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

Eduardo Montero†

12 May 2020
Most Recent Version Here

Abstract: In cooperative property rights systems, workers jointly own and manage production, whereas in outside-ownership systems, an owner contracts workers. Despite a rich theoretical literature on how the organization of property rights matters for equity, efficiency, and specialization, little causal evidence of their impacts exists. During a land reform in El Salvador in 1980, properties owned by individuals with cumulative landholdings over 500 hectares were reorganized into cooperatives managed by the former *hacienda* workers. Properties belonging to individuals with less than 500 hectares remained as outside-owned *haciendas*. Using the discontinuous probability of a property becoming a cooperative and regression discontinuity design, I present causal evidence on the effects of cooperative property rights relative to outside ownership on agricultural choices, productivity, and worker equity. The reform cooperatives are (i) less likely to produce cash crops and more likely to produce staple crops; (ii) less productive when producing cash crops but more productive when producing staple crops; and (iii) have more equitable worker incomes relative to outside-owned *haciendas*. The results are consistent with an incomplete contracting model that compares cooperatives and *haciendas*.

Keywords: Property rights, cooperative ownership, land reform, Latin America.

*I thank Ran Abramitzky, Emily Breza, Melissa Dell, Raissa Fabregas, James Feigenbaum, Price Fishback, Siddharth George, Selim Gulesci, Claudia Goldin, Oliver Hart, Richard Hornbeck, Nancy Qian, Sara Lowes, Michael Kremer, Edgar Marroquín Mena, Nathan Nunn, Gautam Rao, James A. Robinson, Raul Sanchez de la Sierra, Nihar Shah, Andrei Shleifer, Edoardo Teso, Peter Tu, Diego Ubfal, Felipe Valencia Caicedo, Jack Willis, and participants at the Harvard Development Lunch, Harvard Economic History Lunch, Stanford History Group, and Northwestern Development Rookiefest for excellent comments and suggestions. I thank Sandra Diaz, Veronica Melgar, Jose Luis Orellana, Elias Preza, and Xenia Zuniga for their invaluable help. I thank Carlos Schmidt-Padilla and Maria Micaela Sviatschi for generously sharing data. I am grateful for the financial support from the Danielien Travel Research Grant, IQSS, and the Economic History Association.

†University of Michigan, Ford School of Public Policy, 735 S State St, 4219, Ann Arbor, MI 48109. Email: emontero@umich.edu. Website: www.eduardo-montero.com.

1. Introduction

Across the world and throughout history, we observe many types of ownership structures (Otsuka et al., 1992; Hansmann, 1996). Instead of relying only outside ownership, where owners contract workers, societies have often used cooperative ownership, where workers jointly own and manage production on a one-member one-vote basis. Cooperative ownership is prevalent in many settings, such as at U.S. law firms (*partnerships*), in timber production in the pacific northwest in the U.S., firms in Uruguay and Italy, and in the *kibbutz* system in Israel (Pencavel, ed, 2013; Dow, 2003). 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 (see Figure 1).

A key 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 effort, equity, and efficiency under certain conditions (e.g. Sen, 1966; Bonin et al., 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 right 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 non-cooperatives 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 et al., 1993; Pencavel, ed, 2013).

This paper exploits unique features of a land reform program from El Salvador in 1980 to study the causal impacts of cooperative property rights 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 hectares 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, productivities, 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 Hart and Moore, 1998, and Kremer, 1997). 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 contractability, i.e. 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 consumed the output, rendering the contract untenable. In contrast, I assume that the output from cash crops – such as sugar cane 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-rent extraction trade-off that leads to production inefficiencies. Specifically, 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 non-contractible 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 sugar cane 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.[1] These results are consistent with the property rights model of cooperatives and focus group discussions with cooperative workers: cooperative will tend to redistribute cash crop earnings, reducing worker incentives for these crops, whereas staple crop earnings will not subject to this redistribution because their output is non-contractible as workers can consume staple crops directly if their output is taxed. As a result, cooperatives are more likely to focus on staple crop production and are more efficient than *haciendas* at producing staple crops.

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 and those working on *haciendas*. Consistent with the model, the income distributions for cooperative workers are more equitable compared to the income distributions of workers on *haciendas*.

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 Bonin et al., 1993; Pencavel, ed, 2013, for reviews). 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 U.S. 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)

[1] 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.

study medical group partnerships to examine the impacts of profit sharing on productivity.[2] 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.[3] 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*.[5] Motivated by the existence of cooperatives in agriculture, these models similarly studied cooperative members' labor allocation between collective and private production (Sen, 1966; Domar, 1958; Bonin, 1977; Israelseni, 1980; Putterman, 1980, 1981). A common assumption in these models is that effort could be costlessly observed. Motivated by advances in the incomplete contracts literature, subsequent models have examined labor effort choices where effort is unobservable and contracts are incomplete (Hart and Moore, 1996; Kremer, 1997).[6] 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 where 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.[7]

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.

[2]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 Putternman, 1997).

[3]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 if this is due to initial differences in worker attributes (or differences in capital requirements), or due to incentive and agency issues inherent to profit sharing.

[5]The first analysis of cooperative production was provided by Ward (1958), who noted that cooperatives' objective functions differ from capitalist firms due to profit sharing.

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

[7]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 et al., 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 et al., 1984) This paper contributes to this literature by examining share contract decisions under differing ownership structures.

Abramitzky (2008) models *kibbutzism* 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 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 et al. (2002) examine tenancy reform in West Bengal and find large impacts of tenancy reforms on agricultural productivity.[8] This paper contributes to this literature by examining the impact of the specific form of cooperative property rights that was frequently implemented during 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 right reforms instead of focusing on short-term impacts.[9] Land reforms can often be disruptive, implemented in times of civil conflict, and may also impact views on the security of differing property right reforms. Thus, studying the longer-run consequences allows me to better isolate the differences due to property right changes.[10].

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

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

[9]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.

[10]A large theoretical and empirical literature in development suggests that private and secure property rights are a pre-requisite 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. (2018), 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.

in agriculture relative to non-agricultural production in developing countries is much larger than the gap in developed countries (Gollin et al., 2002; Restuccia et al., 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 2 provides background on the El Salvador land reform. Section 3 describes the data, and Section 4 describes the empirical strategy and tests the main identifying assumptions. Section 5 presents the theoretical framework to guide the empirical results. Section 6 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 7 examines alternative explanations for the results. Section 8 concludes.

Figure 1: Land Reforms that Redistributed *haciendas* as Cooperatives

Notes: Constructed using de Janvry (1981) and Albertus (2015)

2. Background on the 1980 El Salvador Land Reform

The 1980 El Salvador land reform had several features that allow me to compare properties that were reorganized into cooperatives to those that were not reorganized into cooperatives. First,

I explain the design and implementation of El Salvador's 1980 land reform law that defined a landholding threshold for expropriating properties and creating cooperatives. I then discuss the steps taken by the government to ensure that the land reform was unexpected for landholders and executed swiftly.

