.1

hand, in Midnapore district, sharecropping status was more likely to be the outcome of a distress sale of land.

[Table 4.1 is about here]

To explore potential efficiency gains from *Operation Barga*, we focus on the two classes of *R* and *S*, since their farm management efficiency is directly linked to the agricultural productivity at the district level. Marshall argued that inefficient resource allocation under share tenancy prohibits it from reaching the optimum output, which is obtained only under cultivation by own labor. Thus, as a stylization of the pre-*Operation Barga* situation, we assume that R_{OL} is more efficient than S_M. Similarly, as hired labor is likely to be less efficient than own labor, R_{OL} is more efficient than R_{HL}. As Bardhan (1984) asserts, share tenancy is often interlinked with two factors: production credit contract explicitly and cost-sharing arrangements implicitly. Thus, we assume that S_P is more efficient than R_{HL}, even though both suffer from lack of motivation in the Marshallian sense. Therefore, on the Marshallian farm efficiency scale, R_{OL} is preferred to S_M and S_M is preferred to R_{HL}.

Among the sharecropping class, we assume that S_M (*mainly sharecroppers*) is the only sub-class that achieves the constrained maximum efficiency under sharecropping. This is because they make their living through farming, and eviction threat for this group is assumed to be less likely. On the other hand, S_P and S_L suffer from Marshallian inefficiency. S_P is less efficient than S_M because *partially sharecroppers*' main source of livelihood is gained other than by farming, and they do not exert enough effort on their farm. S_L is less efficient than S_M because *landless sharecroppers* have little capital for farm management and may give priority to off-farm wage work instead of working on their sharecropped land. The inefficiency of S_P and S_L implies that the landlord may have an incentive to evict them. To cope with such a threat, S_P and S_L need to expend the minimum effort to achieve an efficiency level that satisfies the landlord.

Next, we define agriculture productivity as the ratio of total agricultural output (Y) and total land area cultivated (L). Equation (4-1) presents agricultural productivity at the aggregate

level as the weighted average of agricultural productivity across different classes of farmers, where $\frac{L_i}{L}$ is the share of total land cultivated by the i[th] class:

$$\frac{Y}{L} = \sum_i \frac{Y_i}{L_i}\frac{L_i}{L} \qquad (4\text{-}1)$$

Based on the above argument, since Marshallian efficiency is achieved through R_{OL} or own labor farms, we can modify equation (4-1) with a discounting factor as shown in equation (4-1)', where $\delta_{R_{OL}}(=1) > \delta_{S_M} > \delta_{S_P} > \delta_{R_{HL}} > \delta_{S_L}$. The inequality among the last three groups is for convenience. The ranking among them does not affect our argument below. Laborer classes are absorbed in one or several types of cultivated land:

$$\frac{Y}{L} = \sum_i \delta_i \frac{Y}{L_i}\frac{L_i}{L} \qquad (4\text{-}1)'$$

The discounting factor reflects the average productivity, which is highest and equivalent to Marshallian efficiency for R_{OL}, followed by S_M, and then by R_{HL}, S_P and S_L, respectively. Using this simple framework, the direct target group or beneficiaries of *Operation Barga* are S_M, S_P, and S_L. We argue that the productivity effect of *Operation Barga* can take place through two channels: 1) the direct effect or changes within agrarian classes by improving the value of δ, and 2) indirect effects, through population shifts across agrarian classes. Next, we analyze the possibilities of each channel in turn.

4.2.1. Direct Effect: changes within agrarian classes (improvement of δ)

Operation Barga was meant to improve the production efficiency of *S* through the provision of secure tenancy rights and improvements in rental conditions (especially reductions of the land rent share; Bandyopadhyay, 1980). In most theoretical models of sharecropping, a reduction of the rent share leads to an improvement in efficiency (or, more precisely, does not lead to a reduction in efficiency). On the other hand, whether tenancy security *per se* leads to an improvement of sharecropping is theoretically ambiguous. It is generally argued that, if the share tenancy contract is insecure (with no eviction threat), tenants may not have strong incentives to

invest in improving farm productivity (Banerjee, Gertler and Ghatak, 2002). The two main effects can be summarized as follows:

a. Positive productivity effect on S_M (standard Marshallian inefficiency argument may dominate the effort-reducing effect of security).
b. Negative productivity effect on S_P and S_L is similar to a moral hazard problem, because the eviction threat was a binding factor to keep them at the minimum efficiency level, so that the reduction in the threat would lead to a decrease in their effort level on the sharecropped land.

Which effect was more likely to dominate? It depends on how many sharecroppers from S_P and S_L were included in the list of registered sharecroppers. About 65% of all sharecroppers were registered under *Operation Barga.* Selection bias and heterogeneous distribution of the gain among the beneficiaries might have occurred, favoring the large sharecroppers (Fujita, 2014), who are likely to belong to S_M. Even given these possibilities, the net effect is not likely to be positive because the population share of the sum of S_P and S_L was much larger than that of S_M.

4.2.2. Indirect effects: through population shifts across agrarian classes.

One way to gain productive efficiency through agrarian reforms is to convert R_{HL} into R_{OL}. The redistribution of surplus land attempts this conversion. However, as we discussed in Section 2, the land reform policy was unlikely to achieve this result. Another way is to convert S into R_{OL}. However, this was not included in the Left Front's land reform agenda. Transformation from one agrarian class to another could be possible in the following ways:

a. With higher marginal returns from sharecropping, some S_L sharecroppers may convert themselves into S_M, lending a positive impact on overall productivity. However, the lack of capital and farming experience among S_L may inhibit this conversion.
b. With larger amounts of rice from the sharecropped land, S_M sharecroppers may convert themselves into S_P, exerting a negative impact on overall productivity. This was more likely as rural economic activities were being diversified in West Bengal villages during this period (Rogaly et al., 1999), giving more opportunity for former S_M farmers to find non-farm jobs.

c. *Operation Barga* may reduce the supply of hired labor from sharecroppers, resulting in higher wages, contributing to the conversion of R_{HL} into R_{OL} and exerting a positive impact on overall productivity. We consider this possibility to be also highly unlikely, due mostly to the existence of L_U, a kind of unlimited supply of agricultural labor.

Overall, the net indirect effect of *OB* on productivity (if any) is not likely to be positive. *Operation Barga*'s capacity to contribute to agricultural productivity growth was heavily constrained by the heterogeneity within the sharecropping class. As a result, it seems reasonable to expect a negligible (or less than moderate) gain in agricultural output accruing because of it.

5. Conclusion

India remains a predominantly agrarian economy with a high level of land inequality. Land reform has been one of the top priorities in development policy since its independence in 1947. The state of West Bengal is among two states (the other is Kerala) where the success of land reform is widely hailed (Ghatak and Roy, 2007). In this context, this paper reevaluates the effect of *Operation Barga* on agricultural productivity in West Bengal. In light of the rich history of land reforms in the region, we carefully examine the pathways through which *Operation Barga* could have improved the agricultural yield. Using a transparent data-driven synthetic control method (Abadie, Diamond, and Hainmueller, 2010), we create counterfactual districts for each of the 15 West Bengal districts from a pool of 246 districts in 12 other states in India. Based on a number of observable characteristics for the period from 1960 to 1977, we find robust statistical evidence of a negligible effect of the tenancy reform on agricultural productivity growth. Using a theoretical framework considering different agrarian classes, including different types of sharecroppers prevalent in West Bengal, we spell out two channels. We find that a direct effect on sharecroppers (i.e., a reduction in Marshall–Mill sharecropping distortions due to *Operation Barga*) is incapable of improving the productivity level. The second channel relies on the possibilities for structural transformation across different classes. We provide evidence that these possibilities are also rare due to the prevailing agrarian structure and credit constraints. Together,

this heterogeneous group of sharecroppers points to the inherent limitations of *Operation Barga* program, which may have circumscribed its contribution to agricultural productivity growth.

