Cooperative Property Rights and Development: Evidence from Land Reform in El Salvador

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In cooperative property rights systems, workers jointly own and manage production, whereas in outside-ownership systems, an owner contracts workers. Despite a rich literature on how the allocation of property rights matters for specialization, efficiency, and equity, little causal evidence exists. During a land reform in El Salvador in 1980, the military government reorganized properties owned by individuals with cumulative landholdings over 500 hectares into cooperatives; properties below this threshold remained as outside-owned properties. Using the discontinuous probability of cooperative formation, I provide evidence on the effects of cooperative property rights relative to outside ownership on specialization, productivity, and worker equity.

I. Introduction

Across the world and throughout history, we observe many types of ownership structures (Otsuka, Chuma, and Hayami 1992; Hansmann 1996). Instead of relying only outside ownership, where owners contract workers, societies have often used cooperative ownership, where workers jointly

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own and manage production on a one-member, one-vote basis. Cooperative ownership is prevalent in many settings, such as at US law firms (partnerships), in timber production in the Pacific northwest in the United States, firms in Uruguay and Italy, and in the kibbutz system in Israel (Dow 2003; Pencavel 2013a). Cooperatives are a particularly common ownership arrangement in Latin America, where over half of Latin American countries have attempted land reforms that sought to create agricultural cooperatives with various economic and political goals (see fig. 1).[1]

A key economic benefit to giving workers ownership stakes and decision-making rights, as is found in cooperative property rights systems, is that such arrangements may have beneficial incentive and equity effects (Kandel and Lazear 1992). Economic theory suggests that cooperative property rights may increase both equity and efficiency by making workers more of the residual claimants of their effort (e.g., Sen 1966; Bonin, Jones, and Putterman 1993). However, profit sharing between workers may also lead to free-riding problems within a firm, possibly negating the incentive and equity effects from cooperative ownership (e.g., Holmstrom 1982). Despite this rich theoretical literature on the possible implications of cooperative property rights for efficiency and equity, there is little causal evidence on their impacts.

The main empirical challenge when studying the impacts of cooperative property rights relative to outside ownership is that property rights arrangements are not randomly assigned. The choice of property rights system may reflect the underlying characteristics, such as geography, capital requirements, or cultural practices. These characteristics may also affect outcomes such as productivity. This means that one cannot compare all cooperatives to noncooperatives to identify the impacts of cooperative property rights. This empirical challenge has left a considerable gap in the research on the implications of cooperative ownership relative to outside ownership (Putterman 1991; Bonin, Jones, and Putterman 1993; Pencavel 2013a).

This paper exploits unique features of a land reform program from El Salvador in 1980 to study the causal impacts of cooperative property rights

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[1] These reforms were generally implemented during a time of crisis, in particular civil conflict, and also had important political motives: increasing political support from workers, and reducing the power of the agrarian elite.

FIG. 1.—Land reforms that redistributed haciendas as cooperatives. Figure constructed using de Janvry (1981) and Albertus (2015).

on agricultural choices, productivity, and worker equity. Prior to the land reform, almost all of El Salvador's agricultural production was organized in the form of haciendas, where land owners contract workers. During the land reform, properties belonging to individuals with cumulative landholdings over 500 hectares (ha) were expropriated by the military; the military then reorganized the properties into cooperatives managed by the former hacienda workers. However, properties belonging to individuals with cumulative land holdings under 500 ha remained as outside-owned haciendas.

The El Salvador land reform had two important features that provide discontinuous variation in the probability of cooperative formation that I use to identify the causal impacts of cooperative property rights on economic outcomes. First, the cumulative ownership threshold of 500 ha

creates a set of similar properties, some of which happen to be owned by someone with more than 500 ha in total holdings and were therefore expropriated, and some which were owned by someone with cumulative holdings just below the threshold and therefore were not expropriated. Importantly, since the ownership rule was defined by cumulative holdings and not by characteristics of each individual property, I am not comparing large properties to small properties, but rather properties of similar sizes. The second key feature of the land reform is that the military executed the reform swiftly and took multiple steps to ensure its secrecy prior to its implementation. This prevented large landholders from being able to selectively adjust their cumulative landholdings to avoid expropriation prior to the implementation of the reform.

I use the 500 ha threshold rule from El Salvador's land reform law and a regression discontinuity (RD) design to compare properties that were expropriated and converted to cooperatives to those that were not expropriated but were similar prior to the reform to estimate the economic impacts of cooperative property rights relative to the private ownership system (haciendas). In line with the RD identifying assumptions, I find no evidence that landholders selectively sorted around the threshold to avoid expropriation, and I show that properties near the cumulative landholding threshold of 500 ha are similar in terms of geographic characteristics. I test whether the government enforced the threshold rule using historical government records on the reform. I find most properties above the threshold were successfully reorganized as agricultural cooperatives.

To guide the empirical analysis, I present a simple agency model comparing cooperative ownership to outside ownership (haciendas) that offers predictions on how property rights regimes impact agricultural choices, productivity, and worker incomes. The model has two key features. First, employment contracts are incomplete, and individuals cannot perfectly observe and contract on effort. This means that both cooperatives and haciendas face a moral hazard problem in production. Under cooperative property rights, cooperatives make decisions on issues not specified in contracts through majority voting (as in Kremer 1997 and Hart and Moore 1998). In contrast, in haciendas, the owner makes decisions to maximize profits.

Second, motivated by focus group discussions with cooperative workers on their contracting choices, I assume crops differ in their contractibility, that is, whether or not worker remuneration contracts can be written based on output levels. Specifically, I assume that owners cannot contract on output levels for staple crops—such as maize and beans—because, if they were contracted on, workers could easily hide or directly consume the output, rendering the contract untenable. In contrast, I assume that the output from cash crops—such as sugarcane and coffee—can be contracted on. This is because cash crops differ from staple crops in two keys ways. First,

cash crops require centralized processing to be valuable. Second, cash crops cannot be directly consumed by an individual worker. The key implication is that cooperatives and haciendas can write contracts to remunerate workers based on their cash crop output, but not on their staple crop output.

In the model, neither ownership structure necessarily reaches the most efficient outcome. However, the source of inefficiency varies by property rights regime. In haciendas, the owner faces a motivation versus rent extraction trade-off that leads to production inefficiencies. In particular, owners will offer sharecropping contracts that provide less than optimal incentives (because higher worker incentives reduce the owner's profits). In contrast, in cooperatives, incentives to redistribute earnings across workers with heterogeneous abilities may lead to production inefficiencies. Specifically, when the median member has less than average ability, cooperatives will tend to vote to redistribute their cash crop earnings, undermining effort incentives.

The model offers a specific set of predictions under certain conditions—in particular, when the median-ability member has less than average ability—that I test in the data. First, cooperatives will devote less land to cash crops and more land to staple crops relative to haciendas. This is because, in cooperatives, contractible cash crop earnings will tend to be redistributed across workers, whereas noncontractible staple crop earnings will not be redistributed to other workers or an outside owner. Second, cooperatives will be less productive at cash crops—because members tend to vote to redistribute cash crop earnings—but will be more productive at staple crops—because cooperative members are the full residual claimants on their staple crop earnings. Finally, relative to hacienda workers, cooperative workers are more likely to have more compressed incomes due to the redistribution of cash crop earnings.

Using data from El Salvador's 2007 census of agriculture and a regression discontinuity design, I find that, relative to haciendas, cooperatives are more likely to specialize in staple crop production instead of cash crops. Specifically, cooperatives devote less land to cash crops, such as sugarcane and coffee, and are less productive at cash crops. However, this is not the case for staple crops, such as maize and beans: cooperatives devote more land to produce staple crops and are more productive at these crops relative to haciendas.[2] I then examine the impacts of cooperative property rights on worker incomes and equity to understand the equity implications of cooperative property rights. I use household survey data to identify individuals working in the reform cooperatives

[2] I also examine whether cooperatives are on aggregate less productive than haciendas, as measured by revenues per hectare or profits per hectare, and find no evidence for this, but the results are imprecisely estimated and therefore inconclusive.

and those working on haciendas. I find that the income distributions for cooperative workers are more equitable compared to the income distributions of workers on haciendas. These results are consistent with the aforementioned property rights model.

The paper contributes to several literatures. First, the paper contributes to the literature that empirically examines the costs and benefits of cooperative property rights systems (see for reviews Bonin, Jones, and Putterman 1993 and Pencavel 2013a). Despite a large theoretical literature modeling the effects of different property rights systems (discussed next), few studies provide empirical evidence on the predictions of these models. Craig and Pencavel (1992) and Pencavel and Craig (1994) compare worker cooperatives versus outside-owned firms in the plywood industry in the Pacific northwest in the United States to study how cooperatives respond to shocks relative to outside-owned firms. Taking firm ownership structure as given, they find that cooperatives are more likely to adjust pay rather than employment during shocks. Burdín and Dean (2009) study a longer panel of firms in Uruguay and provide evidence consistent with these differing adjustment mechanisms. Relatedly, Lang and Gordon (1995) study law firm partnerships and Gaynor and Gertler (1995) study medical group partnerships to examine the impacts of profit sharing on productivity.[3]

Finally, Burdín (2016) uses administrative data from Uruguay to compare workers who move between cooperatives and outside-owned firms and finds that labor-managed firms have more equitable compensation structures but higher quit rates for high-ability members. However, all these studies do not address the endogeneity of property rights, where many omitted variables may affect both the initial choice of ownership structure and outcomes of interest.[4]

Second, the paper contributes to the large theoretical literature modeling the effects of cooperative ownership structures, often known as *labor-managed firms*. Motivated by the existence of cooperatives in agriculture, these models similarly studied cooperative members' labor allocation between collective and private production (Domar 1958; Sen 1966; Bonin 1977; Israelseni 1980; Putterman 1980, 1981). A common assumption in these models is that effort could be costlessly observed. Motivated

[3] Additionally, there is an extensive literature on agricultural cooperatives in China that examines the formation of cooperatives from private farms in the 1950s and decollectivization (transitioning from cooperatives to family farming) and explores whether these transitions affected productivity (see Putterman 1987; Kung 1993, 1994; Kung and Putterman 1997). There is also work on manufacturing cooperatives in Italy examining whether cooperative ownership discourages firm formation (Belloc 2017).

[4] For example, if one observes that cooperatives are less efficient, more equitable, and adjust differently to shocks, it is not clear whether this is due to initial differences in worker attributes (or differences in capital access), or due to incentive and agency issues inherent to profit sharing.

by advances in the incomplete-contracts literature, subsequent models have examined labor effort choices in which effort is unobservable and contracts are incomplete (Hart and Moore 1996; Kremer 1997).[5] However, most of these papers do not compare how cooperatives perform relative to other property rights systems (Putterman 1991). In this paper, I contribute to this literature by providing a model comparing cooperative ownership and outside ownership in a setting in which effort is unobservable that highlights that neither ownership structure necessarily reaches the most efficient outcome and that they will tend to specialize in different types of tasks.[6]

In comparing the benefits and costs of cooperative property rights both theoretically and empirically, this paper is most related to work by Abramitzky (2008, 2011, 2018), who examines the impacts of redistribution and outside options on the stability of the Israeli kibbutz system. Abramitzky (2008) models kibbutzim as risk-sharing groups that are subject to three incentive constraints: participation constraints, an adverse selection constraint, and an incentive compatibility constraint to limit shirking. He uses temporal variation in financial shocks to empirically demonstrate that exit rates are decreasing in kibbutz wealth—which increases the cost of exiting and that members with higher outside options tend to be more likely to exit. This paper builds on this body of work by comparing across property rights regimes, instead of focusing only on cooperatives, while still exploring the main equity-efficiency trade-offs discussed in Abramitzky (2018). Additionally, because of particular features of the El Salvador land reform, I am able to present causal estimates of the effects of cooperative property rights relative to outside ownership.