2.1. Decree 153

On March 5th, 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 hectares 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 hectares 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).[11] Rather than providing individual title and possession to workers,

[11] Interestingly, the value of these bonds was tied to the reported property values used in tax filings before the land reform. However, even though landholders had likely underestimated their land values to reduce their tax burdens, due to the outbreak of war (and outmigration of former landholders), the majority of landholders accepted the compensation (Marroquín Mena, 1988).

ISTA organized former *hacienda* laborers into agricultural producer cooperatives where 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.[12]

Approximately 20% of all of El Salvador's farm land was expropriated during Phase I of the agrarian reform (Marroquín Mena, 1988). This expropriated land made up 14 percent of total coffee land, 31 percent of cotton land, and 24 percent of all sugarcane land in El Salvador (Seligson, 1994). Roughly 31,000 working families, or one-fifth of agricultural laborers, in El Salvador, benefited from the land reform (Mennen, 2009).

2.2. *Planning and Execution of the Land Reform*

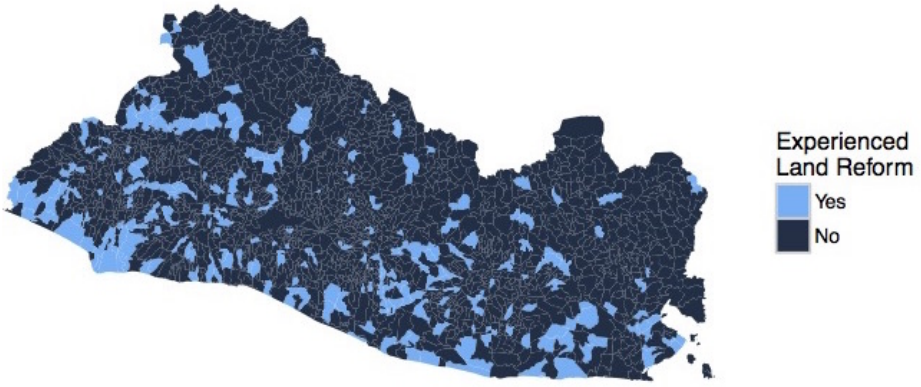
Critically, the 1980 land reform program was unexpected for large landholders. According to accounts from the individuals responsible for its design and implementation, the land reform was "prepared under immense secrecy and executed at full velocity" to avoid strategic adjustments by the landholders (Velis Polío, 2012, pg. 117). The land reform was prompted by the unexpected addition to military junta leadership of a pro-land reform Colonel on March 3rd, 1980. Between March 4th and March 5th, the government took a number of steps to keep the land reform secret. On March 4th, the military leadership called a fake "inter-agency 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 5th, after the "inter-agency 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, pg. 110). Specifically, the government planners did not have enough agronomists and agricultural personnel to expropriate all landholdings over 100 ha and therefore

[12]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.

[13]Additionally, there had also been a freeze on land transactions since October 1979 (Decree 43, Jurado Castillo et al., 1993). This freeze applied to all land over 100 ha (Velis Polío, 2012, pg. 99). See Appendix D for more information.

Figure 2: Land Reform by Canton - El Salvador



Notes: Data are from MAG (1983). *Experienced Land Reform* is equal to *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.

settled on 500 ha as a temporary cut-off. As Velis Polío (2012) 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, pg. 112).

The secrecy of the planning and the swift execution of the reform made it unexpected to large landholders. As Velis Polío (2012, pg. 112) notes, the land expropriation on March 6th, 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."

3. Data

3.1. Data Sources on Land Reform in El Salvador

I gathered government records on reform expropriation, cooperative formation, and pre-reform landholdings to identify properties above 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 pre-reform 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 pre-reform landholdings from 1980 and contain the size in hectares, the canton, and the former owner for each property.[15]

3.2. 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 A I provide more information on the variables used in the analysis, the institutions involved in the census, and the data collection process.[16]

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 3.1 to the corresponding property today using the name, municipality, department and the size of the

[14]See Data Appendix for more details on these sources.

[15]Using two separate data sources for the 1980 landholdings is not ideal because there could be differences in reporting across these two sources (even though this is very unlikely since both sources use data from the property registry of El Salvador). Colindres (1977) provides a similar list of properties owned by landholders with over 100 ha in cumulative landholdings for 1971 for eight of the eighteen districts of El Salvador. Therefore, I use data from Colindres (1977) as a check on the pre-reform landholding distribution to ensure that the 1980 landholding data is reliable.

[16]In particular, I explain that key details of the institutional context and the census enumeration process mean that workers likely report reliable measures of output to government enumerators.

property in ha.[17] Across the threshold, I am able to match approximately 70% of the pre-reform landholdings to a modern-day 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.[18] See Figure A8 for the RD plot of the probability of existing today.[19]

3.3. 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 2002-2013. 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 an *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 using the 2008-2010 household surveys for which I received access to the property/cooperative name for agriculture workers.[20]

[17] 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 in World Bank (2012) to study the reform cooperatives. See Appendix A for more information.

[18] This finding is consistent with work by Burdín (2014), who shows that worker-owned firms are not more likely to fail in Uruguay.

[19] However, one additional possible concern is that the reasons for not finding a match differ systematically across the threshold. In Appendix A 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).

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

4. Empirical Strategy

4.1. 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 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:

$$y_{po} = \alpha + \gamma Above500_o + f(holdings_o) + \epsilon_{po} \quad for \quad o \in RS \tag{1}$$

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.[21] $f(holdings_o)$ is the RD polynomial which controls for a smooth function of total landholdings by owners. Following Calonico et al. (2014a,b), the baseline specification for equation (1) uses a local linear specification estimated separately on each side of cut-off. 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 of the point estimator developed by Calonico et al. (2014b, 2017). Appendix M 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.

[21] Specifically, $Above500_{p,o} = \mathbb{1}(\text{Cumulative Landholdings}_o \geq 500\ ha)$. 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 $Above_{p,o} = \mathbb{1}(\text{Cumulative Landholdings}_o \geq 500\ ha) \neq \mathbb{1}(\text{Land Size}_{po} \geq 500\ ha)$. This is because a former owner could have owned multiple properties (e.g. two properties, both 300 ha in size) where the sum of their sizes was over 500 ha. If this was the case, then all properties were subject to expropriation, as explained in Section 2.

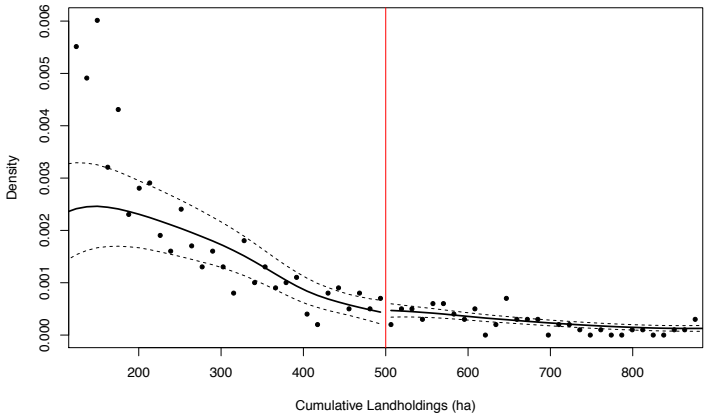
Equation (1) has two important identifying assumptions. First, former landowners must not have selectively sorted around the cut-off based on their characteristics. Second, all relevant factors other than treatment must vary smoothly at the 500 ha threshold. Below, I examine these two assumptions in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

4.2. No Evidence of Sorting Along the 500 ha Cut-off

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 landholdings 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 2.1, 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.