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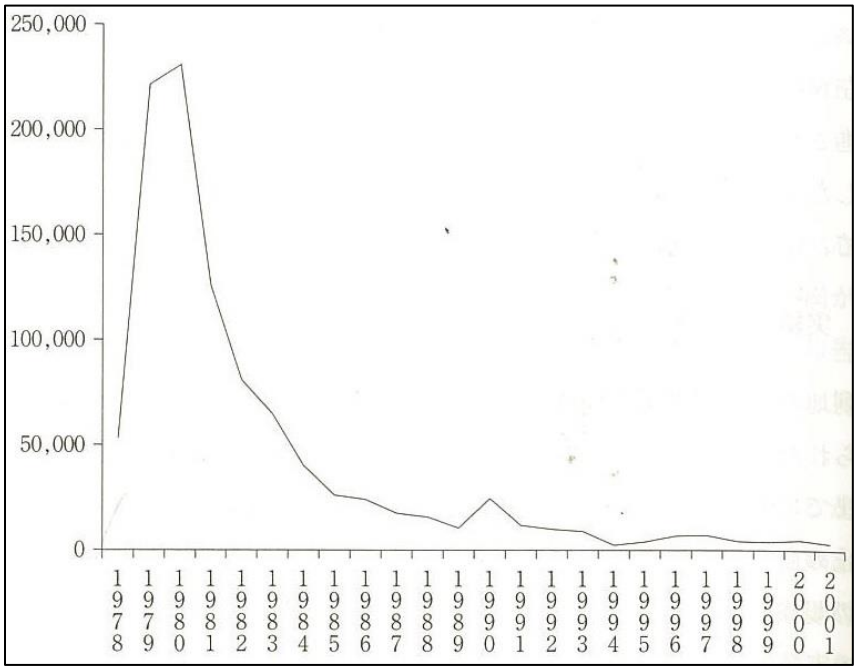
Table 2.1: The ratio of sharecropped land to the whole arable land (%)

District	Land Revenue Commission Report 1940	1951 Census	Survey by Basu and Bhattacharya 1960-1961
24-Parganas	22.3	13.3	26.0
Howrah	23.4	15.0	n.a.
Nadia	24.1	15.6	n.a.
Murshidabad	25.8	20.2	30.0
Burdwan	25.2	29.2	25.0
Birbhum	24.8	22.1	n.a.
Bankura	29.2	27.4	n.a.
Midnapore	17.1	19.0	36.0
Hoogly	30.5	20.4	n.a.
Purulia	n.a.	19.8	n.a.
Malda	9.6	18.2	27.0
West Dinajpur(*)	14.5	21.4	28.0
Cooch Behar	n.a.	19.8	31.0
Jalpaiguri	25.9	32.0	46.0
Darjeeling	n.a.	19.8	n.a.
West Bengal	22.5	20.3	n.a.

Note : (*): The values before independence are for the whole Dinajpur district before 1947.
Sources: Sato (1974)

Figure 2.1: Number of registered *bargadars* in each year under *Operation Barga*



Source: Fujita (2014). Original data from A.K. Chakraborti, *Beneficiaries of Land Reforms: The West Bengal Scenario*, Kalyani: State Institute of Panchayats & Rural Development, 2003, pp. 35-36.

Table 2.2: The number of registered *bargadars* by district

District	Estimated no. of *bargadars* (2) in 1,000 and its ratio to the agriculutral population in 1981 Census (%, (3))		Registration by Jan 1979	Registration by June 1984	Registration by Nov 2010	% of registered *bargadars* in 2010 to the estimated total in 1981
(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6)/((2)*10)
24-Parganas	340	27.9	75,443	162,062	189,226	55.7
Howrah	69	35.8	23,187	37,694	42,788	62.0
Nadia	104	21.9	24,439	51,502	64,512	62.0
Murshidabad	129	18.9	31,614	68,484	86,217	66.8
Burdwan	224	31.0	36,805	102,467	136,134	60.8
Birbhum	102	22.7	32,749	93,199	114,162	111.9
Bankura	113	21.7	40,709	95,445	116,922	103.5
Midnapore	476	32.6	88,678	290,800	319,219	67.1
Hoogly	162	30.8	42,433	89,277	114,652	70.8
Purulia	n.a.	n.a.	n.a.	63	9,348	n.a.
Malda	99	24.0	46,421	73,654	81,992	82.8
West Dinajpur	127	21.7	55,164	94,474	103,932	81.8
Cooch Behar	139	34.3	35,405	70,252	85,127	61.2
Jalpaiguri	194	56.2	31,777	54,747	61,385	31.6
Darjeeling	32	25.5	7,870	12,015	12,879	40.2
total	2,310	26.9	572,694	1,296,135	1,538,495	66.6

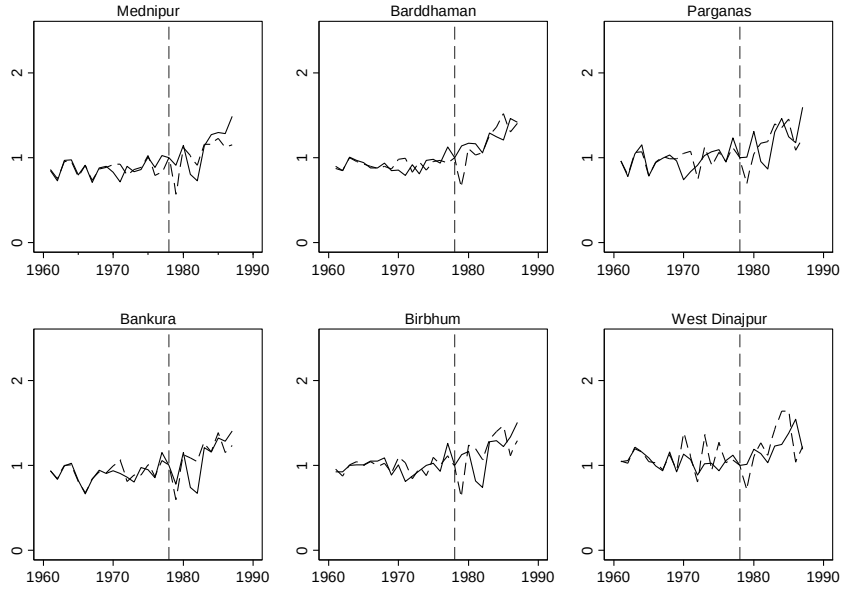
Sources:
(2), (3): Ratam Ghash, "Agrarian Programme of Left Front Government," EPW, June 20-27, 1981, Review of Agriculture, p.A-50
(4): Govt. of West Bengal, "Land Reforms in West Bengal, Statistical Report," 1979, p.14
(5): B. Chattopadhyay and CRESSIDA Research Team 1985), Consolidated Table 1
(6): Government of West Bengal, *Economic Review 2010-11*, Statistical Appendix, pp.98-99.
Note: The names and boundaries of districts are those in 1965 and remained intact until1986. In 1986, 24-Parganas was divided into 2 districts; in 1992, West Dinajpur was divided into 2 districts; and in 2002, Midnapore was divided into 2 districts.