Third, the paper is related to the literature that attempts to understand the lasting impacts of property rights reforms. Besley and Burgess (2000) examine the case of land reforms in India and find that tenancy reforms are associated with subsequent reductions in rural poverty. Similarly, Banerjee, Gertler, and Ghatak (2002) examine tenancy reform in West Bengal and find large impacts of tenancy reforms on agricultural productivity.[7] This paper contributes to this literature by examining the impact of the specific form of cooperative property rights that was frequently implemented during

[5] Other work has focused on cases in which monitoring can be used to observe effort and studies these monitoring choices in cooperatives (Ireland and Law 1988; Putterman and Skillman 1988; Bonin and Putterman 1993).

[6] This paper also contributes to the large literature on the relative efficiency of different share contracts observed in developing economies (Marshall 1890; Cheung 1969; Otsuka, Chuma, and Hayami 1992). This literature has examined whether share contracts can lead to efficient outcomes when taking into account monitoring costs (Cheung 1969), risk sharing (Stiglitz 1974), market failures (Eswaran and Kotwal 1985), and transaction costs (Alston, Datta, and Nugent 1984). This paper contributes to this literature by examining share contract decisions under differing ownership structures.

[7] These tenancy reforms increased the bargaining power of workers; cooperative property rights can be thought of as a maximal form of worker power.

land reforms in Latin America. Figure 1 is a map of Latin America that illustrates which countries have implemented a land reform to create agricultural cooperatives. The majority of countries in Latin America underwent or attempted such land reforms.

This paper differs from other work on land reforms in that it focuses on the longer-run consequences of property rights reforms instead of focusing on short-term impacts.[8] Land reforms can often be disruptive, implemented in times of civil conflict, and may also impact views on the security of differing property rights reforms. Thus, studying the longer-run consequences allows me to better isolate the differences due to property rights changes.[9]

Finally, the paper is related to a growing literature on the sources of differences in agricultural productivity in developing countries. Evidence suggests that the gap between labor productivity in agriculture relative to nonagricultural production in developing countries is much larger than the gap in developed countries (Gollin, Parente, and Rogerson 2002; Restuccia, Yang, and Zhu 2008; Adamopoulos and Restuccia 2014). Additionally, developing countries allocate a much larger share of employment to agriculture than in developed countries (Restuccia 2016). Recent work has begun to focus on how specific land institutions may account for some of this difference (Adamopoulos and Restuccia 2014, 2019). This paper contributes to this literature by providing evidence on how specific property rights structures that may be more common in developing countries can lead to different patterns of agricultural production.

The paper is organized as follows. Section II provides background on the El Salvador land reform. Section III describes the data, and section IV describes the empirical strategy and tests the main identifying assumptions. Section V presents the theoretical framework that guides the empirical results. Section VI presents the main results by analyzing differences in agricultural choices, productivity, and worker income distributions between the reform cooperatives and properties that were never expropriated. Section VII examines alternative explanations for the results. Section VIII concludes.

[8] A notable exception to this is recent work by Galan (2018), who studies an agrarian reform in Colombia that provided individual parcels to individuals to study the intergenerational impacts of access to land.

[9] A large theoretical and empirical literature in development suggests that private and secure property rights are a prerequisite for the process of economic growth (North 1981; Besley 1995; Hornbeck 2010). The empirical literature has mostly focused on the security of property rights and how this affects economic development (Field 2007; Goldstein and Udry 2008; Galiani and Schargrodsky 2010). (An exception to this is recent work by Burchardi et al. 2019, where the authors experimentally vary the amount of output kept by sharecroppers—their residual property rights—and study subsequent agricultural choices and investment.) In this paper, both cooperatives and haciendas today do not face differences in security; thus, differences in outcomes are likely due directly to differences in property rights regimes.

II. Background on the 1980 El Salvador Land Reform

A. Decree 153

On March 5, 1980, the military junta in power in El Salvador passed Decree 153 on land reform (Junta Revolucionaria de Gobierno 1980). The reform specified a plan to reorganize large haciendas into agricultural cooperatives in two phases. Phase I called for the expropriation of all agricultural land owned by an individual with over 500 ha in total landholdings. This land was to be distributed to the permanent laborers working on the land in the form of agricultural cooperatives. An undefined number of years after phase I, phase II of the land reform called for the expropriation of all agricultural land owned by an individual with over 100 ha in total landholdings. However, phase II was never carried out due to organized opposition following phase I. The government officially called off phase II in 1982 following a reorganization of the government leadership (Figueroa Aquino and Marroquín Mena 1991).

Decree 153 outlined three official motivations for the land reform. First, the reform aimed to diminish land inequality and increase agricultural productivity. This goal was motivated by the military leadership's belief that large hacienda owners were absentee landholders and that they did not compensate workers enough. Second, the reform was intended to increase development and reduce poverty. Finally, the military government hoped that the land reform would reduce the power of the economic elite (Junta Revolucionaria de Gobierno 1980).

Phase I was carried out immediately after the reform was announced and was enforced by the military. The morning after the publication of Decree 153, the Salvadoran Institute of Agrarian Transformation (ISTA) sent intervention teams of "agronomists, technicians, and military personnel to the country's largest farms to notify them" of expropriation (Marroquín Mena 1988). Former owners were to be compensated by a mix of cash and bonds paid out over 30 years (Browning 1983).[10] Rather than providing individual title and possession to workers, ISTA organized former hacienda laborers into agricultural producer cooperatives in which farmers would work the land in groups (Mennen 2009). By the end of 1986, ISTA had expropriated 469 estates throughout the country (Marroquín Mena 1988). Figure 2 shows cantons that experienced at least one expropriation.[11]

Approximately 20% of all of El Salvador's farm land was reorganized into cooperatives during phase I of the agrarian reform (Marroquín

[10] The value of these bonds was tied to the reported property values from tax filings prior to the land reform (Marroquín Mena 1988).

[11] Cantons are the smallest administrative unit in El Salvador, equivalent to approximately one village in rural areas. There are over 1,400 cantons in El Salvador.

FIG. 2.—Land reform by canton, El Salvador. Data are from the Ministerio de Agricultura y Ganadería (1983). "Experienced land reform" equals "yes" for a canton if at least one property was expropriated in that canton during phase I of the 1980 land reform, and "no" otherwise. A color version of this figure is available online.

Mena 1988). This land made up 14% of total coffee land, 31% of cotton land, and 24% of all sugarcane land in El Salvador (Seligson 1994). The newly formed worker cooperatives were governed by the cooperative constitution of El Salvador, which specified that cooperative-level decisions—such as land allocation, worker remuneration, and how to utilize or redistribute net cooperative earnings—had to be democratic, on a one-member, one-vote basis (Perez Riva and Chavez Castro 1994).[12] Estimates suggest that roughly 31,000 working families, or one-fifth of agricultural laborers, in El Salvador benefited from the land reform and the reorganization into cooperatives (Mennen 2009).

B. Planning and Execution of the Land Reform

Critically, the 1980 land reform program was unexpected for large landholders. According to accounts from the individuals responsible for its design and implementation, the land reform was "prepared under immense secrecy and executed at full velocity" to avoid strategic adjustments by the landholders (Velis Polío 2012, 117). The land reform was prompted by the unexpected addition to military junta leadership of a pro-land-reform colonel on March 3, 1980. Between March 4 and March 5, the government took a number of steps to keep the land reform secret. On March 4, the

[12] Importantly, most cooperative decisions must be made via majority rule. However, the selling of cooperative land and member entry and exit require a two-thirds supermajority. Appendix A (apps. A–J are available online) provides additional detailed information on the governance and internal organization of cooperatives and haciendas in El Salvador.

military leadership called a fake "interagency coordination" seminar that gathered the critical personnel from ISTA and the Ministry of Agriculture to inform them of the junta's plans and provide them with national police escorts. The officials were given green key cards that meant that the military outside the hotel would bar them from leaving their hotels. On March 5, after the "interagency coordination" seminar designed the reform and the government published Decree 153, the military transported the teams of agronomists, infantry, and technicians to the haciendas overnight (Velis Polío 2012).[13]

Additionally, the 500 ha threshold was chosen as a temporary threshold for implementation reasons (Velis Polío 2012, 110). Specifically, the government planners did not have enough agronomists and agricultural personnel to expropriate all landholdings over 100 ha and therefore settled on 500 ha as a temporary cutoff. As Velis Polío notes, the amount of personnel needed to execute phase I was massive:

> The armed forces—on their own—temporarily deployed almost 10,000 members, among them officers, noncommissioned officers, and troops, all of this coordinated from the chiefs of staff, which additionally implied the utilization of transportation, fuel, food, military equipment, etc. The same can be said of the Ministry of Agriculture and ISTA, which also made use of *all of their resources* [emphasis added] to provide the technical and social promotion personnel, vehicles, fuel, and their weapons consisting of the paperwork to be used in the preparation of documents that would serve as a basis for the legalization of the takeover and possession of the affected properties (Velis Polío 2012, 112).

The secrecy of the planning and the swift execution of the reform made it unexpected to large landholders. As Velis Polío (2012, 112) notes, the land expropriation on March 6, 1980, caught hacienda owners by surprise: "The reform was an economic, political, and social earthquake in the countryside. . . . Landholders saw before their eyes something that they never imagined could possibly happen on the lands that they had always governed absolutely."

III. Data

A. *Data Sources on Land Reform in El Salvador*

I gathered government records on reform expropriation, cooperative formation, and prereform landholdings to identify properties above

[13] There had also been a freeze on land transactions since October 1979 (Decree 43; Jurado Castillo, Naves Medrano, and Robles Rosales 1993). This freeze applied to all land over 100 ha (Velis Polío 2012, 99).

the expropriation threshold that became cooperatives and those below that remained as privately owned haciendas. Data on the reform expropriations comes from the El Salvador Ministry of Agriculture (MAG) and the El Salvador Institute for Agrarian Transformation (ISTA). The Ministerio de Agricultura y Ganadería (1983) report on phase I of the 1980 land reform contains the list of all the properties expropriated; the canton, municipality, and department of the properties; and the name and number of members in the cooperative created in each property. I received the ISTA records for the name of the former owner of each expropriated property from ISTA's offices in San Salvador.[14]

Data on prereform landholdings comes from the Property Registry of El Salvador from 1980. There was no single source with the universe of landholdings before the reform for all of El Salvador. However, ISTA provided records on the total landholdings in 1980 for owners of expropriated properties, and Figueroa Aquino and Marroquín Mena (1991) provide records on the total landholdings for all landholders with above 100 ha in cumulative landholdings in 1980 that were not expropriated by ISTA. Thus, these two sources together provide prereform landholdings from 1980 and contain the size in hectares, the canton, and the former owner for each property.

B. Data from the El Salvador Census of Agriculture

The analysis comparing cooperatives to haciendas uses data from the IV Census of Agriculture in El Salvador. The census was conducted in 2007 and 2008 by the Ministry of Agriculture and the Ministry of the Economy. It surveyed 94,168 distinct agricultural producers and reports detailed information on types of crops produced, area cultivated, amount produced, workers employed, total size, and investment choices. In appendix C I provide more information on the variables used in the analysis, the institutions involved in the census, and the data collection process.

The census also collected the name of each property and information on the geographic location for agricultural producers. The agricultural census from the MAG collected the municipality and department of each property. This allows me to match the properties in section III.A to the corresponding property today using the name, municipality, department, and size of the property in hectares.[15] Across the threshold, I am able to match approximately 70% of the prereform landholdings to a modern-day

[14] See app. C for more details on data sources.