Figure 3: McCrary Sorting Test



Notes: The figure implements the sorting test suggested by McCrary (2008) and plots the number of observations in each cumulative landholding bins. The plotted regressions use the number of observations in each bin as the dependent variable on each side of the cut-off to test if there is a discontinuity in the density of landholdings at the expropriation cut-off. See Data Appendix for more information on data sources and variable definitions.

4.3. Balance on Geographic Characteristics

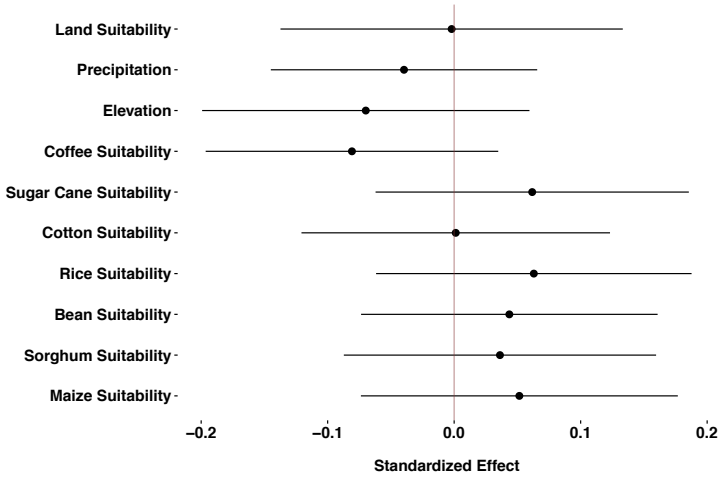
The second RD identification assumption is that all relevant factors aside from treatment vary smoothly at the 500 ha threshold. This assumption is important to ensure that properties just below the ownership threshold serve as an appropriate counterfactual for those above the threshold. This assumption 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 (sugar cane, coffee, and cotton), and suitability for the four main staple crops of El Salvador (maize, beans, rice, and sorghum).[22] For each of these key geographic variables, there is no evidence of a discontinuity at the threshold. This provides evidence that the assumption that relevant factors vary smoothly at the 500 ha threshold is reasonable.[23]

[22] See Data Appendix for more details on these variables.

[23] 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.

Figure 4: Estimates for Differences in Geography



Notes: Figure plots standardized (beta) regression discontinuity coefficients. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017). See Appendix A for details on the data sources and variable construction for the geographic variables.

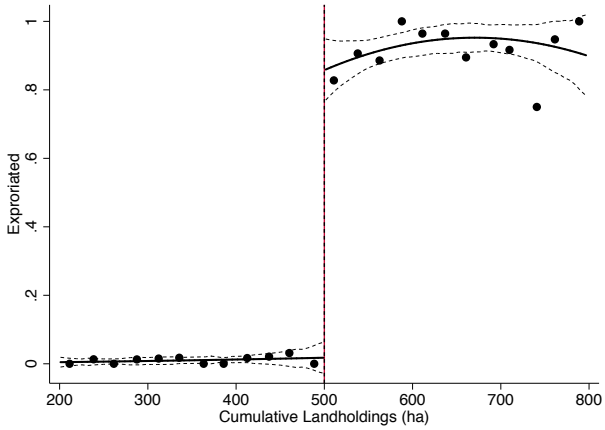
4.4. First-Stage: Holdings Above Ownership Threshold Were Expropriated

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.[24] Each point in the figure represents the average expropriation rates in cumulative landholdings bins. The solid 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 percent 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.[25]

[24] In the figure, *Expropriation* is defined as an indicator variable equal to one if the property is reported as an expropriated property in the 1983 MAG report.

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

Figure 5: Phase I Expropriation RD Plot



Notes: 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 of 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 an uniform kernel. Standard errors are clustered at the former owner level. 95% confidence intervals around the estimated lines are shown in dashed lines. See Data Appendix for data sources and variable definitions.

Additionally, a few properties below the threshold were expropriated even though they should not have been expropriated according to the reform details.[26] Because compliance with the reform threshold was imperfect, the empirical results will also present scaled instrumental variable estimates - i.e. Fuzzy RD estimates.[27] 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.

5. Theoretical Framework

To guide the empirical results, I present a model 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 obser-

[26] Approximately 3% of properties below the threshold were expropriated.

[27] Specifically, the Fuzzy RD estimates use the treatment assignment rule ($Above500_o$ from Equation 1) as an instrument for becoming a cooperative ($ReformCooperative_{po}$). The important identification assumption for the Fuzzy RD design is that the exclusion restriction holds; that is, 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) Cattaneo et al. (2020).

vations from focus group conversations with cooperatives and *haciendas*.[28] 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.

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 votes to maximize their own utility (as in Putterman, 1980, Hart and Moore, 1998, and Kremer, 1997). 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. Thus, both cooperatives and *haciendas* face moral hazard incentive problems in production. Another important feature of the model is that I assume crops differ in their contractability, i.e. whether or not contracts can be written based on output levels. 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 consumed 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.[29]

5.1. Model Set-Up

Land and Crops: Consider an agricultural property with fixed land of size L with N workers.[30] The property can devote a share of land, $\gamma \in [0,1]$, to cash crop production and the rest of the land to staple crop production. The land for cash crops and staple crops is divided equally among the N workers. To simplify notation, I normalize $\frac{L}{N} = 1$, so that each worker will use $\frac{(1-\gamma)L}{N} = 1-\gamma$ of land to produce staple crops and $\frac{\gamma L}{N} = \gamma$ of land to produce cash crops on the property.

[28] See Appendix C for more information on these focus group observations and the internal organization of each ownership form.

[29] For more information on the intuition behind this assumption and a formal derivation of this contracting result, see Appendix B.3. 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).

[30] I assume the number of workers is fixed for cooperatives. This is a reasonable assumption for cooperatives as members do not generally leave the cooperative since (i) the cooperative land is often their largest asset and the cooperative requires a super-majority to sell, and (ii) cooperatives are slow in accepting new members as it dilutes the pool of voters.

Workers: In both cooperatives and *haciendas*, workers individually choose to allocate effort between cash crop production, e_c, and staple crop production, e_s.[31] Land and labor in cash crop production produces output of value $\sum_i^N G(e_c^i, \gamma)$.[32] Staple crop production for each worker produces output of value $f^i = f(e_s^i, 1-\gamma)$. Workers choose effort subject to a time constraint, where $e_c^i + e_s^i \leq 1$.