Table 2.3: The area operated by registered *bargadars* by district

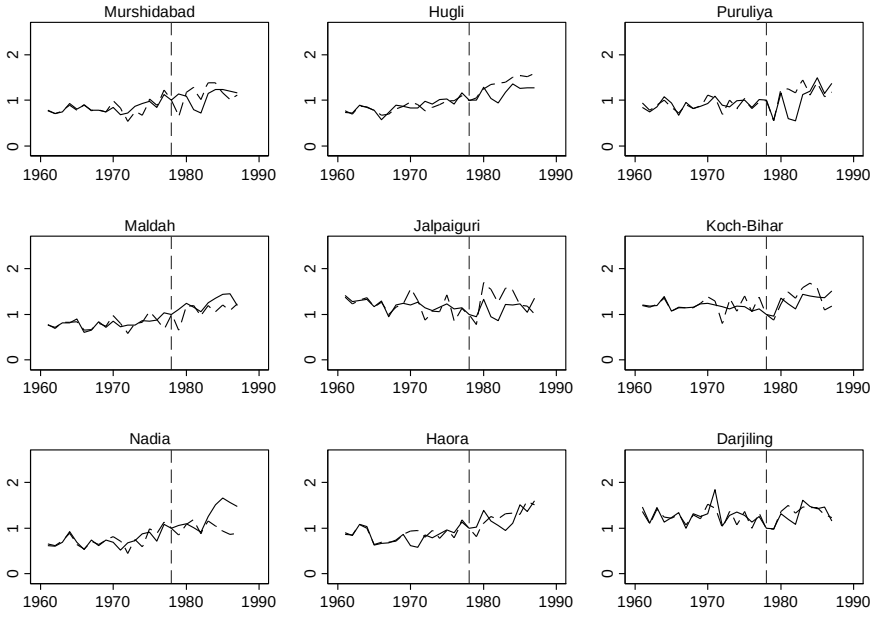
District	Number of registered *bargadars* by Nov 2010	Sharecropped land operated by registered *bargadars* by Nov 2010 (ha)	Average per *bargadar* (ha)	Net cultivated area, average 1976-78 (1,000 ha)	% of registered land to the net cultivate area
(1)	(2)	(3)	(4)=(3)/(2)	(5)	(6)=(3)/((5)*10)
24-Parganas	189,226	54,161	0.29	702.0	7.7
Howrah	42,788	10,074	0.24	94.6	10.6
Nadia	64,512	18,901	0.29	323.0	5.9
Murshidabad	86,217	27,233	0.32	423.6	6.4
Burdwan	136,134	48,139	0.35	488.2	9.9
Birbhum	114,162	46,557	0.41	345.7	13.5
Bankura	116,922	27,180	0.23	362.9	7.5
Midnapore	319,219	52,751	0.17	860.5	6.1
Hoogly	114,652	25,355	0.22	234.0	10.8
Purulia	9,348	3,447	0.37	304.2	1.1
Malda	81,992	32,085	0.39	292.6	11.0
West Dinajpur	103,932	30,758	0.30	461.6	6.7
Cooch Behar	85,127	33,838	0.40	262.7	12.9
Jalpaiguri	61,385	39,109	0.64	322.2	12.1
Darjeeling	12,879	7,013	0.54	47.2	14.9
Total	1,538,495	456,601	0.30	5,525.0	8.3

Sources:
(2),(3): Government of West Bengal, Economic Review 2010-11, Statistical Appendix, pp.98-99.
(5): ICRSIAT-DLS database.
Note: See Table 2.2.

Figure 3.1: Using districts in states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units]



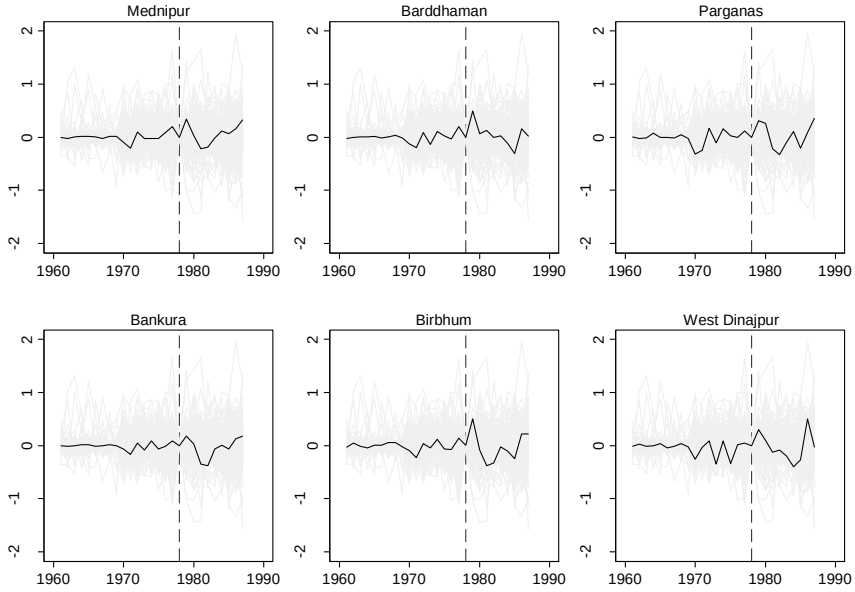
A. The six-largest rice-producing districts



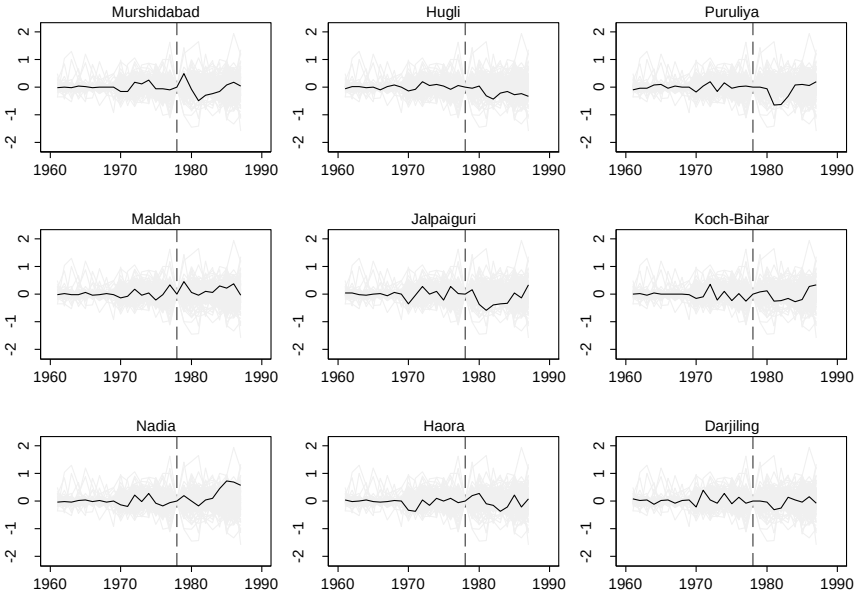
B. Other districts (tons per hectare)

Notes: The vertical axis is rice yield. In both panels, the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit.

Figure 3.2: The effects of tenancy reform in West Bengal's districts (tons per hectare) [Using districts in states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units]



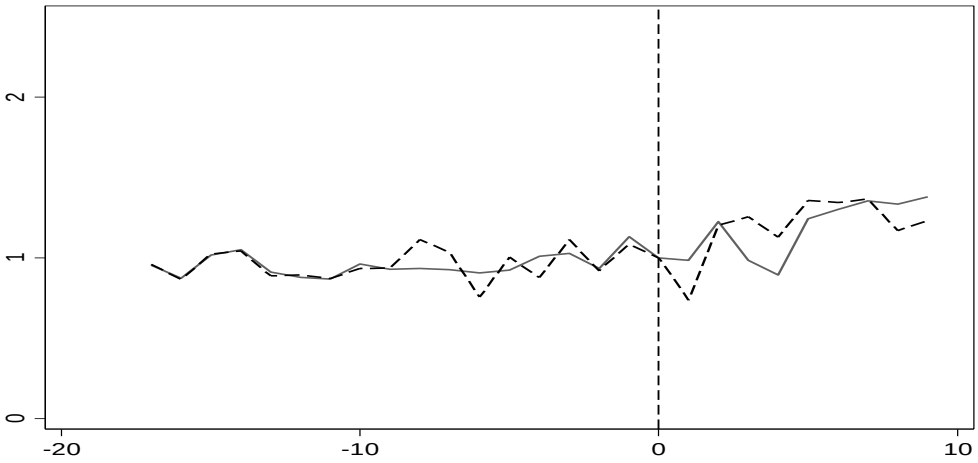
A. The six-largest rice-producing districts