[15] The census includes an indicator variable for whether a property is a cooperative and (often) the name for each cooperative. However, the name for the hacienda is usually not included because many haciendas do not have a formal name. I use these variables to separate cooperatives from haciendas and to match the reform cooperatives to their corresponding name when available. This matching process is similar to the work done by the World Bank (2012) to study the reform cooperatives. See app. C for more information.

agricultural producer from the census. Importantly, there is no difference in the probability of finding a match based on whether the property was owned by an owner over the cumulative landholding threshold: there is no discontinuity at the threshold in this probability of a match, and the slopes on both sides of the discontinuity are effectively zero.[16]

See figure D3 (figs. A1–A3, B1, B2, D1–D26, E1, F1, F2, H1, and J1–J6 are available online) for the RD plot of the probability of existing today.[17]

C. *Data Sources from El Salvador Household Surveys*

To examine differences in worker outcomes for cooperatives and haciendas, I use household survey data—the *Encuesta de Hogares de Propósitos Multiples*—from El Salvador from 2002 to 2013. These household surveys provide detailed information on household incomes, wages, and consumption levels for individuals in El Salvador. The household surveys include detailed questions on the geographic location for each individual—the canton, municipality, and department of each individual. For individuals in agriculture, the surveys include questions on whether a person works in agriculture as a cooperative member or as a hacienda laborer, and the total number of other employees for the property where they work. I use these questions in the household surveys to match individuals to cooperatives and haciendas. Since the household surveys do not include the name of the property in every year, I limit this matching to cantons with only one cooperative/large hacienda, meaning that I have a smaller sample of the properties in this sample of workers. I check the accuracy of this matching process by using the 2008–2010 household surveys for which I received access to the property/cooperative name for agriculture workers.[18]

IV. Empirical Strategy

A. *Specification*

To identify the impacts of cooperative property rights on plot-level outcomes, I exploit the 500 ha threshold rule defined in Decree 153 of the

[16] Interestingly, this finding is consistent with work by Burdín (2014), who shows that worker-owned firms are not more likely to fail in Uruguay. One additional possible concern is that the reasons for not finding a match differ systematically across the threshold. In app. C I show that the probability of finding a match at the threshold is not systematically related to key geographic characteristics (such as land quality or distance to urban centers).

[17] Importantly, there have been few targeted government policies toward cooperatives or haciendas since the 1980 reform. Appendix A provides a thorough account of laws and policies related to cooperatives and haciendas and highlights that, in general, cooperatives did not receive many favorable laws and were not a priority for the government because of the right-wing governments ruling El Salvador after the civil war until 2009.

[18] In this sample, I find that I assign individuals to the correct property 91% of the time.

El Salvador land reform to implement a regression discontinuity (RD) design. The intuition for this empirical design is that, at the time of the reform, properties just above and below the 500 ha cumulative individual ownership threshold were likely very similar except that properties above the threshold were subject to expropriation and organized as agricultural cooperatives while those below were not. Thus, properties just below the threshold serve as a reasonable counterfactual to those above it that became cooperatives.

The empirical specification used is as follows:

$$y_{po} = \alpha + \gamma \text{Above500}_o + f(\text{holdings}_o) + \epsilon_{po} \text{ for } o \in \text{RS}, \quad (1)$$

where y_{po} is the outcome of interest for plot p owned by owner o before the reform and Above500_o is an indicator variable for whether owner o had over 500 ha in cumulative landholdings before the reform.[19] Here $f(\text{holdings}_o)$ is the RD polynomial that controls for a smooth function of total landholdings by owners. Following Calonico, Cattaneo, and Titiunik (2014a, 2014b), the baseline specification for equation (1) uses a local linear specification estimated separately on each side of the cutoff. The coefficient of interest is γ, the causal difference in outcomes between properties subject to expropriation and reorganized into cooperatives and those that were not susceptible to expropriation and remained as privately owned haciendas. Since former landholder o may have owned multiple plots, and the threshold depends on total holdings for o, standard errors are clustered at the former landholder level. RS defines the "risk set" of former owners who had cumulative landholdings within a bandwidth near 500 ha; the baseline bandwidth is the optimal bandwidth that minimizes the mean squared error (MSE) of the point estimator developed by Calonico, Cattaneo, and Titiunik (2014b) and Calonico et al. (2017). Appendix J provides robustness tests using different RD polynomials and using various sample bandwidths to address concerns that the estimation results are specific to the choice of RD polynomial or bandwidth.

Equation (1) has two important identifying assumptions. First, former landowners must not have selectively sorted around the cutoff based on their characteristics. Second, all relevant factors other than treatment must vary smoothly at the 500 ha threshold. Below, I examine these two assumptions in more detail and provide evidence that they are likely satisfied.

[19] Specifically, $\text{Above500}_{po} = \mathbf{1}(\text{cumulative landholdings}_o \geq 500 \text{ ha})$. Note that this variable is a function of cumulative landholdings of the former owner and not just the size of a given property. In other words, $\text{Above}_{po} = \mathbf{1}(\text{cumulative land holdings}_o \geq 500 \text{ ha}) \neq \mathbf{1}(\text{land size}_{po} \geq 500 \text{ ha})$. For instance, a former owner could have owned multiple properties (e.g., two properties, both 300 ha in size) for which the sum of their sizes was over 500 ha; in this case, both properties were subject to expropriation (see sec. II).

B. No Evidence of Sorting along the 500 Ha Cutoff

Equation (1) requires the absence of selective sorting around the 500 ha cumulative landholding threshold. This would be violated, for instance, if landholders were able to selectively alter their cumulative landholding amount at the time the reform was announced to avoid expropriation.

To test whether there was sorting around the threshold, I implement the McCrary test (McCrary 2008) by collapsing the data into landholding amount bins and using the number of observations in each bin as the dependent variable in equation (1). Figure 3 illustrates that there is not a discontinuous change in the number of observations in each bin around the threshold. This suggests that landholders were unable to change their landholdings to avoid expropriation. This is consistent with the details of the reform implementation presented in section II.A, which describes how the land reform was executed swiftly and that there was a large effort by the military to keep key planning details secret from large landowners.

C. Balance on Geographic Characteristics

The second RD identification assumption is that all relevant factors aside from treatment vary smoothly at the 500 ha threshold. This assumption

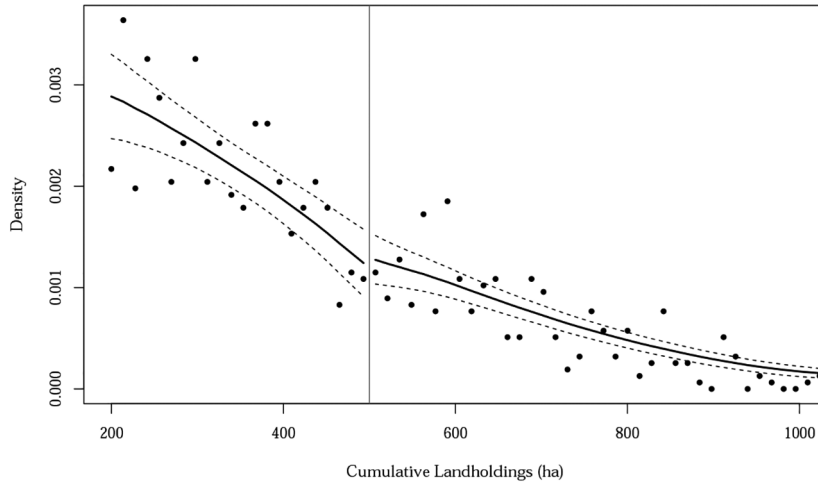

FIG. 3.—McCrary sorting test. The figure implements the sorting test suggested by McCrary (2008) and plots the number of observations in each cumulative landholding bin. The plotted regressions use the number of observations in each bin as the dependent variable on each side of the cutoff to test whether there is a discontinuity in the density of landholdings at the expropriation cutoff. See appendix C for more information on data sources and variable definitions. A color version of this figure is available online.

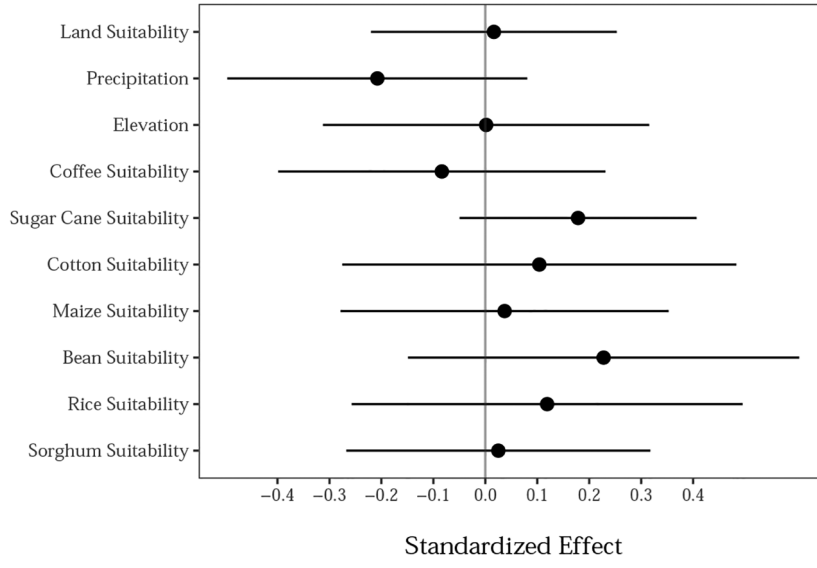

FIG. 4.—Estimates for differences in geography. Figure plots standardized (β) regression discontinuity coefficients. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017). See appendix C for details on the data sources and variable construction for the geographic variables. A color version of this figure is available online.

is important to ensure that properties just below the ownership threshold serve as an appropriate counterfactual for those above the threshold. This assumption would not hold if, for example, properties with an owner over the 500 ha threshold differ systematically in their characteristics (such as land suitability or geographic location) from properties with an owner just below the threshold.

To assess the plausibility of this assumption, I examine whether key geographic characteristics are balanced across the 500 ha threshold. In particular, I estimate equation (1) for different geographic characteristics for each property and present the estimated coefficient of interest, γ, for each of these variables in figure 4. The geographic characteristics used are land suitability, precipitation, elevation, suitability for the three main cash crops at the time (sugarcane, coffee, and cotton), and suitability for the four main staple crops of El Salvador (maize, beans, rice, and sorghum).[20] For each of these key geographic variables, I find little evidence of a discontinuity at the threshold, though the estimates are imprecise.[21] This provides suggestive

[20] See app. C for more details on these variables.

[21] Because some of the estimates are imprecisely estimated, I complement these findings by (i) showing that the results are robust to using matching methods, and (ii) exploring the sensitivity of the main results by assuming that reform properties are on the edge of the balance test confidence intervals. I present these results in apps. D.2 and D.3, respectively.