The utility of a worker is assumed to be separable in income from cash crops and income from staple crops of the following form: $U^i = y_c + y_i$, where y_c equals the earnings from cash crop production and y_i equals the earnings from staple crop production f^i.[33] Because there is no utility of leisure in the utility function, e_s will equal $1 - e_c$.[34] Additionally, each worker receives an unobserved shock to their productivity equal to A_i for their cash crop production, making their effective cash crop output equal to $G(e_c^i, \gamma) + A^i\gamma$. This shock captures natural risks that are out of an individual's control that affect their productivity (such as health, liquidity, or plot-specific environmental shocks on their staple crop plot). The shock is larger the larger the amount of land devoted to cash crops, γ. This realized shock for a worker has support $\left[A^{min}, A^{max}\right]$, where the mean of A, $\bar{A}$, is equal to one.I assume that the median of A, A^m, is less than mean of A, $\bar{A}$.[35] This assumption will be essential to the argument below because I assume that cooperatives make decisions through voting.

Finally, I assume that workers face limited liability constraints. Specifically, I assume that $U^i > \bar{u}$, where $\bar{u}$ denotes subsistence level of utility. This means that the *hacienda* owner or the cooperative members cannot write contracts with large penalties for low realizations of output. This assumption is important for the *hacienda* workers because it implies that they cannot directly purchase land from the *hacienda* owner. It also implies that the rent the owner charges for staple crop production is constrained by the lowest ability member.

---

[31] For cooperatives, I assume workers choose effort taking the effort levels of all other worker as given. This is the Cournot-Nash assumption invoked by multiple papers on cooperative choices (see Putterman and Skillman, 1988; Ireland and Law, 1988; Bonin and Putterman, 1993).

[32] I assume that: $G(0,\gamma) = 0$, $G_e(e,\gamma) = \frac{\partial G(e,\gamma)}{\partial e} > 0$, and $G_{ee}(e,\gamma) = \frac{\partial^2 G(e,\gamma)}{\partial e^2} < 0$.

[33] I assume $f(0,1-\gamma)=0$, $f_e(e_s,1-\gamma) = \frac{\partial f(e_s,1-\gamma)}{\partial e_s} > 0$ and $f_{ee}(e_s,1-\gamma) = \frac{\partial^2 f(e_s,1-\gamma)}{\partial^2 e_s} = 0$ so that worker preferences are single-peaked.

[34] The utility function of workers is simplified considerably. Alternatively, one could assume that the utility of workers includes leisure so that a worker has utility that is separable in income and leisure in the following form: $U^i = y_c + y_i + u_i(T - e_c - e_s)$, where y_c equal the earnings from the cash crop production, y_i equals the earnings from staple crop productions, and $u_i()$ measures a worker's valuation of leisure (similarly, the cost of effort) with $u' > 0$ and $u'' < 0$ and workers differ in their value of leisure as in Putterman (1980). However, the main predictions of the model hold with this alternative form of utility.

[35] Additionally, I assume that $A^{min} > 0$ so that the shock is always increasing in the amount of land devoted to cash crops.

Decision Making: In *haciendas*, choices regarding crop shares γ and workers' remuneration are decided by the owner to maximize profits. In cooperatives, decisions are made through majority voting, as in Putterman (1980), Kremer (1997), and Hart and Moore (1998), on a one member, one vote basis.

Because staple crop output is non-contractible due to the threat of hiding, cooperatives will not be able to share staple crop output.[36] For *haciendas*, the non-contractibility of staple crop output implies that owners can only charge rent for the staple crop land instead of share contracts based on staple crop output.[37] However, both cooperatives and *haciendas* can contract on cash crop output and will decide on a linear wage schedule as a function of output (i.e. a piece rate) to remunerate workers for cash crop production. In cooperatives, members will vote on the share of cash crop output that will be redistributed equally to all members (τ_c). In contrast, *hacienda* owners will decide on the share of cash crop output kept by owner (τ_h).

Worker Remuneration: For both ownership structures, I conceive of worker remuneration for cash crop production as workers getting paid a piece rate.[38] Specifically, in *haciendas*, $1-\tau_h$ is the proportion of the cash crop output's value after deducting processing costs that the workers receive as their piece rate for cash crop production.[39] In cooperatives, $1-\tau_c$ is the proportion of cash crop output (net of processing costs) that is used by the cooperative to pay workers a piece rate in proportion to their work in the production of cash crops. The cooperative uses the surplus proportion, τ_c, in various ways, such as directly sharing profits (as dividends), financing the purchase of inputs for production, providing field preparation services, or providing public goods. Thus, both cooperatives and *haciendas* try to link pay to work done, and that this is more feasible in cash than in staple crops. I assume that the supervision or monitoring problems are approximately equal in both sectors, with neither having a comparative advantage in supervision,

[36] This matches focus group evidence from cooperatives in El Salvador (see Appendix C). Note that this does not mean that income does not get shared; this only means that staple crop output is not totaled and then shared centrally as a cooperative. However, cooperative members can still share income afterward. For an example of a model with this latter feature, see Delpierre et al. (2016).

[37] This matches the historical structure of *haciendas* in Latin America, as *haciendas* often allowed their workers to have a small private plot for staple crop production for which the owner charged rent. See de Janvry (1981) for more details on this dualistic agrarian structure. Note that cooperatives will not charge rent in equilibrium – as the rent would be the same for all members and would then get redistributed equally. Thus, I abstract from cooperatives charging rent in the model.

[38] This implies that workers may not explicitly see their output value being taxed. As well, for the voting, workers are voting over the pay rate per unit of observed or recorded effort or output, not on an explicit (redistributive) tax.

[39] Section Appendix C provides more details on the organizational structure of *haciendas* and cooperatives, and describes how workers are paid piece rates in practice for their production of cash crops.

and therefore abstract from this.[40]

Decisions and Timing: The model for cooperatives and *haciendas* has the following general timing and decision structure:

1. Each worker receives shocks to their productivity, A^i.
2. The cooperative or *hacienda* decides on the share of land to devote to cash crop production, γ_c or γ_h respectively.
3. The cooperative or *hacienda* then decides on a linear wage schedule (i.e. a piece rate) as a function of output to remunerate workers for cash crop production. In cooperatives, members vote on the share of cash crop output that will be redistributed equally to all members (τ_c). In *haciendas*, the owner decides on the share of cash crop output kept by owner (τ_h) and the rent charged for staple crop production (R^h).
4. Each worker chooses effort levels (e^i) and produces output.
5. Transfers occur: workers are remunerated for cash crop production, cooperative workers receive their share of redistributed cash crop output, and *hacienda* workers pay rent to the owner.