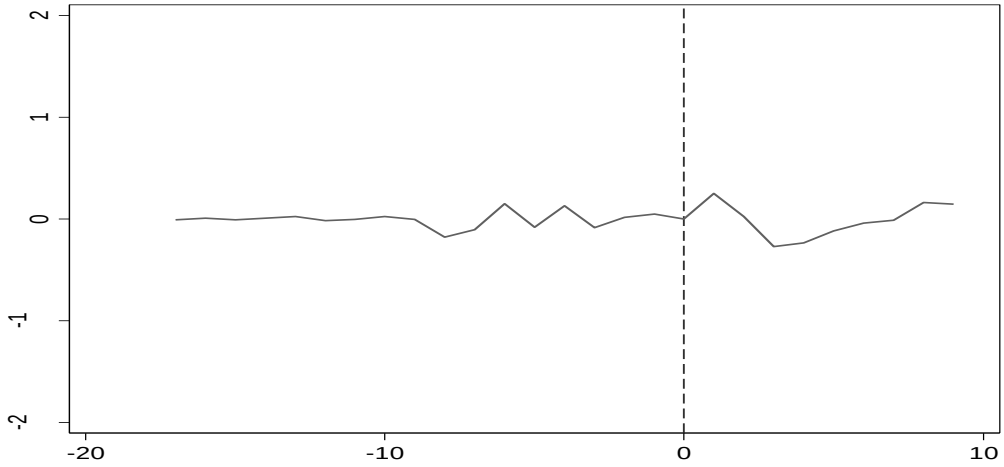
B. Other districts

Notes: In both panels, the grey lines are the placebo effects. The vertical dash-line is the year 1978. In Panel (3.2.b), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.1.

Figure 3.3: The average effects of the tenancy reforms across all 15 districts (tons per hectare)
[Using districts in states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units



A. The trend of rice yield

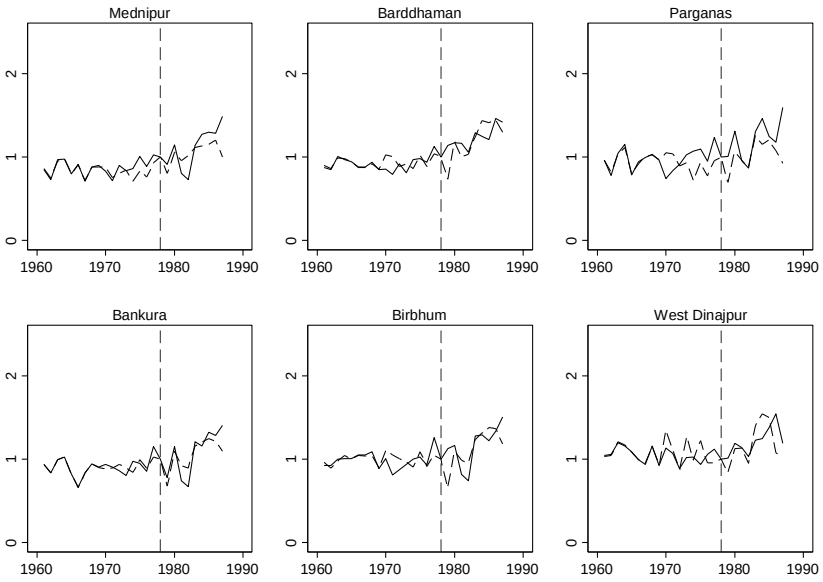


B. The effects of the tenancy reform

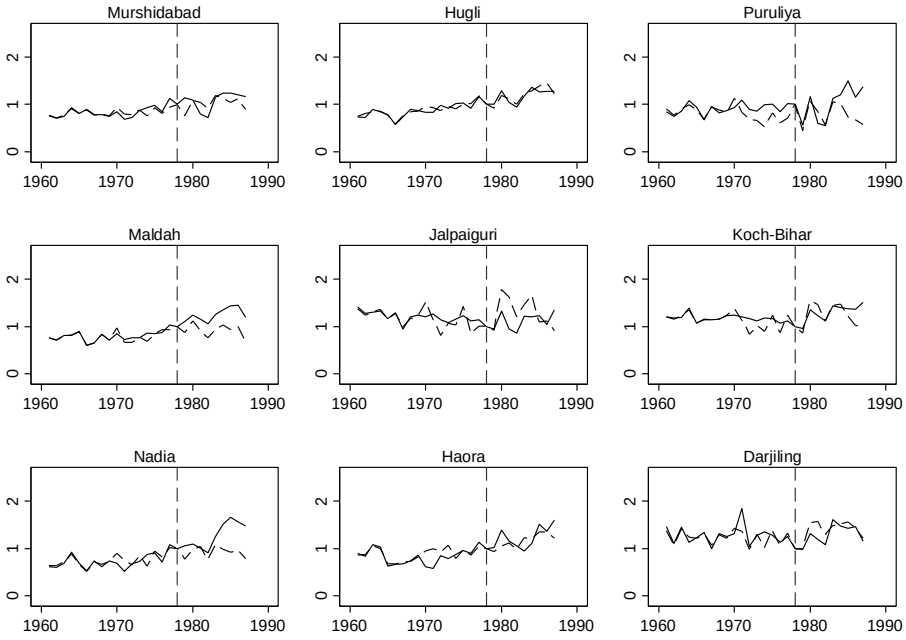
Notes: The vertical axis is rice yield. In both panels, "0 "indicates the year 1977.

Notes: The vertical axis is rice yield. In Panels (a) and (b), the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit. The grey lines in Panel (b) are the placebo effects. The vertical dash-line is the year 1978. In Panel (c), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.1.

Figure 3.4: The trends of rice yield in West Bengal's districts (tons per hectare) [Using all districts in the pool of control units]



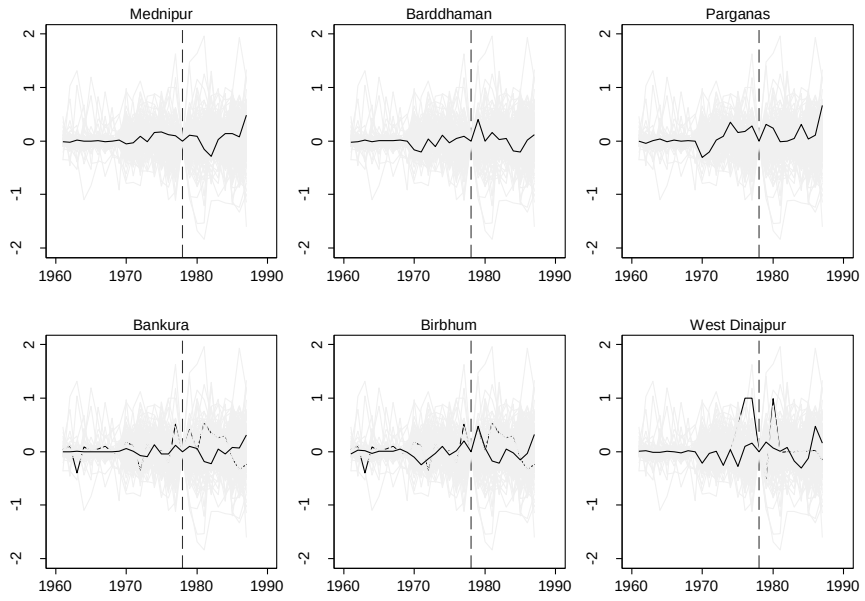
A. The six-largest rice-producing districts



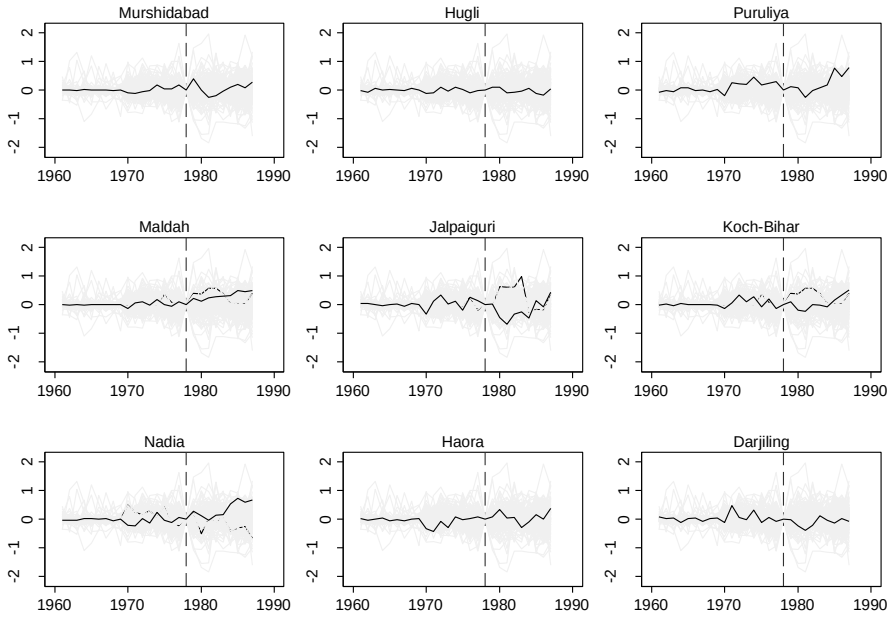
B. Other districts (tons per hectare)

Notes: The vertical axis is rice yield. In both panels, the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit.