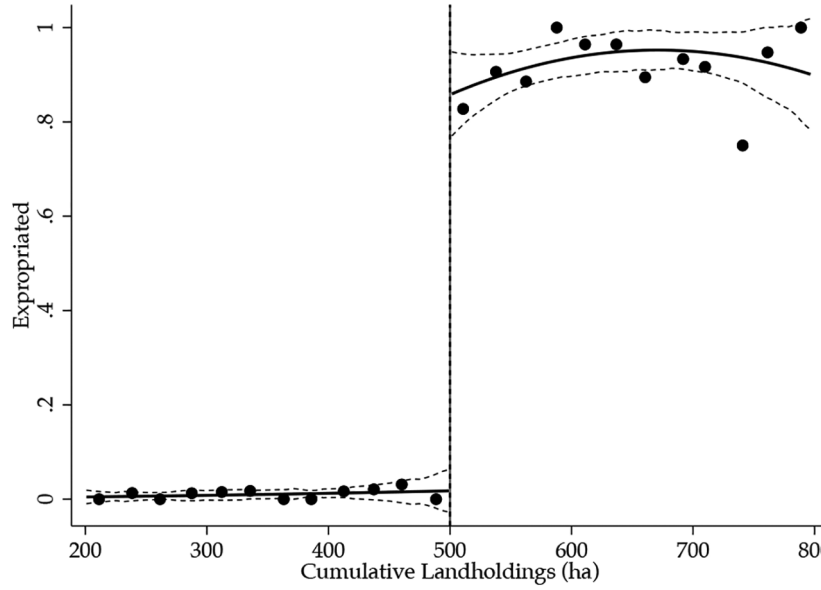

FIG. 5.—Phase I expropriation RD plot. The figure presents the estimated regression discontinuity plot on an indicator variable equal to 1 if a property was expropriated. The points represent the average value of the outcome variable in bins of width 25 ha. The regressions are estimated using local quadratic polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within a fixed bandwidth of 300 ha and use a uniform kernel. Standard errors are clustered at the former-owner level. The 95% confidence intervals around the estimated lines are shown as dashed lines. See appendix C for data sources and variable definitions. A color version of this figure is available online.

evidence that the assumption that relevant factors vary smoothly at the 500 ha threshold is plausible.[22]

D. *First Stage: Holdings above Ownership Threshold Were Expropriated*

This section examines whether the land reform did, in fact, follow the details of Decree 153. In particular, I confirm whether properties owned by landholders with cumulative landholdings over 500 ha were expropriated. Figure 5 graphically examines the relationship between cumulative landholdings and expropriation. Each point in the figure represents the average expropriation rates in cumulative landholding bins. The solid

[22] Figure 2 presents a map of cantons in El Salvador that did and did not experience an expropriation and illustrates that the reform properties were not concentrated in one single geographic location of the country but were instead spread out across the country.

line plots predicted values from a regression of expropriation on a quadratic polynomial in the total landholdings of the former owner, estimated separately on either side of the 500 ha threshold. The dashed lines present the 95% confidence intervals for the regressions. The regressions are estimated on properties within 300 ha of the cumulative ownership threshold. Figure 5 shows that there is a discontinuous change in the probability of being expropriated above the 500 ha threshold. Specifically, properties with an owner owning over 500 ha in cumulative landholdings are approximately 75% more likely to have been expropriated after the 1980 land reform was announced. Interestingly, compliance with the reform rules was not perfect. Not all properties above the threshold were expropriated.[23] Additionally, a few properties below the threshold were expropriated even though they should not have been expropriated according to the reform details. Because compliance with the reform threshold was imperfect, the empirical results will also present scaled instrumental variable estimates—that is, fuzzy RD estimates.[24] Overall, the 1980 land reform was successful in expropriating most properties above the threshold and redistributing these properties to the former hacienda workers in the form of agricultural cooperatives.

V. Theoretical Framework

To guide the empirical results, I describe the model derived in appendix B comparing cooperative ownership to outside ownership (haciendas) to examine differences in agricultural choices, productivity, and worker incomes between these ownership structures. The modeling choices were motivated by observations from focus group conversations with cooperatives and haciendas; I provide detailed information on these focus group observations and the internal organization of each ownership form in appendix A. In the model, both cooperatives and haciendas are assumed to have identical production technologies and worker preferences. Thus, any differences in choices will be due to differences in economic organization.

[23] About 20% of these properties remained as privately owned haciendas, as shown in fig. 5. This is in contrast to the accounts presented by the executioners of the reform (e.g., Velis Polío 2012), which suggested that all properties that should have been expropriated according to Decree 153 were indeed expropriated.

[24] Specifically, the fuzzy RD estimates use the treatment assignment rule (Above500_v from eq. [1]) as an instrument for becoming a cooperative ($\text{reform cooperative}_{pv}$). The important identification assumption for the fuzzy RD design is that the exclusion restriction holds; i.e., within the narrow RD bandwidth, the outcomes of interest are only affected through the change in expropriation probability at the threshold and not by the running variable itself (former-owner cumulative ownership). See Cattaneo, Idrobo, and Titiunik (2020).

The defining difference between cooperatives and haciendas in the model is how decisions get made. Under cooperative property rights, cooperatives make decisions on issues through majority voting on a one-member, one-vote basis, and each worker-owner votes to maximize their own utility (as in Putterman 1980, Kremer 1997, and Hart and Moore 1998). In contrast, in haciendas, the owner makes decisions to maximize profits.

The model has two main features. First, employment contracts are incomplete, meaning that individuals cannot perfectly observe and contract on worker effort. Additionally, workers in the model receive heterogeneous productivity shocks and face limited liability constraints. These details imply that both cooperatives and haciendas face moral hazard incentive problems in production.

Second, informed by focus group evidence on contracting choices in cooperatives and haciendas, I assume that crops differ in their contractibility, that is, whether or not contracts can be written based on output levels. Specifically, I assume that owners cannot contract on output levels for staple crops because, if they were contracted on, then workers could either hide or directly consume the output, rendering the contract untenable. In contrast, cash crops cannot be directly consumed by an individual worker because they require processing to be valuable. Thus, cooperatives and haciendas can write contracts to remunerate workers based on their cash crop output but not on their staple crop output.[25]

Decisions and timing.—In both cooperatives and haciendas, owners decide on the share of land to allocate to cash versus staple crop and how to remunerate workers for cash crop production.[26] Because both cooperatives and haciendas can contract on cash crop output, owners will decide on a linear wage schedule as a function of output to remunerate workers for cash crop production.[27] In cooperatives, members will vote on the share of cash crop output that will be redistributed equally to all members. In contrast, hacienda owners will decide on the share of cash crop output kept by the owner. Workers then individually choose to allocate effort between cash crop production and staple crop production. Finally, transfers

[25] For more information on the intuition behind this assumption and a formal derivation of this contracting result, see app. B.5. Note that these assumptions regarding the differences for cash and staple crop production are common in the theoretical literature on cooperatives (see Putterman 1986) and haciendas (see Sadoulet 1992; de Janvry and Sadoulet 2007).

[26] Because staple crop output is noncontractible, cooperatives will not be able to share staple crop output. This matches focus group evidence from cooperatives in El Salvador (see app. A). For haciendas, the noncontractibility of staple crop output implies that owners can only charge rent for the staple crop land.

[27] This assumption that payment occurs directly as a function of output (i.e., piece rate) may be unrealistic for some agricultural tasks (i.e., tasks when workers are not assigned specific parts of the land to work on and monitor); however, as discussed in app. A, many tasks in both cooperatives and haciendas are assigned and remunerated in this manner.

occur: workers are remunerated for cash crop production, cooperative workers receive their share of redistributed cash crop earnings, and hacienda workers pay rent to the owner. The formal model setup and derivation are presented in detail in appendix B.

Model implications.—An important result of the model is that neither cooperatives nor haciendas necessarily induce the most efficient outcome in terms of effort and crop choices. These inefficiencies occur for different reasons. In cooperatives, worker heterogeneity and the voting process for decisions may lead to a redistribution of earnings. This redistribution dampens worker incentives to provide higher levels of effort. In particular, if workers receive positively skewed productivity shocks (where the median worker is below the mean worker in terms of productivity), the cooperative members will choose to redistribute cash crop earnings and choose to devote a larger share of cash crop production than is optimal to further redistribute earnings.

In contrast, in haciendas, the owner faces a motivation versus rent extraction trade-off. In order to increase effort, the owner would need to allow workers to keep a larger share of their earnings; however, this would reduce his profits. Thus, the desire to maximize profits, and limited liability constraints for workers, means that the owner will decide to keep a higher than optimal share of cash crop output for himself at the expense of lower worker effort incentives. Additionally, the owner will devote a larger share of land to cash crops than optimal to ensure workers devote more time to cash crop production instead of staple crop production.

When comparing the decisions of cooperatives and haciendas, the framework offers four important predictions summarized in table 1. First, relative to haciendas, cooperatives will devote less land to cash crops and more land to staple crops. Second, for cash crops, cooperatives are less productive than haciendas. Third, for staple crops, cooperatives are more productive than haciendas. These three predictions highlight that cooperatives are more likely to specialize in staple crop production, while haciendas will specialize more in the production of cash crops. The reason for this is that cash crop earnings are redistributed in cooperatives, dampening

TABLE 1
SUMMARY OF MODEL PREDICTIONS AND CORRESPONDING EMPIRICAL TESTS

	Prediction	Empirics
(1) Cash crop land allocation	↓ in cooperatives	Percentage of land devoted to cash crops vs. staple crops
(2) Cash crop productivity	↓ in cooperatives	Yields for cash crops
(3) Staple crop productivity	↑ in cooperatives	Yields for staple crops
(4) Worker earnings equality	↑ in cooperatives	Interquartile range of worker earnings

NOTE.—See app. B for more information on the model setup and derivation. The predictions are relative to hacienda choices.

effort incentives, but not staple crop earnings; this means that the cooperative will be more productive at staple crops over cash crops. Conversely, in haciendas, the owner is able to extract more profits from workers' cash crops (since the owner can contract on output) and will give people strong incentives to work on the cash crop land (over working on staple crops). Finally, cooperative members will likely have more compressed incomes as they will redistribute earnings from cash crop production.

Table 1 presents how each of these model predictions will be tested empirically in section VI. A critical question when linking the theory to the empirics is whether the staple crop output data are reliable given the assumption that, since staple crop output can be hidden, it is noncontractible.[28] In appendix C, I highlight several important empirical details regarding the institutional context and the census enumeration process to explain why, in this empirical setting, workers likely report reliable measures of output to government enumerators and the measures reported to the government cannot be used in practice in contracts between the owners and workers.[29] In particular, in 2007, the MAG partnered with the Food and Agriculture Organization (FAO) of the United Nations to produce a high-quality, confidential, and technically sound census after years of not having a census. The MAG has a pro-rural-worker mission and reputation; in fact, MAG leadership in 2007 was composed of individuals involved in the 1980 land reform. Enumeration—conducted in person, in the field—involved extensive monitoring, data back checks, and quality checks.[30] For all these reasons, workers likely report high-quality and reliable staple crop measures to government enumerators.[31]

This framework abstracts from three important aspects of cooperatives and haciendas. First, the model abstracts from differences in monitoring by organizational structure.[32] Second, the model does not address the

[28] Note that this concern applies only to prediction 3 in table 1.

[29] In addition, in app. B.5, I formally show that staple crop output becomes noncontractible if the threat of hiding is high enough and discuss why, in equilibrium, workers likely provide reliable answers to census enumerators.

[30] The monitoring was particularly high for the agricultural census because the government had strong incentives to monitor enumerators: evidence that enumerators shared confidential census information with owners would jeopardize the MAG's reputation and its partnership with the FAO.

[31] In app. C, I conduct a series of data manipulation checks using the reported output for different crops. I find no evidence that there are differences in the extent of data manipulation when reporting output to census enumerators across organizational forms. Note that none of the census data are used to determine government taxes.