Objective Function for Cooperative Workers: In cooperatives, given γ_c and τ_c, a cooperative member indexed by i chooses effort to maximize:

$$\max_{e_c^i} \underbrace{(1-\tau_c)(G(e_c^i,\gamma_c)+A_i\gamma_c)}_{\text{Cash crop output that is not redistributed by cooperative}} + \underbrace{\tau_c(\sum_j^N (G(e_c^j,\gamma_c)+A_j\gamma_c))/N}_{\text{Cash crop output that is redistributed by cooperative}} + \underbrace{f(1-e_c^i,1-\gamma_c)}_{\text{Staple crop output}} \tag{2}$$

$$\text{subject to:} \quad (1-\tau_c)(G(e_c^i,\gamma_c)+A^i\gamma_c)+\tau_c(\sum_j^N (G(e_c^j,\gamma_c)+A_j\gamma_c))/N + f(1-e_c^i,1-\gamma_c) \geq \bar{u} \qquad (\text{PC}_c)$$

where (1-τ_c) denotes the share of cash crop output kept by each worker and $\bar{u}$ denotes workers' outside option value. Given the timing structure of the model, workers will subsequently vote to choose γ_c and τ_c, using this objective function as well.

[40] In a seminal paper, Alchian and Demsetz (1972) argued that outside owned firms are more likely to monitor and chose the optimal level of monitoring because, if the monitor is also the owner, then the monitor is given the residual income of the firm. This implies that the monitoring choice by an outside owner will be more efficient than the choice of monitoring 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 cooperative due to profit-sharing (Putterman and Skillman, 1988; Wietzman and Kruse, 1991). However, *haciendas* differ from the traditional firms conceived of by Alchian and Demsetz (1972) in that owners are often absentee owners. Therefore, in *haciendas* in practice, there is no one who plays the role of a specialized monitor who is also a residual claimant.

Objective Function for *Hacienda* Owner and Workers: In *haciendas*, the *hacienda* owner solves:

$$\max_{\tau_h,\gamma_h,R^h} \sum_{i}^{N} [\underbrace{\tau_h(G(e_c^i,\gamma_h)+A^i\gamma_h)}_{\text{Cash crop output kept by hacienda owner}} + \underbrace{(1-\tau_h)(G(e_c^{min},\gamma_h)+A^{min}\gamma_h) + f(1-e_c^{min},\gamma_h) - \bar{U}]}_{\text{Rent charged by hacienda owner for staple crop output, } R^h} \quad (3)$$

$$\text{subject to: } \underset{e_c^i}{\text{argmax}} \quad (1-\tau_h)(G(e_c^i,\gamma_h)+A^i\gamma_h) + f(1-e_c^i,1-\gamma_h) - R^h \; \forall \, i \quad (\text{IC}_h)$$

$$(1-\tau_h)(G(e_c^i,\gamma_h)+A^i\gamma_h) + f(1-e_c^i,1-\gamma_h) - R^h \geq \bar{u} \; \forall \, i \quad (\text{PC}_h)$$

τ_h denotes the share of worker output kept by the owner, (IC_h) denotes the *hacienda* workers' incentive compatibility constraints, and (PC_h) denotes the workers' participation constraints.[41] I provide a summary of the set up of the model in Table A1.

5.2. Solving for Worker Effort in Cooperatives and Haciendas

In cooperatives, given the objection function presented in (2), each cooperative worker maximizes utility by solving for their optimal effort levels, e_c^i and $e_s^i = 1 - e_c^i$, taking other workers' choices as given and γ_c and τ_c as given. The first-order condition assuming N is large:

$$(1-\tau_c)G_e(e_c,\gamma_c) = f_e(1-e_c,1-\gamma_c).$$

This implies that workers under-supply effort to cash crops when $\tau_c > 0$ relative to the first-best effort level, which occurs when workers set $G_e(e_c^i,\gamma) = f_e(1-e_c^i,1-\gamma)$.[42] This is because, when $\tau_c > 0$, cooperatives are redistributing an individuals' share of cash crop output to other members, reducing the incentives to work on the cash crop output relative to the first-best.

For *hacienda* workers, note that the maximization problem faced by individual workers when choosing effort levels given τ_h and R^h in (IC_h) is the same maximization problem faced by cooperative workers. Thus, the first-order condition for workers in an *hacienda* is:

$$(1-\tau_h)G_e(e_c,\gamma_h) = f_e(1-e_c,1-\gamma_h).$$

This implies that *hacienda* workers also under-supply effort relative to the first-best effort level when $\tau_h > 0$. This is because, when $\tau_h > 0$, the *hacienda* workers are giving a share of their

[41] The participation constraints of the workers and the assumption that workers are liquidity constraints means that the rent that the owner will charge, R^h, is set at the expected income of the lowest ability member minus their outside option. Additionally, the following conditions must hold: $0 \leq \gamma \leq 1$, $e_s \geq 0$ and $e_c \geq 0$.

[42] Note that if $\tau_c = 0$, then the cooperative does achieve optimal effort. This mirrors the results from other papers on the theory of cooperatives (see Sen, 1966, Putterman, 1981, Ireland and Law, 1981), in which cooperatives with labor-proportionate schemes are not always less productive. Additionally, note that in this formulation, as in Kremer (1997), all workers will set the same effort levels regardless of their ability realization. This is done to simplify the derivations but is not essential to the arguments made in the model.

cash crop output to the outside-owner, reducing the incentives to work on the cash crop output relative to the first-best.

5.3. Solving for Worker Wages and Crop Choices in Cooperatives and Haciendas

In this section, I derive the wage rates for cooperatives and *haciendas*, τ_c and τ_h, and the crop choices, γ_c and γ_h. Subsequently, to capture the main intuition of the model and simplify the comparison of the effort levels and crop choices of cooperatives and *haciendas*, I make a few simplifying assumptions on the production functions.

Wage Rates in Cooperatives: Workers will maximize their utility, equation (2), when voting over their preferred wage rate, τ_c. Since worker preferences are single-peaked, the median voter theorem applies, meaning that median voter will determine the wage rate (Roberts, 1977; Kremer, 1997). This implies that a worker with the median shock, A^m, prefers τ_c that maximizes:

$$\max_{\tau_c,\gamma_c} \; [(1-\tau_c)A^m\gamma_c + \tau_c\bar{A}\gamma_c] + G(e(\tau_c),\gamma_c) + f(1-e(\tau_c),1-\gamma_c)$$

subject to the cooperative incentive compatibility constraint (IC_c) and participation constraint (PC_c) for $A^i = A^m$.[43] The median voter will set:

$$(\bar{A} - A^m)\gamma_c = e'(\tau_c)(f_e(1-e(\tau_c),1-\gamma_c) - G_e(e(\tau_c),\gamma_c)),$$

where the left-hand side of this first order condition represents the extra income accruing to the median voter with shock, A_m, from raising the redistribution rate, τ_c, holding effort of all members constant. Conversely, the right-hand side denotes the reduction in effort caused by raising the tax rate, multiplied by the welfare cost of this reduction in effort.[44] The tax rate chosen by the cooperative, τ_c, is increasing in the difference between the mean and median shock, $\bar{A} - A^m$.