Figure 3.5: The effects of tenancy reform in West Bengal's districts (tons per hectare) [Using all districts in the pool of control units]



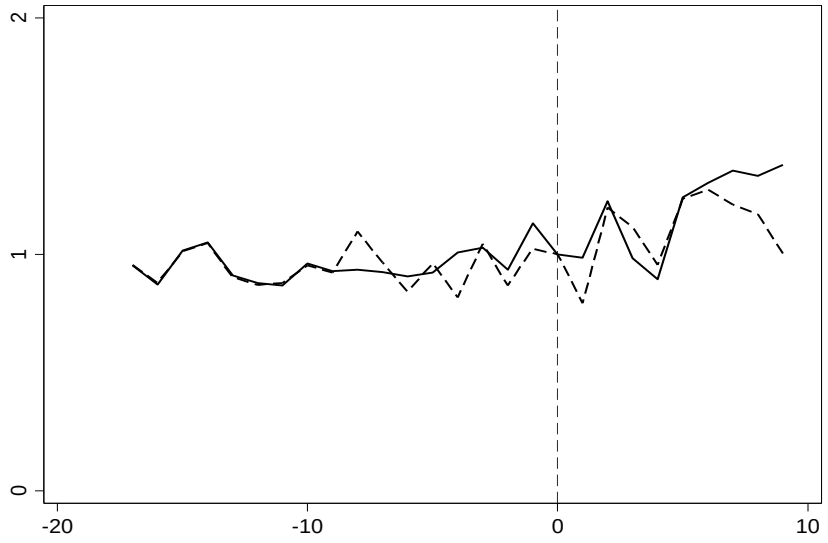
A. The six-largest rice-producing districts



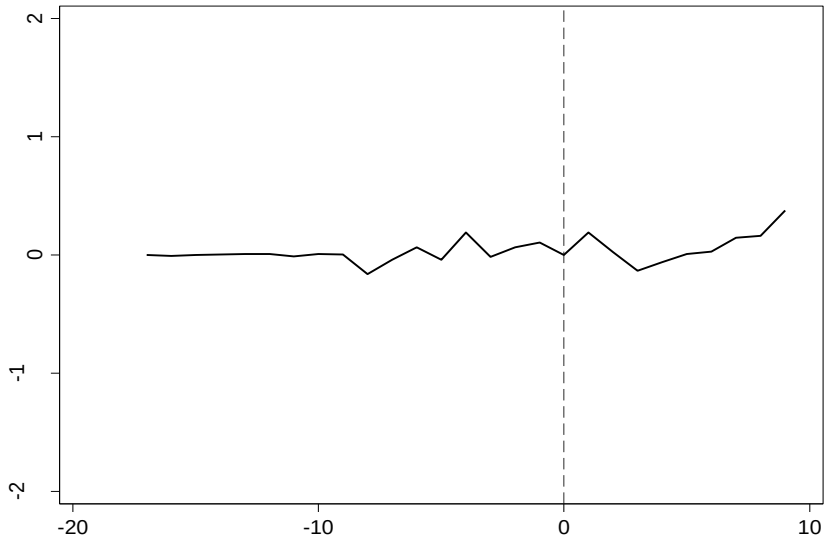
B. Other districts

Notes: In both panels, the grey lines are the placebo effects. The vertical dash-line is the year 1978. In Panel (3.2.b), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.2.

Figure 3.6: The average effects of the tenancy reforms across all 15 districts (tons per hectare)
[Using all districts in the pool of control units]



A. The trend of rice yield

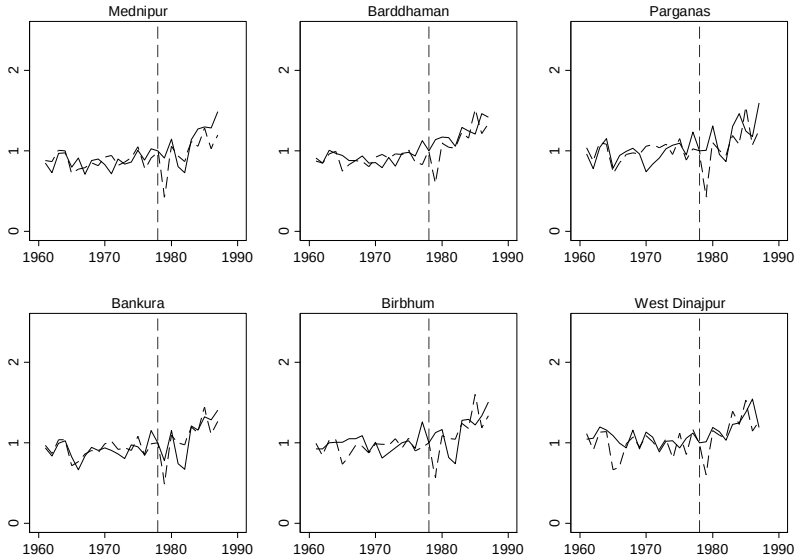


B. The effects of the tenancy reform

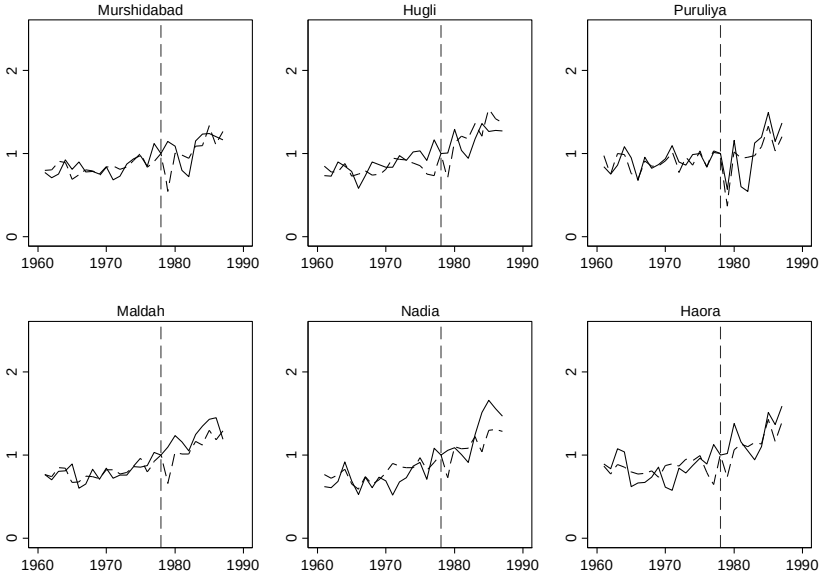
Notes: The vertical axis is rice yield. In Panels (a) and (b), the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit. The grey lines in Panel (b) are the placebo effects. The vertical dash-line is the year 1978. In Panel (c), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.2.