[32] Prior work has explored whether there is more or less monitoring in outside-owned firms compared to cooperatives. Alchian and Demsetz (1972) argued that the monitoring choice by an outside owner would be more efficient than under profit sharing in cooperatives because all benefits of monitoring accrue to the owner in the former, whereas the benefits of monitoring are potentially diluted among the members of a cooperative

threat of exit for cooperatives studied by Abramitzky (2008) and considers a static problem.[33] Finally, the model abstracts from macrorisk considerations. Other work has motivated the existence of cooperatives as a way of coping with idiosyncratic risks.[34] In this model, I do not explicitly study heterogeneity in risk aversion. Including heterogeneity among cooperative members in their risk aversion or the degree of idiosyncratic risk across individuals in a cooperative would strengthen the incentives to redistribute earnings as a form of insurance. However, some crops may involve greater price or production risk than others, which would symmetrically affect all workers in a cooperative. If members are risk averse and face credit constraints while hacienda owners do not face credit constraints, this could explain differences in crop choices. I examine this alternative mechanism in the empirical section by examining differences in credit access by ownership type in section VII.[35]

VI. Results: Agriculture Choices, Productivity, and Worker Incomes

In this section, I compare differences in crop choices, crop-specific productivities, and aggregate productivity between cooperatives and haciendas using the 2007 agricultural census of El Salvador. I then examine differences in worker income distributions between cooperatives workers and hacienda workers using household survey data. I discuss whether the results are consistent with the predictions of the theoretical framework.

(Putterman and Skillman 1988). Yet, other work has argued that since all cooperative members have incentives to monitor each other and can use social sanctions as well, the technology of monitoring in cooperatives is quite different from the monitoring technologies in traditional firms (Wietzman and Kruse 1991; Kandel and Lazear 1992).

[33] I examine differences in migration patterns empirically in sec. VII. For papers that study cooperatives in a repeated-game setting, see MacLeod (1993). Theoretically, dynamics could lead to vote trading in cooperatives in the absence of commitment problems. However, in this setting, most cooperatives vote via secret ballots; this makes vote trading more difficult to sustain because it is difficult to verify how one individual voted.

[34] See, e.g., Bonin (1977), Carter (1987), Parliament, Tsur, and Zilberman (1989), and Delpierre, Guirkinger, and Platteau (2019).

[35] However, studying agricultural producers allows me to abstract from one proposed explanation for why there might be differences in access to capital between cooperative ownership and outside ownership in other contexts. In particular, scholars have highlighted that cooperatives in other sectors are less likely to raise funds through equity, as selling shares dilutes the voting power of worker members (Hart and Moore 1996). This means that they may be more credit constrained as they do not have as many ways to access capital. However, as argued in Putterman (1986), this argument is less relevant for agricultural cooperatives, as agricultural producers do not sell equity.

TABLE 2
AGRICULTURAL CHOICES AND PRODUCTIVITY: CASH CROPS

	CASH CROPS	SUGARCANE			COFFEE		
	Share	Producer	Share	Yield	Producer	Share	Yield
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Above500	−.594***	−.369***	−.234**	−32.25***	−.398***	−.349***	−20.09***
	(.152)	(.130)	(.104)	(7.510)	(.123)	(.134)	(7.124)
Observations	119	155	166	45	263	182	37
Clusters	77	97	103	34	161	114	21
Mean dependent variable	.515	.277	.179	67.98	.373	.286	13.47
Bandwidth	81.83	97.29	102.9	102.9	137.4	110.7	64.15

NOTE.—Standard errors clustered at the former-owner level reported in parentheses. "Share" for cash crops measures the share of land in a property devoted to cash crop farming (coffee or sugarcane). "Producer" is an indicator variable equal to 1 if any positive amount of the crop was reported as produced. "Share" measures the share of land in a property devoted to a given crop. "Yield" is measured as total produced, in tons per area in manzanas for sugarcane, and in quintales per area in manzanas for coffee. "Above500" is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. All regressions include a local linear polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidths are chosen using the MSE optimal procedure suggested by Calonico et al. (2017) and are reported in hectares.

** $p < .05$.

*** $p < .01$.

A. *Crop Choices and Crop Productivity*

To understand differences in crop choice and productivity, I utilize the crop-specific measures of production and yields collected in the agricultural census of El Salvador. The agricultural census reports quantity produced, amount of land used, and yields for the major crops for each property. The major crops reported are sugarcane, coffee, maize, and beans. Guided by the theoretical framework in section V, I present the results for the major cash crops in El Salvador—sugarcane and coffee—and then for the main staple crops—maize and beans.[36]

For cash crops, I estimate a version of equation (1) in which the dependent variable is an indicator variable equal to 1 if a property produces a positive amount of that crop and zero otherwise. Then, for each cash crop, I estimate equation (1), where I vary the dependent variable to be (i) an indicator equal to 1 if a property produces a positive amount of that crop and zero otherwise, (ii) the share of land in a property devoted to that crop, and (iii) the reported yield for that crop. I report the estimates in table 2. I present the RD plots for the share of land devoted to cash crops in figure D1.

[36] Historically, cotton was a major cash crop in El Salvador leading up to the Civil War. However, following the Civil War, cotton was no longer produced (Marroquín Mena 1988). Haciendas prior to the reform were almost exclusively cash crop producers (Colindres 1976).

I find that cooperatives devote less land to cash crops and are less likely to produce sugarcane and coffee relative to haciendas. Cooperatives devote 59% less of their land to cash crops, 23% less land to sugarcane, and 35% less land to coffee production. Conditional on producing these crops, cooperatives also have lower yields for these cash crops.[37] Yields for sugarcane are 32 quintales per manzana (QQ/mz) lower in cooperatives than in haciendas and yields for coffee are 20 QQ/mz lower in cooperatives than in haciendas.[38]

For staple crops, I follow the format for the cash crop results and first estimate the main specification using the share of land in property devoted to staple crops as the dependent variable. Then, for each main staple crop, I estimate the main specification, where I vary the dependent variable to be (i) an indicator equal to 1 if a property produces a positive amount of that crop and zero otherwise, (ii) the share of land in a property devoted to that crop, and (iii) the reported yield for that crop.[39] I report the estimates in table 3. Additionally, I present the RD plots for the share of land devoted to staple crops in figure D1.

I find that cooperatives are more likely to produce staple crops than haciendas. Cooperatives devote 42% more of their land to staple crop production relative to haciendas. Specifically, cooperatives devote 44% more land to produce maize and are 35 percentage points more likely to produce beans (though there is no statistically significant difference in the share of land devoted to beans). Conditional on producing these crops, however, cooperatives have higher yields for these staple crops. Yields for maize are 17 QQ/mz higher in cooperatives than in haciendas.

These results on crop choices and yields demonstrate that cooperatives are less likely to produce cash crops and more likely to produce staple crops relative to properties that were never expropriated; however, cooperatives are more productive when producing staple crops. I discuss these results and their implications in more detail in section VI.D before examining the robustness of these results and performing various extensions of this analysis.

[37] One possible concern when interpreting the yield results is that the results are conditional on selecting into producing the crop. To address the concern of possible selection bias in the yield results, I estimate the yield results using Heckman selection correction methods (Heckman 1976), using the suitability of each crop as the first-stage predictor for producing the crop. I present the results in fig. D9 for both cash crops and staple crops and show that the patterns of results discussed in this section are very similar when correcting for selection into production.

[38] The quintal (plural: quintales) is the unit of quantity used in El Salvador and is equivalent to 101.4 pounds or 46 kg. The manzana (plural: manzanas) is the unit for land area in El Salvador and is equivalent to 1.72 acres or 0.70 hectares. More information on the variables used and their definitions is provided in app. C.

[39] In practice, properties do not devote the entirety of their land to either cash crops or staple crops. Figure D15 presents the RD plot for the share of land not devoted to these crops. I find no differences in the share of land not devoted to these main crops.

TABLE 3
AGRICULTURAL CHOICES AND PRODUCTIVITY: STAPLE CROPS

	STAPLE CROPS	MAIZE			BEANS		
	Share (1)	Producer (2)	Share (3)	Yield (4)	Producer (5)	Share (6)	Yield (7)
Above500	.421**	.524**	.439**	17.34**	.352*	.0395	1.527
	(.191)	(.219)	(.194)	(7.236)	(.189)	(.057)	(3.932)
Observations	303	164	289	59	213	236	61
Clusters	190	101	180	46	132	142	57
Mean dependent variable	.204	.402	.188	47.55	.160	.040	14.87
Bandwidth	154.5	100.7	147.5	91.61	121.8	128.4	242.3

NOTE.—Standard errors clustered at the former-owner level reported in parentheses. "Share" for staple crops measures the share of land in a property devoted to staple crop farming (maize or beans). "Producer" is an indicator variable equal to 1 if any positive amount of the crop was reported as produced. "Share" measures the share of land in a property devoted to a given crop. "Yield" is measured as total produced in quintales per area in manzanas. "Above500" is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. All regressions include a local linear polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidths are chosen using the MSE optimal procedure suggested by Calonico et al. (2017) and are reported in hectares.

* $p < .1$.

** $p < .05$.

B. Aggregate Agricultural Productivity

To examine whether cooperative property rights lead to lower overall agricultural productivity compared to haciendas, I construct three measures as proxies for agricultural productivity. The first is revenues per hectare, the aggregate equivalent to crop yields. The second measure is profits per hectare, which takes into account production costs for each crop. The third follows the methodology suggested by Restuccia and Santaeulalia-Llopis (2017) to estimate producer-specific total factor productivity.

Formally, the first measure is the following: revenue per hectare$_p$ = $\ln[(\Sigma_i p_i q_i)/l_p]$, where q_i is the total quantity produced for each crop i and p_i the price of each crop i in 2007 reported by the Ministerio de Agricultura y Ganadería (2007a). I then normalize each measure by the property size in hectares (l_p). However, while revenues per hectare are easy to interpret, they serve as a poor proxy for productivity. As the results from section VI.A demonstrate, cooperatives and haciendas produce different types of crops, and these have different input costs. In particular, cash crops tend to have much higher costs of production compared to staple crops.

Thus, to capture revenues net of costs, the second measure is as follows: profits per hectare$_p$ = $\ln[(\Sigma_i p_i q_i - c_i)/l_p]$, where c_i is the costs of producing for each crop i. The 2007 agricultural census for El Salvador does

not report these crop-specific costs for each property.[40] However, the Ministry of Agriculture reports the production cost for each crop in 2007 by the Ministerio de Agricultura y Ganadería (2007b). To construct a proxy for profits per hectare for each crop i, I take the costs for each reported by the Ministerio de Agricultura y Ganadería (2007b; measured in dollars per manzana) and multiply this cost per the amount of land devoted to each crop (in manzanas). The costs used for each crop include estimated labor costs. I then normalize each measure by the property size in hectares (l_p). I take logarithms of the revenue and productivity measures because these measures are naturally right-skewed.

Finally, I follow the methodology suggested by Restuccia and Santaeulalia-Llopis (2017) and Aragon Sanchez, Restuccia, and Rud (2019) to estimate a producer-specific component of total factor productivity (TFP) for agricultural producers, denoted by $\ln(s_i)$. This measure has the additional benefit of controlling for unobserved shocks (such as weather shocks) and time-invariant differences in geography. I describe the construction of this TFP measure in more detail in appendix C.9.

Table 4 presents the regression discontinuity estimates from equation (1). Columns 1 and 2 report the estimates using revenue per hectare as the measure of productivity, columns 3 and 4 report the estimates using profits per hectare, and columns 5 and 6 report the estimates using farm productivity. Columns 1, 3, and 5 report reduced form estimates using an indicator variable for whether a property was owned in 1980 by an owner with over 500 ha in cumulative landholdings, while columns 2, 4, and 6 report second-stage estimates (i.e., fuzzy RD estimates described in sec. IV.D). As highlighted in section IV.D, not all properties above the ownership threshold were expropriated. Thus, columns 2, 4, and 6 use the indicator variable equal to 1 if a property was above the threshold as an instrument for an indicator equal to 1 if a property got expropriated and became a cooperative, and then estimates the second-stage regression using the latter indicator as the independent variable.