Wage Rates in *Haciendas*: The owner will maximize their profits as denoted in equation (3) subject to the *hacienda* workers' incentive compatibility constraints (IC_h) and participation constraints (PC_c). Thus, the owner will set τ_h such that:

$$G(e_c^i,\gamma_h) - G(e_c^{min},\gamma_h) + \bar{A} - A^{min} = e'(\tau_h)[\tau_h G_e(e_c^i,\gamma_h) + (1-\tau_h)G_e(e_c^{min},\gamma_h) - f_e(1-e_c^{min},\gamma_h)],$$

[43] Note that the incentive compatability constraint in cooperatives, (IC_c), is the same as the objective function for individual worker effort. That is, (IC_c) is defined as:

$$\underset{e_c^i}{\text{argmax}} \; (1-\tau_c)(G(e_c^i,\gamma_c) + A_j\gamma_c) + \tau_c(\sum_j^N (G(e_c^j,\gamma_c) + A_j\gamma_c))/N + f(1-e_c^i,1-\gamma_c) \; \forall \, i \qquad (IC_c)$$

[44] We can solve for the general form of τ_c, where the cooperative will set: $\tau_c = \frac{(\bar{A}-A^m)(G_{ee}-f_{ee})-G_e(f_e-G_e)}{(\bar{A}-A^m)G_{ee}}$.

where the left-hand side of the owner's first order conditions denotes the extra income accruing to the owner from raising the tax rate holding worker effort constant. In contrast, the right-hand side represents the reduction in worker effort caused by raising the tax rate, multiplied by the welfare cost to the owner of this reduction in effort.[45]

Crop Choices in Cooperatives: When voting over γ_c, workers know that they will subsequently vote on τ_c and then individually choose effort and produce output.[46] The first order condition for γ for the worker with median ability is:

$$(\tau_c \bar{A} + (1-\tau_c)A^m) = e'(\gamma_c)(f_e(e,1-\gamma_c) - G_e(e,\gamma_c)) + f_\gamma(e,1-\gamma_c) - G_\gamma(e,\gamma_c)$$

Thus, the median ability worker prefers γ_c that is more than the optimal amount of land to devote to cash crops (i.e. the amount that equalizes the marginal product of cash crop land to the marginal product of staple crop land). This difference between the optimal amount of γ_c is increasing in τ_c and in the distance of A^m from $\bar{A}$.

Crop Choices in *Haciendas*: The *hacienda* owner will set γ_h to maximize their earnings from cash crop production and the rent from staple crop production. The owner will set γ_h such that:

$$\tau_h G_\gamma(e_c,\gamma_h) = A^{min} + f_\gamma(e_s^{min},1-\gamma_h),$$

meaning that the owner will set the marginal product of the cash crop land equal to the marginal product on the lowest productivity private plot (i.e. the rental rate). Thus, the amount of land devoted to cash crops is a function of how much the owner can extract in rent from the staple crop output of the lowest ability worker. This will differ from the optimal crop choice, which would set the marginal product of the cash crop land equal to the marginal product on the average staple crop plot, because the owner will be constrained to charge the same rental rate to liquidity constrained workers.[47]

Cooperative and *Hacienda* Choices Relative to the First Best: An important initial result from the model is that neither cooperatives nor *haciendas* necessarily induce the most efficient outcome – relative to the first best – in terms of effort and crop choices. In the model, inefficiency in effort

[45] Solving for the general form of τ_h implies that $\tau_h = \frac{G(G_{ee}-f_{ee})}{G_{ee}G-G_e^2}$.

[46] I assumed the voting occurs sequentially to avoid voting cycles.

[47] This prediction differs slightly from Sadoulet (1992), where the owner in that model can set individual-specific rental rates and thus can extract surplus from all workers (and all workers earn $\bar{w}$). However, I assumed that this is not possible because, in practice, most *haciendas* do not set different rental rates across workers.

choices in cooperatives and *haciendas* is increasing in τ_c and τ_h, respectively. Interestingly, these inefficiencies occur for different reasons.

In cooperatives, heterogeneity in workers and the voting process for decisions (on a one member, one vote basis) induces distortions due to incentives to redistribute earnings: if the median ability member has less ability than the average ability member, the cooperative members will (i) vote to set $\tau_c > 0$ to redistribute cash crop earnings and (ii) vote for a larger share of cash crop production than is optimal to increase the amount of redistributed cash crop earnings. In contrast, in *haciendas*, profit maximization and limited liability constraints for workers induces distortions as the owner faces a motivation-rent extraction trade-off when making decisions. This means that the owner will (i) set a high share of cash crops for himself to maximize profits at the expense of lower worker effort incentives ($\tau_h > 0$), and (ii) devotes a large share of land to cash crops to ensure workers devote more effort in cash crop production.

Comparing Cooperatives and *Haciendas*: The model also highlights that the question of which ownership structure is more productive is *ex-ante* unclear and depends on the distribution of shocks and the amount of land devoted to cash crop production.[48] To compare the choices of cooperatives and *haciendas* on τ_c and τ_h and crop choices, I make two simplifying assumptions on the productions functions.[49] Specifically, I let cash crop output, $G(e_c,\gamma)$, be equal to $\sqrt{e_c\gamma} + A_i\gamma$, and I let staple crop output, $f(e_s,1-\gamma)$, be equal to $e_s(1-\gamma)$.[50]

In this case, the cooperative members will set: $\tau_c = 2(1-\gamma_c)(\bar{A} - A^m)$. Conversely, the *hacienda* owner will set: $\tau_h = 2(1-\gamma_h)(\bar{A} - A^{min})$. If $2(1-\gamma_c)(\bar{A} - A^m) > 2(1-\gamma_h)(\bar{A} - A^{min})$, the cooperative workers will undersupply effort at cash crops more than workers in an *hacienda*. Conversely, if $2(1-\gamma_c)(\bar{A} - A^m) < 2(1-\gamma_h)(\bar{A} - A^{min})$, the opposite would hold: the *hacienda* workers will undersupply effort in cash crops more than workers in the cooperative. Using the same production functions as above, we next solve for the specific crop choices, γ_h and γ_c. The cooperative members will set: $\gamma_c = \frac{4(\bar{A}-A^m)^2-\sqrt{4(\bar{A}-A^m)^2+1}+1}{4(\bar{A}-A^m)^2}$, and the *hacienda* owner will set: $\gamma_h = \frac{4(\bar{A}-A^{min})^2-\sqrt{4(\bar{A}-A^{min})^2+1}+1}{4(\bar{A}-A^{min})^2}$. In this case, γ_h will be larger than γ_c, meaning the cooperative will specialize less in cash crops and more in staple crops. These crop allocations also imply that the cooperative will set $\tau_c > \tau_h$, meaning that cooperative workers will devote less effort to cash

[48] This is under the assumption that both ownership structures have the same production functions.

[49] These assumptions also ensure that we can apply the median voter theorem to voting outcomes in cooperatives.