Figure 3.7: The effects of tenancy reform in West Bengal's districts (tons per hectare) [Using districts in crop-zone states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units]

(a) The trends of rice yield in West Bengal's districts (tons per hectare)



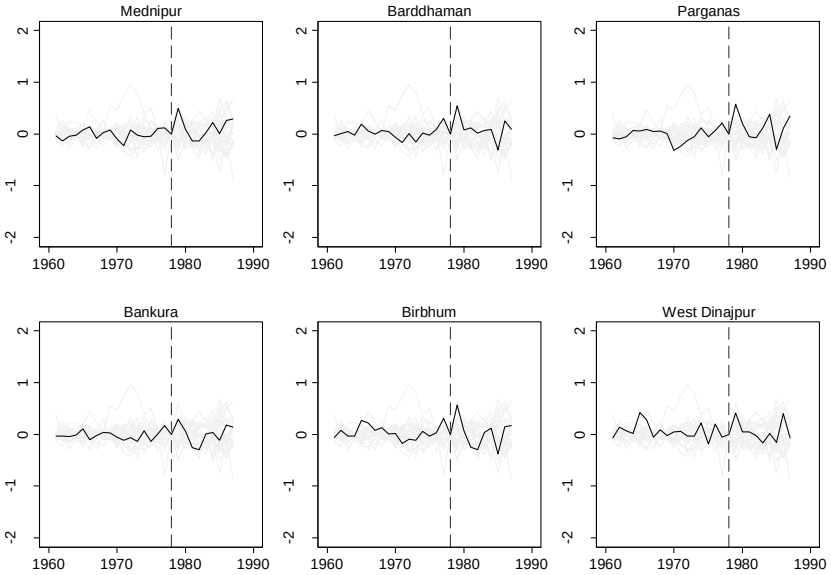
A. The six-largest rice-producing districts



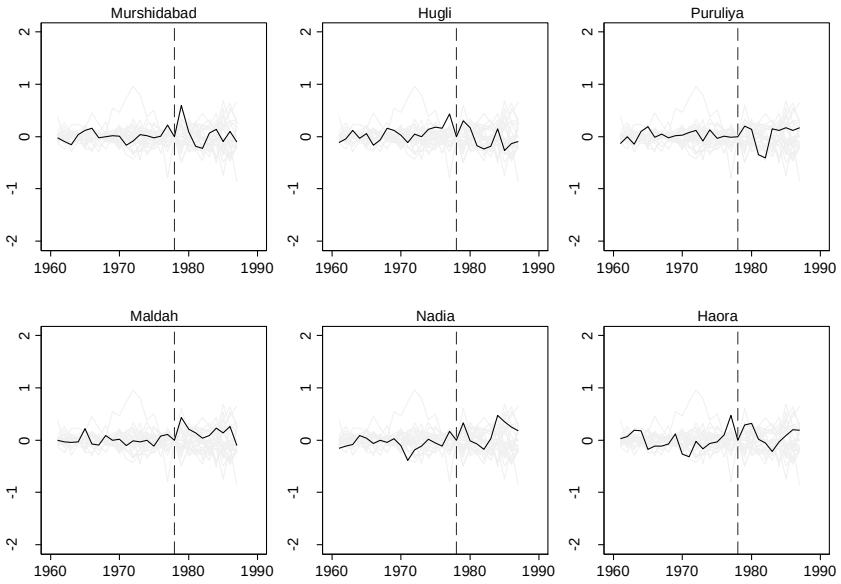
B. Other districts (tons per hectare)

Notes: The vertical axis is rice yield. In both panels, the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit.

Figure 3.8: The effects of tenancy reform in West Bengal's districts (tons per hectare) [Using districts in crop-zone states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units]



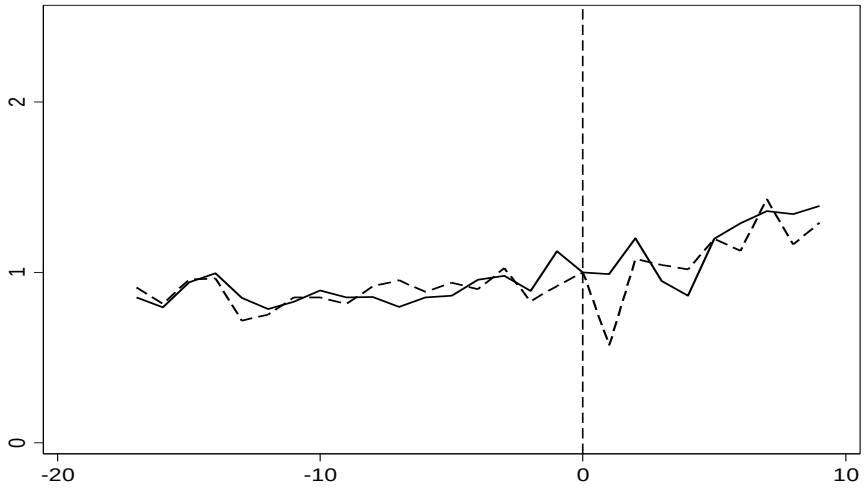
The six-largest rice-producing districts



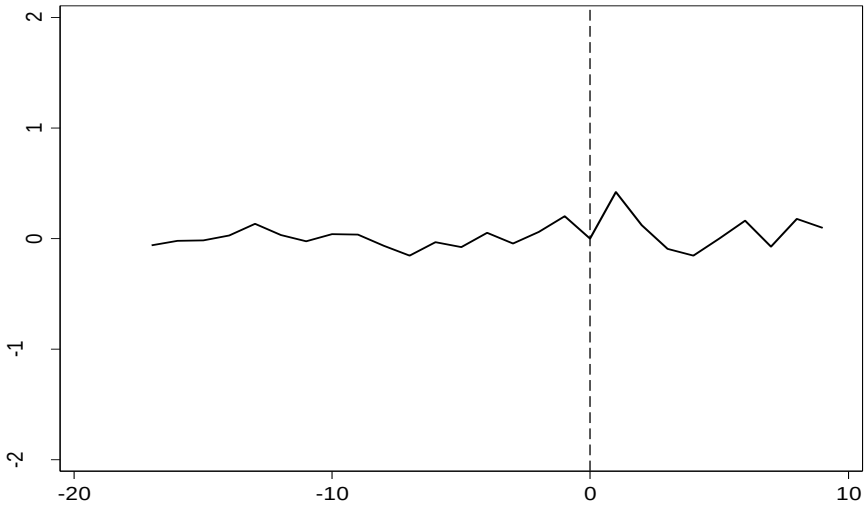
(b.2) Other districts

Notes: In both panels, the grey lines are the placebo effects. The vertical dash-line is the year 1978. In Panel (3.2.b), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.3.

Figure 3.9: The average effects of the tenancy reforms across all 15 districts (tons per hectare)
[Using districts in crop-zone states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units]



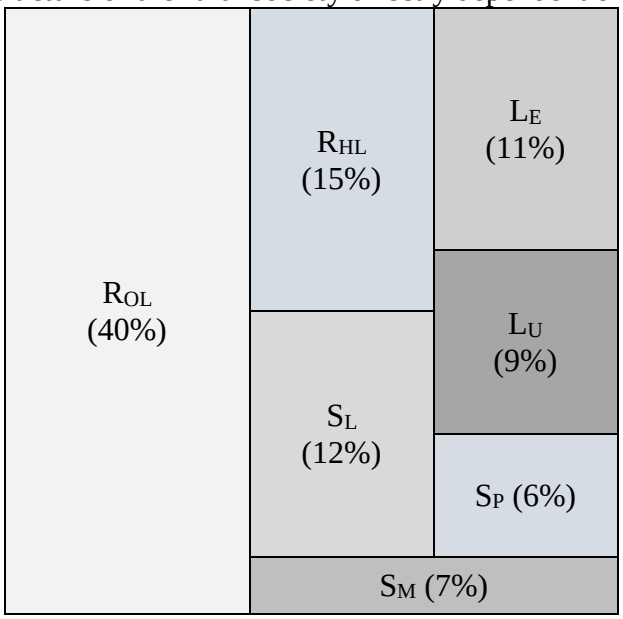
A. The trend of rice yield



B. The effects of the tenancy reform

Notes: The vertical axis is rice yield. In Panels (a) and (b), the solid line is the average trend of rice yield in West Bengal; the dash line that in the synthetic control unit. The grey lines in Panel (b) are the placebo effects. The vertical dash-line is the year 1978. In Panel (c), "0 "indicates the year 1987. We provide the statistics for statistical inferences in Table A.3.