The estimated coefficients presented in table 4 suggest that cooperatives have 30% lower revenues per hectare, 9% lower profits per hectare, and 4% lower TFP. The main estimated coefficients are negative, suggesting there might be an equity/efficiency trade-off for cooperative ownership, as highlighted by Abramitzky (2018). However, this is only suggestive evidence because across all three measures of productivity, the estimated coefficients are imprecisely estimated and are not statistically significantly different from zero. RD plots for these variables are presented in appendix D.1.

[40] The census reports indicator variables for the use of some agricultural inputs. Interestingly, there are no differences in the probability of using a given input between cooperatives and haciendas—see fig. D13—suggesting that using the same production costs for a given crop is not an unreasonable assumption.

TABLE 4
COOPERATIVE PROPERTY RIGHTS AND AGGREGATE AGRICULTURAL PRODUCTIVITY

	REVENUE PER HECTARE (ln($/ha))		PROFITS PER HECTARE (ln($/ha))		FARM PRODUCTIVITY (ln(s_i))	
	(1)	(2)	(3)	(4)	(5)	(6)
Above 500	−.308	−.319	−.0891	−.0963	−.0381	−.0367
	(.362)	(.373)	(.734)	(.793)	(.0482)	(.0472)
Fuzzy RD	No	Yes	No	Yes	No	Yes
Observations	142	142	174	174	102	102
Clusters	91	91	113	113	68	68
Mean dependent variable	7.215	7.215	5.871	5.871	.329	.329
Bandwidth	101.8	101.8	120.7	120.7	77.78	77.78

NOTE.—Standard errors clustered at the former-owner level reported in parentheses. Revenue per hectare is measured as total value in 2007 dollars of crops produced divided by area in hectares. Profits per hectare is measured as total value in 2007 dollars of all crops produced minus the costs of production of each crop from MAG production reports divided by area in hectares. Farm productivity is constructed by estimating a producer-level production function and measures the producer-specific component of total factor productivity following the methodology developed by Restuccia and Santaeulalia-Llopis (2017). "Above500" is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. All regressions include a local linear polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidths are chosen using the MSE optimal procedure suggested by Calonico et al. (2017) and are reported in hectares.

Thus, even though the reform cooperatives in El Salvador differ considerably from haciendas in terms of their crop choices and yields for cash crops and staple crops as highlighted in section VI.A, the evidence presented in this section does not find conclusive evidence that they are either more or less productive than haciendas as measured by revenues per hectare, profits per hectare, or farm-specific TFP. Studies in other settings and industries comparing cooperatives to outside-owned firms have not found significantly large differences in efficiency (see Craig and Pencavel 1995; Pencavel 2013b). However, the results for this setting are inconclusive and cannot pin down the precise magnitude for the differences in aggregate productivity between cooperatives and haciendas.[41]

C. *Worker Income Distributions*

Using data from household surveys for El Salvador from 2002 to 2013, I examine whether cooperative members have more compressed income

[41] Due to power concerns with RD designs in general, I present the RD power calculations developed by Cattaneo, Titiunik, and Vasquez-Bare (2019) in fig. D14. The calculations suggest that the RD in this setting is underpowered for studying standardized effect sizes smaller than 0.50. Figures J1 and J5 plot the standardized (β) coefficients for revenues per hectare and profits per hectare, respectively, across different bandwidths and also show that the estimated effect is consistently imprecisely estimated regardless of the bandwidth.

TABLE 5
IMPACT OF OWNERSHIP TYPE ON EARNINGS AND EARNINGS DISTRIBUTIONS

	HOUSEHOLD EARNINGS PER CAPITA (PREVIOUS MONTH)			
	Levels		Interquartile Range	
	(1)	(2)	(3)	(4)
Above500	60.49*	52.79	−42.97**	−51.79**
	(31.03)	(40.61)	(17.82)	(24.79)
Observations	4770	1583	327	118
Properties	327	118	327	118
Clusters	98	36	98	36
Mean dependent variable	73.59	74.81	38.63	37.52
Bandwidth	300	150	300	150

NOTE.—Standard errors clustered at the former-owner level reported in parentheses. Household earnings per capita measures a household's monthly earnings per capita in dollars for agricultural workers in the El Salvador Household Surveys. Interquartile range measures the difference between the 75th and 25th percentile in reported household earnings per capita within each property. "Above500" is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. All regressions include survey fixed effects.

* $p < .1$.

** $p < .05$.

distributions compared to workers in haciendas. The theoretical framework presented in section V suggests that there may be incentives to redistribute earnings in cooperatives. I use the household survey data to examine whether cooperative members have more equal income distributions relative to the income distributions for current employees of haciendas.[42] To construct measures of the income distributions, I limit the sample to cooperatives and haciendas for which there are at least five members represented in the household surveys and examine the interquartile range of the income distributions within each property for cooperatives and haciendas.

Table 5 presents the estimated differences in earning levels and distributions. Columns 1 and 2 report the results for household earnings per capita in dollars per month for workers, while columns 3 and 4 show the interquartile range of earnings for cooperatives and haciendas. Columns 1 and 3 report the results limiting the sample to properties within 300 ha of the reform threshold, while columns 2 and 4 limit the sample of properties to those within 150 ha of the reform threshold. All regressions include survey round fixed effects. Columns 3 and 4 of table 5 show that the interquartile range of cooperatives is approximately $43 per month lower

[42] Unfortunately, the household surveys do not report whether workers are full-time or part-time. However, in this setting, haciendas and cooperatives use relatively small and similar numbers of temporary workers.

than the interquartile range of worker incomes for hacienda workers, consistent with cooperatives having more equitable income distributions.[43]

Additionally, I use quantile regressions to study how the income premium for cooperative workers varies across the worker income distribution. If cooperatives redistribute earnings as argued in section V, then we might expect that the magnitude of the earnings differential for working in a cooperative to be greater at the bottom of the wage distribution. To perform this analysis, I estimate quantile regressions to estimate the income earnings difference for being a worker in a cooperative at each 10% quantile $q \in [0.1,0.9]$ of the distribution of log monthly incomes for workers. I present the quantile coefficient estimates in figure 6. The figure shows that the income premium associated with being a worker in a property owned by a landholder in 1980 with over 500 ha in cumulative landholdings is highest in the lowest quantile and is smaller in higher quantiles. This suggests that the earnings policies within reform cooperatives seem to help workers at the bottom of the income distribution.[44] These findings that cooperative workers have more equitable income distributions are consistent with recent evidence from Burdín (2016), who compares labor-managed firms to outside-owned firms in Uruguay. This growing evidence suggests that cooperative ownership has important equity implications for workers.

D. Discussion

The results presented in this section reveal important differences between agricultural cooperatives and haciendas. Relative to haciendas,

[43] Columns 1 and 2 suggest that cooperative workers earn approximately $60 more per month compared to hacienda workers (consistent with one of the political goals of the reform). However, since the land was expropriated and workers became collective owners, the earning differences could be due to either rents from land ownership or greater efficiency of the cooperative structure. (Note that differences in land rents are unlikely to explain the income compression results since the interquartile range is mean invariant.) To examine whether rental rates can explain the income differences, I use estimates for the rental value of land in El Salvador to conduct sensitivity analysis accounting for different ranges of returns to the land for cooperatives. I present the results in table D4. I find that while the estimated differences in earnings remain positive for low and medium rental returns to land, the differences become negative for high values of land. Additionally, the differences are no longer statistically significant when accounting for potential rental returns. Thus, I am unable to conclude that the differences in worker income are due to greater efficiency of the cooperative structure.

[44] In this section, I only examine worker earnings; however, workers may also care about levels of access to public goods. Theoretically, both cooperatives and haciendas have incentives to provide some public goods to their workers (Abramitzky 2018). I complement these earnings results and empirically examine differences in access to public goods in app. E. I find that cooperative workers have more access to public goods. Interestingly, cooperatives also seem to have more access to government-provided public goods, suggesting that they are better at bargaining for access with the local government. However, the main results are not sensitive to controlling for distance to government centers.

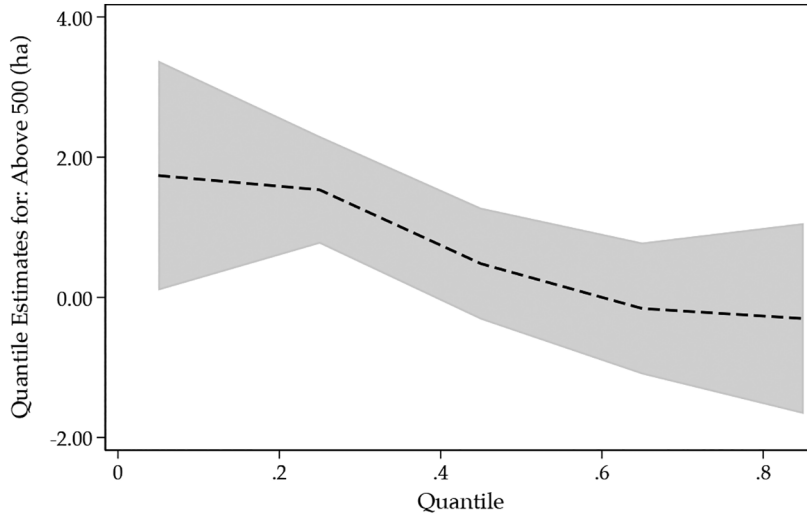

FIG. 6.—Quantile estimates, worker earning levels. The figure presents the estimated quantile regression discontinuity coefficients where "Above500," an indicator variable equal to 1 if the property was owned by a landholder with over 500 ha in cumulative landholdings in 1980, is the independent variable of interest and the log of worker earnings in the previous month (in dollars per month) from the El Salvador Household Surveys is the dependent variable. Gray areas represent the 95% confidence intervals. The regressions include survey fixed effects and control for the age, age squared, and sex of each worker. The regressions include linear polynomials for the cumulative landholding amount of a property owner in 1980 estimated separately on each side of the 500 ha threshold within a bandwidth of 150 ha from the reform threshold. Standard errors are clustered at the former-owner level.

cooperatives are less likely to specialize in cash crops and more likely to specialize in staple crops. Specifically, cooperatives devote a larger share of their land to the production of staple crops instead of cash crops compared to haciendas. As well, relative to haciendas, cooperatives are less productive for cash crops but more productive for staple crops. Additionally, there is no strong evidence that cooperatives are less productive on aggregate compared to haciendas.

These findings are broadly consistent with the predictions from section V. First, the theory predicts that cooperatives will be less likely to choose cash crops relative to haciendas. Cooperative voting by workers leads to voters deciding to devote more land to produce (private) staple crops instead of cash crops—where the earnings may be redistributed and, thus, have worse work incentives compared to staple crops—while haciendas devote a larger share of land to cash crops to maximize profits for the owner. However, cooperatives still choose to invest in producing cash crops because of median voters benefiting from some redistribution. Second, the theory predicts that cooperatives will be more productive than

haciendas when producing staple crops and not cash crops. This is because cooperatives will redistributive earnings for cash crops, reducing work incentives. However, since cooperatives are contractually constrained by the fact that members can choose to consume some of their staple crop production, earnings for staple crops will be private, inducing higher incentives for work on these crops.[45] The results provide evidence on the causal impacts on agricultural productivity and choices of cooperative property rights relative to outside ownership and highlight how cooperative property rights induce different specialization choices compared to outside ownership.

Interestingly, this set of results is consistent with the limited empirical and noncausal literature comparing cooperatives to outside-owned firms in other settings. For example, reviews provided by Bonin, Jones, and Putterman (1993) and Pencavel (2013a) on these studies highlight that these studies have generally found that cooperatives have more equitable compensation structures than outside-owned firms. As well, these studies tend to find little evidence that cooperatives are less productive than outside-owned firms, and that cooperatives tend to choose to specialize in industries in which workers themselves are more of the residual claimants on their individual effort rather than the outside owner.[46] This finding on specialization is similar to the predictions of the model in section V comparing staple crop to cash crop allocations.[47] This finding is also related to the observation by Abramitzky (2018) that profit sharing seems to be more sustainable in cases in which output is more observable.[48] Thus, while this set of studies does not address the endogeneity of the choice of ownership structure, the causal estimates and results presented in this paper match these broader patterns in differing data sets and settings in which researchers have compared cooperatives to outside-owned firms.