[50] In other words, cash crop production is assumed to be Cobb-Douglas production, a standard assumption in the literature on misallocation in agriculture (Restuccia, 2016).

crops and more effort to staple crops. The reason for this is that cooperatives will redistribute earnings from cash crops but not staple crops, as workers can consume staple crops but not cash crops. This means that workers will get to keep more of their output for staple crops, but share cash crop output, reducing incentives to supply effort to cash crop production over staple crop staple crop production. Thus, the cooperative workers will be more productive at staple crops. The opposite incentives occur in the outside ownership system, where the owner will be constrained by the fact that, if producing staple crops, workers could consume their output; thus, the owner will choose to produce more cash crops and will need to give people strong incentives to work on the cash crop land (over working on their own staple crop plots). Therefore, in sum, the cooperative both (i) devotes less land to cash crops and (ii) is also less productive (in terms of worker effort) at cash crops over staple crops compared to the *hacienda*.

5.4. Discussion of the Model

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 (on a one member, one vote basis) may lead to incentives to redistribute earnings. This redistribution dampens worker incentives to provide higher levels of effort. In particular, if the median ability member has less ability than the average ability member, 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 redistribute more cash crop earnings.

In contrast, in *haciendas*, the owner faces a motivation-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 large share of land to cash crops than optimal to ensure workers devote more time to (verifiable) cash crop production instead of (unverifiable) staple crop production.

When comparing the decisions of cooperatives and *haciendas*, the framework offers four important predictions summarized in Table 1 under the assumptions discussed in the previous section. 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 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 from workers' cash crops (since the owner can verify output) and will give people strong incentives to work on the cash crop land (over working on their own staple crop plots). 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 6. A critical question when linking the theory to the empirics is whether the staple crop output data is reliable given the assumption that, since staple crop output can be hidden, it is non-contractable.[51] In Appendix A, 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.[52] In particular, the mission statement and goals of the MAG prioritize rural workers' well-being, and the leadership in 2007 was comprised of individuals who were involved in the 1980 land reform. Additionally, in 2007, the MAG partnered with the FAO to produce a high quality, confidential, and technically sound census after years of not having a census. Enumeration – conducted in person, in the field – involved extensive monitoring and data quality checks. Sharing confidential census information with owners would jeopardize the MAG's mission and reputation, and would have put individual enumerators at serious risk for losing their job. Therefore, workers likely trust the MAG and report reliable staple crop measures to government enumerators.[53]

This framework abstracts from three important aspects of cooperatives and *haciendas*. First,

[51] Note that this question only applies to prediction 3) in Table 1 and not the rest of the predictions.

[52] In Appendix B.3, I formally show that staple crop output becomes non-contractable if the threat of hiding is high enough and discuss why, in equilibrium, workers likely provide reliable answers to census enumerators.

[53] In addition, in Appendix A, 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.

Table 1: Summary of Model Predictions and Corresponding Empirical Tests

	Prediction:	*Empirics:*
1) Crop Choices:	$\gamma^h > \gamma^c$	% of land devoted to cash crops vs. staple crops
2) Cash Crop Production:	$e^h > e^c$	Yields for cash crops
3) Staple Crop Production:	$e_s^h < e_s^c$	Yields for staple crops
4) Worker Incomes:	$\sigma(y^h) > \sigma(y^c)$	Inter-quartile range of incomes for workers

the model abstracts from differences in monitoring by organizational structure.[54] Second, the model does not address the threat of exit for cooperatives studied by Abramitzky (2008) and considers a static problem.[55] Finally, the model abstracts from macro-risk considerations. Other work has motivated the existence of cooperatives as a way of coping with idiosyncratic risks (see, for example, Bonin, 1977; Carter, 1987; Parliament et al., 1989; Delpierre et al., 2016). In this model, I do not explicitly study heterogeneity in risk aversion. Including heterogeneity amongst 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 last alternative story in the empirical section by examining differences

[54]Other 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 the choice of monitoring 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 cooperative due to profit-sharing (Putterman and Skillman, 1988). However, 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 (Kandel and Lazear, 1992; Wietzman and Kruse, 1991).

[55]I examine differences in migration patterns empirically in Section 7. 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 using secret ballots; this makes vote trading more difficult to sustain because it is difficult to verify how one individual voted.

in credit access by ownership type in Section 7.[56]

6. 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 *haciendas* workers using household survey data. I discuss whether the results are consistent with the predictions of the theoretical framework.

6.1. 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 sugar cane, coffee, maize, and beans. Guided by the theoretical framework in Section 5, I present the results for the major cash crops in El Salvador – sugar cane and coffee – and then for the main staple crops – maize and beans.[57]

For cash crops, I estimate a version of equation (1) where the dependent variable is an indicator variable equal to one 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 one 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 A7.

I find that cooperatives devote less land to cash crops and are less likely to produce sugar cane and coffee relative to *haciendas*. Cooperatives devote 62% less of their land to cash crops, 18%

[56]However, the setting of agricultural production 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.

[57]Historically, cotton was a major cash crop in El Salvador leading up to 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).

less land to sugar cane, and 31% less land to coffee production. Conditional on producing these crops, cooperatives also have lower yields for these cash crops.[58] Yields for sugar cane are 15.6 *quintales* per *manzanas* (QQ/mz) lower in cooperatives than in *haciendas* and yields for coffee are 18.3 QQ/mz lower in cooperatives than in *haciendas*.[59]

Table 2: Agricultural Choices and Productivity: Cash Crops

	Cash Crops	**Sugar Cane**			**Coffee**		
	Share	Producer	Share	Yield	Producer	Share	Yield
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Above500	-0.628***	-0.236**	-0.186*	-15.60*	-0.340***	-0.311***	-18.30***
	(0.127)	(0.119)	(0.0985)	(8.375)	(0.115)	(0.119)	(4.173)
Observations	168	232	213	62	275	214	78
Clusters	103	142	132	48	166	132	39
Mean Dep. Var.	0.550	0.263	0.191	69.90	0.356	0.268	11.72
Bandwidth	92.56	122	121.5	122.6	133.8	115	125.2

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Share* for *Cash Crops* measures the share of land in a property devoted to cash crop farming (coffee or sugar cane). *Producer* is an indicator variable equal to 1 if the 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 sugar cane, and in quintales (QQ) per area in manzanas (mz) 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 ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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) indicator equal to one 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.[60] I report the estimates in Table 3. Additionally, I present the RD plots for the share of land devoted to staple crops in Figure A7.

I find that cooperatives are more likely to produce staple crops than *haciendas*. Cooperatives devote 48% more of their land to staple crop production relative to *haciendas*. Specifically,

[58] 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 for each crop as the first-stage predictor for producing the crop. I present the results in Figure A12 for both cash crops and staple crops and show that the pattern of results discussed in this section are very similar when correcting for selection into production.

[59] *Quintales* is the unit of quantity used in El Salvador and is equivalent to 101.4 pounds or 46 kg. *Manzanas* are the unit for land areas in El Salvador and are equivalent to 1.72 acres or 0.70 hectares. More information on the variables used and their definitions is provided in Appendix A.

[60] In practice, properties do not devote the entirety of their land to either cash crops or staple crops. Figure A18 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.

cooperatives devote 43% more land to produce maize and are 36% 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 18 QQ/mz higher in cooperatives than in *haciendas*.