Figure 4.1: The structure of the rural society directly dependent on agricultural land



Source: Authors' own compilation based on Ghosh and Dutt (1977).

Table 4.1: Sharecropping as livelihood opportunity against prior farming experiences

	Before 1925	1926-29	1930-39	1940-45	1946-52
	% of families taking up sharecropping with no prior cultivating experience				
Howrah	10.37	10.33	15.14	23.32	0.46
Birbhum	30.7	0.55	0.27	0.24	40.54
Midnapur	10.5	0.1	0.1	0.26	0.11
	% of families cultivated own land prior to sharecropping				
Howrah	20.31	0	0.5	0.44	10.19
Birbhum	20.12	0.1	0.24	0.2	20.25
Midnapur	30.23	0.3	9.24	0.72	20.26

Source: Ghosh and Dutt (1977), page 125

Appendix 1: Using districts in states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units

	Med	Bar	Par	Ban	Bir	Din	Mur	Hug	Pur	Mal	Jal	Koc	Nad	Hao	Dar	Average
A. Estimates																
Lead 1	0.34	0.49	0.31	0.18	0.51	0.30	0.50	-0.04	0.01	0.45	0.17	0.08	0.21	0.21	0.02	0.25
Lead 2	0.02	0.06	0.26	0.02	-0.08	0.09	-0.08	0.04	-0.05	0.06	-0.37	0.11	0.01	0.28	-0.04	0.02
Lead 3	-0.22	0.13	-0.22	-0.35	-0.38	-0.13	-0.49	-0.32	-0.65	-0.03	-0.59	-0.26	-0.18	-0.09	-0.31	-0.27
Lead 4	-0.18	0.00	-0.33	-0.37	-0.33	-0.08	-0.30	-0.42	-0.62	0.10	-0.40	-0.23	0.04	-0.15	-0.24	-0.23
Lead 5	-0.02	0.03	-0.09	-0.06	-0.03	-0.20	-0.23	-0.22	-0.33	0.06	-0.35	-0.16	0.10	-0.38	0.15	-0.12
Lead 6	0.11	-0.11	0.11	0.01	-0.11	-0.39	-0.16	-0.15	0.09	0.29	-0.32	-0.28	0.47	-0.22	0.04	-0.04
Lead 7	0.07	-0.31	-0.21	-0.06	-0.25	-0.26	0.08	-0.28	0.10	0.23	0.04	-0.20	0.73	0.22	-0.03	-0.01
Lead 8	0.16	0.16	0.09	0.13	0.22	0.51	0.19	-0.24	0.07	0.37	-0.13	0.27	0.70	-0.22	0.17	0.16
Lead 9	0.33	0.01	0.36	0.18	0.22	-0.04	0.05	-0.32	0.19	-0.03	0.34	0.33	0.58	0.08	-0.08	0.15
B. The proportions of placebo effects that are at least as large as the main effect																
Lead 1	0.20	0.08	0.23	0.44	0.07	0.24	0.07	0.80	0.93	0.12	0.47	0.70	0.39	0.40	0.92	0.002
Lead 2	0.92	0.78	0.27	0.91	0.75	0.68	0.71	0.88	0.80	0.79	0.15	0.58	0.97	0.26	0.86	0.78
Lead 3	0.35	0.54	0.35	0.16	0.14	0.54	0.09	0.21	0.03	0.84	0.04	0.28	0.40	0.68	0.22	0.002
Lead 4	0.47	0.98	0.26	0.19	0.26	0.79	0.28	0.14	0.04	0.72	0.17	0.37	0.92	0.54	0.37	0.01
Lead 5	0.91	0.89	0.70	0.76	0.89	0.35	0.27	0.31	0.16	0.78	0.15	0.48	0.67	0.13	0.53	0.11
Lead 6	0.64	0.64	0.65	1.00	0.65	0.14	0.55	0.56	0.70	0.27	0.25	0.30	0.10	0.41	0.88	0.61
Lead 7	0.80	0.35	0.54	0.80	0.47	0.43	0.78	0.40	0.74	0.50	0.89	0.56	0.08	0.53	0.89	0.92
Lead 8	0.59	0.59	0.75	0.65	0.45	0.16	0.53	0.42	0.81	0.22	0.67	0.38	0.04	0.45	0.57	0.08
Lead 9	0.30	0.98	0.28	0.54	0.48	0.94	0.90	0.30	0.54	0.94	0.30	0.30	0.13	0.80	0.81	0.18
C. The proportions of placebo pseudo t-statistics that are at least as large as the main pseudo t-statistic																
Lead 1	0.04	0.005	0.18	0.12	0.005	0.24	0.01	0.75	0.93	0.05	0.49	0.73	0.31	0.36	0.94	0.000
Lead 2	0.88	0.68	0.22	0.81	0.58	0.69	0.62	0.81	0.76	0.78	0.16	0.64	0.96	0.24	0.86	0.72
Lead 3	0.15	0.42	0.32	0.02	0.05	0.58	0.05	0.07	0.01	0.83	0.06	0.32	0.40	0.69	0.24	0.000
Lead 4	0.25	0.98	0.17	0.02	0.09	0.74	0.14	0.06	0.02	0.68	0.16	0.42	0.90	0.54	0.39	0.002
Lead 5	0.89	0.87	0.63	0.48	0.85	0.35	0.18	0.15	0.08	0.78	0.17	0.46	0.60	0.12	0.51	0.07
Lead 6	0.47	0.52	0.64	0.96	0.52	0.14	0.41	0.35	0.64	0.20	0.25	0.30	0.06	0.38	0.90	0.61
Lead 7	0.74	0.13	0.50	0.65	0.23	0.45	0.75	0.14	0.67	0.43	0.92	0.58	0.03	0.51	0.92	0.78
Lead 8	0.37	0.44	0.73	0.29	0.22	0.13	0.42	0.20	0.74	0.17	0.68	0.39	0.02	0.47	0.60	0.03
Lead 9	0.13	0.98	0.23	0.24	0.30	0.94	0.87	0.16	0.40	0.94	0.33	0.35	0.08	0.80	0.83	0.11

Notes: We indicate the districts using the first three letters of their names. The estimates of the effects are in tons per hectare. The proportions are analogous to the p-values. The last column is for the averages across all 15 West Bengal's districts.