[45] In addition, while the results in table 3 do not contain information on input use (because of to data constraints), cooperative members might also use more optimal levels of purchased inputs than do workers on haciendas, in addition to more effort. This input use pattern would be consistent with the possibility that cooperatives use the surplus cash crop earnings to help their members buy and access inputs. I thank a referee for this observation.

[46] Note that some of these findings on sectorial specialization abstract from political economy forces regarding the choice of property rights regimes across industries. The set of findings, however, may help inform the potential reasons why governments endogenously select cooperative property rights arrangements (e.g., to benefit certain sectors).

[47] Additionally, other work has highlighted that cooperative ownership may lead to stronger norms of cooperation and solidarity (see, in particular, Abramitzky 2018). Stronger cultural norms of cooperation may reduce the moral hazard problems. Interestingly, the results suggest that cooperatives are much less likely to devote land to cash crops (for which profits get redistributed) and instead devote more land to staple crops, compared to haciendas.

[48] Abramitzky (2018) also suggests a complementary interpretation to the specialization findings: when output or effort is more observable, it may be easier to sustain more profit sharing through the use of social sanctions (to alleviate the moral hazard problem inherent in profit sharing). See also Kandel and Lazear (1992).

E. Robustness

1. Alternative RD Specifications

In this section, I describe additional robustness checks to regression discontinuity results presented in section VI. One possible alternative explanation for the results is that the patterns found in the data exist only for very specific regression discontinuity specifications. To examine whether the results are robust to alternative RD specification choices, I conduct a number of robustness checks that I present in the appendixes. In particular, in appendix J, I present the main results using alternative RD polynomials (constant, linear, and quadratic, estimated separately on each side of the threshold), using additional bandwidth options suggested by Calonico et al. (2017), and varying the kernel choice to the RD results. Additionally, I present the results employing local randomization methods suggested by Cattaneo, Frandsen, and Titiunik (2015) in appendix I. Overall, I find that the set of results discussed in section VI is robust to alternative RD specifications.

2. Alternative Empirical Strategy: Matching Estimates

An important concern with the regression discontinuity strategy used so far is that it relies on the identifying assumption that properties above the reform threshold are similar to properties just below the threshold. While section IV.C shows suggestive evidence that the two sets of properties are balanced on key geographic characteristics, the estimates are imprecise.

To address the concern that the properties might be unbalanced, I present results using an alternative matching strategy. Specifically, because the reform threshold was based on cumulative landholdings rather than the size of a particular property, I can compare properties that are highly matched on all key dimensions (e.g., size and geographic characteristics), aside from whether or not they became a cooperative.[49] I present the results in figure D4 from using this matching strategy. I find that the matching results are quite similar in terms of magnitudes and statistical significance to the RD results. This provides complementary evidence that the results are due to differences in ownership structures.

3. Temporal External Validity

The aggregate measures of productivity presented in section VI.B have a few important limitations. Aggregate measures of productivity may

[49] The threat to validity for this strategy is that properties with similar observables might be systematically different if one is owned by a large landowner while the other one is owned by a smaller landowner and this difference in landowner type directly affects the outcomes of interest. However, because this is a different threat to validity, the strategy is meant as a complement to the RD approach.

obscure important crop-specific differences in production choices and productivity. Additionally, because crop prices are volatile and the measures are weighted by prices in 2007, a particularly high (low) price of a crop in 2007 will give much more (less) weight to this crop in the productivity measures. Price shocks could potentially make some producers seem more productive, even without underlying productivity differences. For these reasons, I perform an exercise in which I calculate both measures of productivity using all crop prices from 2005 to 2015, holding constant quantities and crop choices. I then plot the estimated productivity differences to examine whether the differences in productivity examined in section VI.B are sensitive to the use of other crop prices from other years. This exercise has the additional benefit of examining whether there is evidence of the temporal external validity of the results, as suggested by Rosenzweig and Udry (2020).

To perform this exercise, I use crop prices and production costs from the El Salvador Ministry of Agriculture (MAG) from 2005 to 2015. The MAG price data are provided by the Ministerio de Agricultura y Ganadería (2005–2015b) while the production costs data are provided by the Ministerio de Agricultura y Ganadería (2005–2015a).[50] Using these crop prices and costs, I recalculate the measures of agricultural productivity for each year, holding the crop mix and quantities produced constant for each property at their 2007 level from the agricultural census. I then estimate equation (1) for each year and plot the coefficient on a property being owned by an owner in 1980 with over 500 ha in cumulative landholdings in figure D6. The results suggest that the estimates presented in section VI.B are not particularly sensitive to the specific prevailing prices and costs in 2007.

VII. Examining Alternative Explanations

In this section, I examine whether alternative explanations on possible differences between cooperative ownership and outside ownership are also consistent with the agricultural choices, productivities, and equity results in section VI that might be different from the agency mechanisms highlighted in the incomplete-contracts model described in section V. Specifically, I examine whether differences in credit access, crop risk, capital use, insecurity, human capital investment, or worker migration can explain the differences observed on agricultural choices, productivities, and equity.

[50] Importantly, the MAG reports domestic crop prices for El Salvador. This is critical because staple crops are not always traded on international markets; therefore, world prices for these crops may differ considerably from domestic prices. The MAG does not report sugarcane prices, only processed-sugar markets; instead, I use FAO data on sugarcane prices for El Salvador.

TABLE 6
CREDIT ACCESS AND SOURCES: RD ESTIMATES

			Credit Source			
	Applied for Credit (1)	Credit Approval Timely (2)	State Bank (3)	Private Bank (4)	Credit Coop (5)	NGO (6)
Above500	.205	−.0322	.687**	−.302	−.254	−.0307
	(.245)	(.0322)	(.318)	(.458)	(.218)	(.0635)
Observations	215	62	23	34	62	52
Clusters	133	53	17	28	52	43
Mean dependent variable	.302	.968	.348	.471	.113	.0385
Bandwidth	122.8	120.1	71.33	84.84	118.4	107.9

NOTE.—Standard errors clustered at the former-owner level reported in parentheses. "Applied for credit" is an indicator variable equal to 1 if the property reported applying for credit. "Credit approval timely" is an indicator variable equal to 1 if the property reported that the credit approval was timely. In the sample, all properties that applied for credit report being approved for credit. Credit source variables are an indicator variable equal to 1 if the credit used by the property comes from a state bank, private bank, credit cooperative, and NGO, respectively. "Above500" is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. All regressions include a local linear polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidths are chosen using the MSE optimal procedure suggested by Calonico et al. (2017) and are reported in hectares.
** $p < .05$.

Additionally, I examine whether cooperatives that are more heterogeneous are less productive to test a secondary prediction of the model.

A. *Alternative Explanation: Credit Access*

One potential alternative explanation for the differences in crop choices between cooperatives and haciendas is that cooperatives may have less access to credit than haciendas; this may explain their crop choices. The agricultural census provides questions on whether properties applied for credit, whether the credit was approved (and approved in a timely manner), and the sources for this credit.[51] Table 6 presents the estimates from estimating equation (1) for these outcome variables, except for whether the credit was approved as every property in the sample reports that their credit application was approved. Cooperatives are not less likely to have applied for credit, and they tend to receive credit from sources similar to those for haciendas. These findings are consistent with key institutional features of cooperatives in El Salvador—where cooperatives can legally use their land collectively as collateral for loans (see

[51] Unfortunately, the census only includes binary questions of whether properties applied for and received credit, not intensive margin questions on how much credit they receive. However, if cooperatives were credit constrained, it is likely that one would observe differences in success in credit applications and differences in the sources of credit used.

app. A)—and suggest that differences in credit access are unlikely to explain differences in crop choices.[52]

B. Alternative Explanation: Crop Risk

A second potential difference between cash crops and staple crops is that cash crops might be subject to more price risk. As discussed in section V, this type of risk cannot be managed through the redistribution of earnings among cooperative members. Thus, if cash crops have more price volatility and cooperatives are more risk averse than haciendas, this could explain differences in crop choices. Using monthly crop price data from the Ministerio de Agricultura y Ganadería (2005–2015b), I examine whether cash crop prices are more volatile than staple crop prices in several ways. First, I calculate the 6 month rolling standard deviation of prices for a portfolio made up of the main staple crops (equal parts maize and beans) to a portfolio consisting of the main cash crops (sugarcane and coffee) and plot the results in figure D22. Staple crop prices seem to be just as volatile by this measure. To examine whether this result is driven by a particular crop, figure D23 plots the 6 month rolling standard deviation for these four crops separately and shows that the results are not driven by a particular crop. Next, instead of examining rolling standard deviations, I construct the return (log price return) for each crop over different time periods. Specifically, I examine what return a crop would have if purchased at the start of a period and held until the end to examine whether the returns to cash crops are more volatile than staple crop returns. I plot these crop returns for the four main crops—maize, beans, sugarcane, and coffee—for periods of 1 year, 6 months, or 1 month in figures D24, D25, and D26, respectively. There is little evidence that the returns on cash crops are more volatile than the returns to staple crops in El Salvador.[53]

[52] One additional possible reason for differences in crop choices is that because former landowners' connections were important for market access (Browning 1971), reform cooperatives may have lost market access and may not have been able to reestablish connections to the market after reform. I thank a referee for this comment. In app. F, I explore whether there are differences in the commercialization sources between cooperatives and haciendas today. I find no evidence of significant differences across ownership structures, and show that the results are robust to controlling for the main commercialization avenue used by each property. Additionally, I find little evidence of heterogeneity in the main results by whether properties are close to markets or not. These results suggest that cooperatives have been able to reestablish similar market access.

[53] One additional possible hypothesis for differences in crop choice due to risk is that if cooperatives consume much of what they produce, then they are not fully proportionately affected by market price changes for staple crops (whereas they would be fully affected by changes in cash crops that are never consumed). For instance, Fafchamps (1992) provides a model in which small-scale farmers may be more likely to produce staple crops rather than cash crops because of self-sufficiency concerns and missing rural credit markets. However, note that in this setting, the cooperatives are large, have similar levels of access to credit to potentially smooth price shocks, and produce large amounts of staple crops (i.e., much more than the amount needed solely for self-consumption). Thus, this explanation is unlikely to drive the differences in crop choices in this context.

C. *Alternative Explanation: Capital Use*

Another potential difference between cooperatives and haciendas is that cooperatives may be less likely to make capital investments because of holdup problems across members (Hansmann 1996). Specifically, since cooperatives need to vote on major capital purchases, it may be harder to make these decisions relative to haciendas, where only the owner needs to make a decision. To examine whether this alternative story is consistent with the results, I use agricultural census data on whether a property owns various capital goods such as machinery and equipment to compare differences in capital ownership.[54] I examine two types of capital goods: general agricultural capital and cash-crop-specific capital. If cooperatives invest less in both types of capital goods compared to haciendas, then this would be consistent with the holdup argument. In contrast, if cooperatives invest similarly for general agricultural capital compared to haciendas, this would provide some evidence that is inconsistent with the holdup problem. I present the estimated differences for these capital goods in figure D12. The estimates show that cooperatives are not less likely to own capital for all goods: cooperatives are only less capital intensive for goods used for cash crops—such as coffee-processing machinery—but not less capital intensive for other general agriculture capital goods.[55] The results suggest that capital holdup is unlikely to explain differences across cooperatives and haciendas in this setting.