Appendix 2: Using all districts in the pool of control units

	Med	Bar	Par	Ban	Bir	Din	Mur	Hug	Pur	Mal	Jal	Koc	Nad	Hao	Dar
A. Estimates															
Lead 1	0.11	0.41	0.31	0.10	0.48	0.18	0.39	0.09	0.12	0.22	0.03	0.10	0.28	0.09	-0.01
Lead 2	0.08	-0.01	0.24	0.06	0.07	0.07	0.00	0.10	0.08	0.12	-0.45	-0.20	0.12	0.33	-0.23
Lead 3	-0.15	0.16	-0.01	-0.18	-0.17	0.01	-0.25	-0.09	-0.25	0.25	-0.68	-0.23	-0.04	0.04	-0.38
Lead 4	-0.29	0.02	0.00	-0.22	-0.21	0.08	-0.19	-0.07	-0.01	0.29	-0.34	0.01	0.15	0.07	-0.22
Lead 5	0.03	0.05	0.05	0.05	0.04	-0.17	-0.03	-0.05	0.07	0.31	-0.24	-0.01	0.17	-0.29	0.13
Lead 6	0.14	-0.18	0.31	-0.04	-0.03	-0.30	0.09	0.07	0.18	0.31	-0.46	-0.08	0.53	-0.10	-0.03
Lead 7	0.14	-0.20	0.04	0.07	-0.16	-0.12	0.19	-0.12	0.76	0.50	0.14	0.16	0.74	0.16	-0.14
Lead 8	0.08	0.02	0.10	0.07	-0.03	0.47	0.08	-0.17	0.47	0.45	-0.07	0.34	0.59	0.01	0.03
Lead 9	0.48	0.12	0.67	0.31	0.32	0.16	0.27	0.04	0.79	0.50	0.43	0.52	0.68	0.38	-0.07
B. The proportions of placebo effects that are at least as large as the main effect															
Lead 1	0.63	0.15	0.23	0.65	0.09	0.49	0.17	0.70	0.61	0.38	0.89	0.67	0.27	0.70	0.96
Lead 2	0.71	0.99	0.29	0.79	0.78	0.78	1.00	0.65	0.73	0.60	0.11	0.37	0.58	0.18	0.32
Lead 3	0.48	0.46	0.94	0.42	0.45	0.96	0.32	0.70	0.32	0.33	0.05	0.35	0.85	0.85	0.15
Lead 4	0.30	0.94	0.98	0.41	0.43	0.79	0.49	0.83	0.97	0.29	0.23	0.97	0.56	0.81	0.42
Lead 5	0.92	0.84	0.85	0.85	0.86	0.45	0.91	0.85	0.78	0.19	0.29	0.97	0.45	0.22	0.61
Lead 6	0.58	0.44	0.24	0.86	0.89	0.25	0.69	0.76	0.45	0.24	0.11	0.75	0.07	0.69	0.88
Lead 7	0.67	0.54	0.87	0.81	0.63	0.73	0.57	0.72	0.06	0.16	0.68	0.63	0.08	0.62	0.68
Lead 8	0.76	0.96	0.71	0.79	0.89	0.16	0.76	0.59	0.16	0.17	0.78	0.30	0.09	0.97	0.92
Lead 9	0.17	0.69	0.09	0.35	0.35	0.61	0.41	0.90	0.04	0.15	0.22	0.14	0.09	0.29	0.85
C. The proportions of placebo pseudo t-statistics that are at least as large as the main pseudo t-statistic															
Lead 1	0.43	0.02	0.30	0.35	0.02	0.43	0.01	0.45	0.72	0.10	0.91	0.67	0.20	0.76	0.96
Lead 2	0.48	0.96	0.35	0.51	0.67	0.76	1.00	0.35	0.82	0.31	0.13	0.37	0.48	0.23	0.38
Lead 3	0.30	0.32	0.95	0.11	0.34	0.96	0.10	0.46	0.46	0.08	0.06	0.35	0.83	0.87	0.23
Lead 4	0.09	0.92	0.98	0.09	0.27	0.72	0.21	0.61	0.97	0.09	0.27	0.97	0.49	0.83	0.49
Lead 5	0.88	0.72	0.90	0.60	0.83	0.39	0.85	0.68	0.86	0.04	0.36	0.98	0.36	0.28	0.60
Lead 6	0.31	0.22	0.29	0.73	0.89	0.18	0.54	0.58	0.63	0.04	0.13	0.77	0.02	0.76	0.91
Lead 7	0.47	0.30	0.91	0.60	0.52	0.69	0.28	0.47	0.11	0.01	0.73	0.63	0.02	0.68	0.73
Lead 8	0.63	0.94	0.74	0.60	0.87	0.11	0.64	0.25	0.26	0.02	0.83	0.26	0.04	0.96	0.95
Lead 9	0.03	0.54	0.13	0.06	0.20	0.55	0.19	0.80	0.13	0.02	0.28	0.17	0.04	0.35	0.85

Notes: We indicate the districts using the first three letters of their names. The estimates of the effects are in tons per hectare. The proportions are analogous to the p-values.

Appendix 3: Using districts in crop-zone states whose cumulative number of tenancy reforms in 1987 is two or fewer in the pool of control units

	Med	Bar	Par	Ban	Bir	Din	Mur	Hug	Pur	Mal	Jal	Koc	Average
A. Estimates													
Lead 1	0.49	0.55	0.58	0.29	0.56	0.41	0.60	0.30	0.20	0.44	0.33	0.29	0.42
Lead 2	0.08	0.08	0.20	0.06	0.07	0.04	0.08	0.17	0.14	0.21	-0.01	0.32	0.12
Lead 3	-0.14	0.12	-0.05	-0.26	-0.24	0.04	-0.18	-0.17	-0.34	0.14	-0.07	0.02	-0.09
Lead 4	-0.14	0.02	-0.08	-0.30	-0.30	-0.03	-0.22	-0.23	-0.41	0.04	-0.17	-0.05	-0.16
Lead 5	0.02	0.07	0.11	0.01	0.03	-0.17	0.06	-0.19	0.15	0.09	0.03	-0.21	0.00
Lead 6	0.22	0.09	0.38	0.04	0.12	0.01	0.14	0.15	0.11	0.23	0.47	-0.03	0.16
Lead 7	0.01	-0.31	-0.30	-0.12	-0.38	-0.15	-0.10	-0.26	0.17	0.14	0.36	0.08	-0.07
Lead 8	0.26	0.25	0.11	0.18	0.15	0.40	0.10	-0.14	0.12	0.26	0.25	0.20	0.18
Lead 9	0.29	0.09	0.35	0.14	0.17	-0.08	-0.10	-0.10	0.17	-0.10	0.18	0.19	0.10
B. The proportions of placebo effects that are at least as large as the main effect													
Lead 1	0.08	0.04	0.04	0.25	0.04	0.13	0.04	0.25	0.46	0.13	0.21	0.25	0.000
Lead 2	0.75	0.75	0.29	0.88	0.75	0.96	0.75	0.42	0.46	0.29	1.00	0.04	0.02
Lead 3	0.54	0.58	0.79	0.13	0.25	0.88	0.50	0.50	0.00	0.54	0.71	0.92	0.07
Lead 4	0.63	0.88	0.67	0.13	0.13	0.88	0.21	0.21	0.08	0.79	0.46	0.79	0.02
Lead 5	0.88	0.71	0.67	0.92	0.75	0.42	0.75	0.33	0.54	0.71	0.83	0.25	0.99
Lead 6	0.29	0.58	0.17	0.75	0.38	0.83	0.38	0.38	0.38	0.29	0.04	0.79	0.02
Lead 7	1.00	0.33	0.33	0.83	0.25	0.71	0.83	0.38	0.63	0.75	0.25	0.92	0.45
Lead 8	0.46	0.46	0.71	0.63	0.63	0.21	0.71	0.67	0.71	0.46	0.46	0.54	0.04
Lead 9	0.17	0.83	0.08	0.71	0.54	0.83	0.79	0.79	0.58	0.79	0.50	0.50	0.23
C. The proportions of placebo pseudo t-statistics that are at least as large as the main pseudo t-statistic													
Lead 1	0.00	0.000	0.00	0.13	0.04	0.21	0.00	0.29	0.25	0.00	0.21	0.46	0.000
Lead 2	0.63	0.67	0.29	0.67	0.79	0.92	0.63	0.50	0.29	0.13	1.00	0.29	0.03
Lead 3	0.46	0.58	0.71	0.13	0.33	0.88	0.33	0.58	0.00	0.33	0.67	0.92	0.07
Lead 4	0.50	0.83	0.67	0.00	0.25	0.83	0.21	0.46	0.00	0.67	0.54	0.83	0.004
Lead 5	0.79	0.67	0.63	0.88	0.79	0.54	0.67	0.46	0.38	0.54	0.88	0.54	0.78
Lead 6	0.13	0.50	0.04	0.71	0.50	0.92	0.25	0.46	0.29	0.04	0.00	0.83	0.001
Lead 7	1.00	0.29	0.33	0.63	0.29	0.71	0.71	0.54	0.54	0.54	0.33	0.92	0.49
Lead 8	0.38	0.42	0.67	0.42	0.63	0.38	0.67	0.67	0.63	0.29	0.46	0.63	0.07
Lead 9	0.13	0.71	0.13	0.50	0.67	0.79	0.71	0.71	0.42	0.67	0.67	0.71	0.24

Notes: We indicate the districts using the first three letters of their names. The estimates of the effects are in tons per hectare. The proportions are analogous to the p-values. The last column is for the averages across all 12 West Bengal's district.