D. *Alternative Explanation: Insecurity Following Reform*

A potential explanation for the results is insecurity following the land reform. This includes both property rights insecurity for haciendas shortly following the reform, and physical insecurity due to Civil War violence. I examine whether these differences in security might explain the long-run differences in crop choices, productivities, and worker incomes in turn.

First, important contextual details underscore that property rights insecurities for haciendas existed only for a period of 2 years and, in fact, government policies following reform have tended to lock-in haciendas and cooperatives. In particular, the pro-land-reform leaders were ousted from the military government in December 1980; phase II of the reform was officially called off in March 1982 following the election of an anti-land-reform civilian government (Figueroa Aquino and Marroquín Mena

[54] The census only reports the extensive margin on these goods and not the intensive margin.

[55] One possible explanation for these results, aside from crop choices driving capital choices, is that cooperatives face a holdup problem specifically for cash crop capital; however, it is unclear why holdup would only apply to cash crop capital and not other types of capital.

1991; Velis Polío 2012).[56] This civilian government ratified a new constitution that barred future land transactions for properties over 245 ha, effectively locking-in haciendas and cooperatives by introducing considerable land market frictions. In addition, following the Civil War, there was little government policy intervention in either ownership form: the right-leaning ARENA party that remained in power until 2009 did not prioritize the agricultural sector.[57] These contextual details specific to El Salvador highlight that, in this setting, property rights insecurity was short lived and is unlikely to explain the long-run differences between cooperatives and haciendas.

Second, the years following reform were marked by periods of violence and physical insecurity due to the Civil War. To empirically explore whether physical insecurity might explain the long-run differences between cooperatives and haciendas, I digitized detailed conflict data from the UN Truth and Reconciliation Report for El Salvador (Commission on the Truth 1993). This report contains extensive data on all reported conflict incidents during the El Salvador Civil War at the canton level, including information on the perpetrators of each event.[58] Using these data, I estimate (1) but control for exposure to various types of violence and conflict during the Civil War to explore whether the results are sensitive to the inclusion of these controls. I present the estimated coefficients in figure D18. I find that the results are not sensitive to the inclusion of violence controls. These results provide evidence that the long-run results are unlikely to be driven by short-run changes in security following reform.

E. Worker Human Capital

One additional reason cooperatives may differ from haciendas is due to differences in human capital investment. As noted by Abramitzky (2018), cooperative workers face opposing incentives for investing in human capital. On the one hand, compared to hacienda workers, cooperative workers

[56] Note that the insecurity for haciendas following phase I but before phase II was called off could have led them to switch their crop choices and that this might explain some of the crop differences today. However, this explanation is at odds with both qualitative evidence and empirical evidence. First, qualitative accounts detailed in app. A highlight that the switch in crop choices was instead driven by cooperatives moving away from cash crops shortly after the reform (e.g., Perez Riva and Chavez Castro 1986; González and Romano Martínez 2000; Wood 2003). Second, in fig. D20, I compare the crop allocations for haciendas below the threshold to haciendas that were above the threshold but were not expropriated (and might have felt relatively more secure given that they survived phase I). I find little evidence for differences in crop allocations across these two groups, providing additional suggestive evidence that a lack of security between phase I and the official calling-off of phase II did not lead to lasting crop allocation differences.

[57] See app. A for more information.

[58] The three main actors during the Civil War were the military, left-wing insurgents (FMLN), and right-wing paramilitary groups.

might have lower incentives to invest in education due to the redistribution of earnings across workers. On the other hand, in their role as owners, cooperative workers collectively benefit from a more educated workforce.[59] Likewise, hacienda owners might have reasons to provide education to improve the productivity of their workforce. However, both cooperatives and haciendas have incentives to not induce too much investment in education, as this might increase workers' outside options and lead to brain drain (discussed in sec. VII.F). For all these reasons, it is unclear ex ante whether cooperative workers or hacienda workers will have higher levels of human capital investment.

To test these hypotheses, I compare education outcomes for cooperative workers and hacienda workers using household survey data and present the results in appendix G. I find that, compared to hacienda workers, cooperative workers are more likely to be literate and have more years of education. These results suggest that cooperative workers have higher levels of human capital investment compared to hacienda workers.

F. Worker Selection and Migration Patterns

In this section, I explore whether there are differences in migration patterns for cooperatives compared to haciendas. As noted by Abramitzky (2018), cooperatives face two different incentive problems that might induce different migration patterns.

First, cooperatives may face adverse selection issues: lower ability workers might be more willing to join a cooperative due to the redistribution of earnings. As detailed in appendix A, cooperatives in El Salvador make joining difficult for prospective members: joining entails a long screening process and requires a supermajority approval by cooperative members.[60] However, even with these mechanisms in place, cooperatives may still face adverse selection.

Second, cooperatives may suffer from brain drain. As Abramitzky (2008, 2018) and Burdín (2016) discuss, high-ability workers have a higher incentive to leave cooperatives because they have higher outside options and benefit less from the redistribution across members. Cooperatives try to limit this brain drain by "locking-in" cooperative assets via communal ownership: quitting members forfeit their land and access to cooperative public goods.[61] Yet even with these rules in place, brain drain is potentially more of a problem for cooperatives.

[59] In fact, many cooperatives often set up schools for their members using their shared profits as a form of redistribution across workers (see app. A).

[60] Interestingly, these screening mechanisms are similar to the rules put in place by kibbutzim to address adverse selection (Abramitzky 2018).

[61] Again, this is quite similar to how kibbutzim try to limit brain drain (Abramitzky 2018, 134). See fig. E1 for evidence that cooperatives provide more public goods than haciendas.

To empirically examine the consequences of these incentive problems, I explore differences in worker characteristics and differences in worker migration patterns in appendix H. An important implication of cooperatives facing more adverse selection and brain drain is that cooperative workers should be of "lower ability" than hacienda workers. While worker ability is unobservable, I proxy for differences in worker ability by examining differences in worker education, literacy, and age in appendix G. I find that cooperative workers are more educated and literate compared to hacienda workers. Additionally, cooperative workers are not significantly older than hacienda workers.[62] This suggests that even with adverse selection and brain drain problems, I find no evidence that cooperative workers are of observably worse quality than hacienda workers.

Second, to examine whether there are different patterns of migration for cooperatives and haciendas, I compare migration patterns for cooperatives and haciendas in appendix H by using data from both household surveys and the 2007 population census. At the individual level, I find some evidence of brain drain: cooperative families tend to have more household members abroad. At a more aggregate level comparing across cantons, I find no evidence of adverse selection—cantons with more cooperatives do not have higher rates of in-migration—but I do find some weak and imprecise evidence of brain drain—educated workers are more likely to leave cantons with more cooperatives. Importantly, given the higher levels of human capital in cooperatives (see sec. VII.E), the differences in migration are not strong enough to lead to an overall lower quality workforce. Note that this finding is potentially due to particular features of the context: cooperatives are allowed to institute rules to address these incentive issues (screening and lock-in) and there are low levels of mobility for rural workers in El Salvador.

G. Heterogeneity in Cooperatives

A secondary prediction of the theoretical framework outlined in section V is that cooperatives with more heterogeneity in membership are less productive. The ideal measure of heterogeneity within a cooperative would be the distribution of ability of all cooperative members. However, these data does not exist as there is no complete census of all cooperative members for El Salvador. Thus, to explore this secondary prediction, I construct a proxy measure of heterogeneity in members by using the heterogeneity in the characteristics of agricultural workers within the census neighborhood of a cooperative using the 2007 population census of El Salvador (*Censo de Población y Vivienda 2007*). The census provides

[62] The estimated coefficient is also small in magnitude: cooperative workers are estimated to be 0.46 years older relative to a mean of age of 39 years.

information on demographics and occupational sectors of all individuals, as well as very detailed geographic information on the current residence of all individuals in El Salvador. Specifically, the census reports the *segmento censal* for each individual (roughly equivalent to neighborhoods). I use the geographic information from the census and ISTA maps on the location of expropriated properties to construct finer measures of the characteristics of the *segmentos censales* that are likely part of a cooperative.[63] I combine this census data with maps on the location of the reform cooperatives from ISTA and calculate measures of the heterogeneity in demographic characteristics for the census neighborhoods within 100 ha of each cooperative. Following Friebel et al. (2017), I use the variation in the ages of agricultural workers for each cooperative's census neighborhood as a measure of the heterogeneity of a cooperative.

Table D6 (tables B1–B3, D1–D7, F1, G1, G2, H1–H3, I1, I2, and J1–J5 are available online) presents the results of estimating equation (1) for samples above and below the median for the difference between the mean and median age of agricultural workers in a census neighborhood near each cooperative. Columns 1 and 3 present the RD estimate using cooperatives above the median value of age distribution while columns 2 and 4 present the RD estimate using cooperatives below the median value. I find suggestive evidence that cooperatives that have more age inequality have lower profits per hectare relative to those with less inequality. The results suggest that cooperatives with more heterogeneity seem to be less productive, consistent with the framework in section V.[64]

VIII. Conclusion

Property rights institutions are of central importance to understanding economic development (Alchian and Demsetz 1972), particularly because there is considerable heterogeneity in ownership structures across the world (Hansmann 1996). Economists have developed a rich theoretical literature on the impacts of differences in ownership structure on firm choices. Yet, because property rights are often endogenously determined, there is limited causal empirical evidence on the impacts of different property rights systems.

This paper addresses this gap in the literature by presenting causal evidence on the effects of cooperative property rights on agricultural productivity and economic development in the context of the El Salvador land reform program of 1980. I find that the reorganization of properties

[63] I am only able to do this for the cooperatives and not the haciendas as there is no equivalent map of the locations of haciendas.

[64] Note that the results in table D6 are consistent with the model but are not a definitive test of the model (because there could be a correlation between age heterogeneity and having more older, possibly less productive workers).

above the 500 ha cumulative landholding threshold from outside ownership (haciendas) into cooperatives following the land reform had two important impacts. First, the reform led to a shift in the type of agriculture practiced. Compared to properties that remained as haciendas, cooperatives tend to specialize in staple crop production instead of cash crop production. Additionally, relative to haciendas, cooperatives are less productive when producing cash crops but more productive when producing staple crops. Second, cooperative property rights have led to higher incomes and more equitable wage distributions for current cooperative members relative to workers on the haciendas. These results suggest that cooperative property rights have changed the patterns of production in agriculture in El Salvador and have increased equity among workers.

The evidence presented in this paper hopefully also serves as a starting point to understand the understudied consequences of similar land reforms that were implemented across Latin America.[65] Many countries in Latin America reorganized haciendas into cooperatives, and the impacts of these land reforms may be important for understanding Latin America's comparative economic development. Future research could use linked administrative data to explore the impact of cooperative ownership on individuals, use political data to understand the political consequences of cooperative formation, or use data on social norms to understand how cooperatives change social norms. For instance, Abramitzky (2018) highlights how kibbutzim have led to different social norms and values and also provides an argument for how social norms can lead to more equitable cooperative arrangements: profit sharing may be more sustainable for tasks for which effort or output is more observable through the use of social sanctions. Thus, exploring the role that social norms may have on the success of cooperatives is an important avenue for future research as well.

The results in this paper also speak to a modern policy question in Central America today, where there has been renewed interest in exploring "cooperative development" in the last few years. In fact, the United Nations declared the year 2012 as the "International Year of Cooperatives." Thus, understanding the long-run impacts of land reforms that reorganized firms from outside ownership toward cooperatives can provide important evidence on the implications of cooperative property rights for economic development.

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[65] The evidence is also of importance for El Salvador: since 2013, the government has decreed March 6 "National Land Reform Day" (Decree 289).

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