Table 3: Agricultural Choices and Productivity: Staple Crops

	Staple Crops	**Maize**			**Beans**		
	Share	Producer	Share	Yield	Producer	Share	Yield
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Above500	0.482**	0.547***	0.431**	18.44***	0.362**	0.0556	3.857
	(0.242)	(0.193)	(0.199)	(7.127)	(0.173)	(0.0689)	(4.676)
Observations	295	223	278	71	278	284	51
Clusters	185	136	173	54	176	175	46
Mean Dep. Var.	0.227	0.387	0.186	47.60	0.141	0.0399	15.15
Bandwidth	150.1	116.1	142.9	101.1	133.3	144.8	180

Notes: Standard errors clustered at the former owner level reported in parenthesis. *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 the 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 (QQ) per area in manzanas (mz). *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 ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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 6.4 before examining the robustness of these results and performing various extensions of this analysis.

6.2. 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 is follows the methodology suggested by Restuccia and Santaeulalia-Llopis (2017) to estimate producer-specific total factor productivity.

Formally, the first measure is: Revenue per Hectare$_p = ln(\frac{\sum_i p_i q_i}{l_p})$, where q_i is the total quantity produced for each crop i and p_i the price of each crop i in 2007 reported in Ministerio de

Agricultura y Ganadería (2007a). I then normalize each measure by the property size in hectares (l_p). However, while revenues per hectare as easy to interpret, they serve as a poor proxy for productivity. As the results from Section 6.1 demonstrate, cooperatives and *haciendas* produce different types of crops, and these have different inputs 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: $\text{Profits per Hectare}_p = ln(\frac{\sum_i p_i q_i - c_i}{l_p})$, 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.[61] However, the Ministry of Agriculture reports the production cost for each crop in 2007 in 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 in Ministerio de Agricultura y Ganadería (2007b) (measured in $ per mz) and multiply this cost per the amount of land devoted to each crop (in mz). 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 logs 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 et al. (2019) to estimate a producer-specific component of total factor productivity 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 A.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, 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 Section 4.4). As highlighted in Section 4.4, not all properties above the ownership threshold were expropriated. Thus, columns (2), (4) and (6) use the indicator variable equal to one

[61] 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 Figure A16 – suggesting that using the same production costs for a given crop is not an invalid assumption.

if a property was above the threshold as an instrument for an indicator equal to one 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 3% 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.[62]

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 6.1, 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 hectares, or farm-specific TFP. Evidence from other settings and industries comparing cooperatives to outside-owned firms (see Craig and Pencavel, 1995; Pencavel, 2013) have not found significantly large differences in efficiency. 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*.[63]

[62] I present the RD plots for these variables in Appendix E.1.

[63] Due to power concerns with RD designs in general, I present the RD power calculations developed by Cattaneo et al. (2017) in Figure A17. The calculations suggest that the RD in this setting is under-powered for studying standardized effect sizes smaller than 0.50. Figures A34 and A38 plot the standardized (beta) coefficients for revenues per ha and profits per ha, respectively, across different bandwidths and also show that the estimated effect is consistently imprecisely estimated regardless of the bandwidth.

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	-0.311	-0.319	-0.0864	-0.0936	-0.0278	-0.0269
	(0.363)	(0.373)	(0.731)	(0.792)	(0.0467)	(0.0457)
Fuzzy RD	N	Y	N	Y	N	Y
Observations	141	141	177	177	112	112
Clusters	90	90	114	114	74	74
Mean Dep. Var.	7.219	7.219	5.845	5.845	0.330	0.330
Bandwidth	100.3	100.3	121.7	121.7	81.62	81.62

Notes: Standard errors clustered at the former owner level reported in parenthesis. *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). *Above 500* 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 ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

6.3. Worker Income Distributions

Using data from household surveys for El Salvador from 2002-2013, I examine whether cooperative members have more compressed income distributions compared to workers in *haciendas*. The theoretical framework presented in Section 5 suggests that there may be incentives to redistribute earnings in cooperatives. I use the household survey data to examine whether cooperatives members have more equal income distributions relative to the income distributions for current employees of *haciendas*.[64] 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 inter-quartile 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 inter-quartile 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 inter-quartile range of cooperatives is approximately $37 per month lower

[64]Unfortunately, the household surveys do not distinguish between whether workers are full-time or part-time workers. However, Figure A20 suggests that *haciendas* and cooperatives use a relatively small and similar number of temporary workers.

than the inter-quartile range of worker incomes for *hacienda* workers, consistent with cooperatives have more equitable income distributions.[65]

Additionally, I use quantile regressions to study how the income premium discussed above for cooperative workers varies across the worker income distribution. If cooperatives redistribute earnings as argued in Section 5, 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 percent 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, declining in higher quantiles, and is positive at the lowest quantile. This suggests that the earnings policies within reform cooperatives seem to help workers at the bottom of the income distribution.[66]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.

[65]Columns (1) and (2) suggest that cooperative workers earn approximately $55 more per month compared to *hacienda* workers. However, since the land was expropriated and workers became collective owners, the earning differences could either be due to 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 inter-quartile 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 A6. 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.

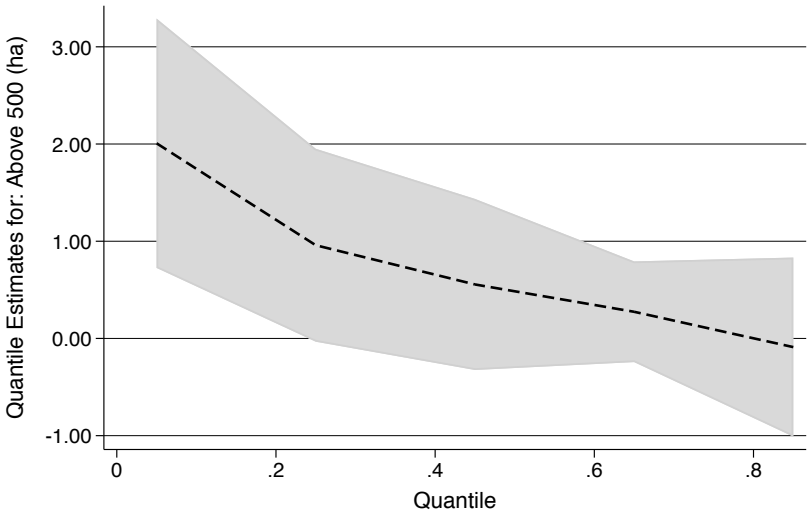
[66]In this section, I only examine worker earnings; however, workers may also care about levels of public good access. Theoretically, both cooperatives and *haciendas* have incentives to provide some public goods to their workers (Abramitzky, 2018). I complement these earnings results and empirically examine differences in access to public goods in Appendix F. I find that cooperative workers have more access to public goods.

Table 5: Impact of Ownership Type on Earnings and Earnings Distributions

	HH Earnings per capita (previous month)			
	Levels		*Inter-Quartile Range*	
	(1)	(2)	(3)	(4)
Above 500	55.06**	53.73	-37.06*	-53.06**
	(25.26)	(36.41)	(19.20)	(22.73)
Observations	6280	2,273	344	127
Properties	344	127	344	127
Clusters	99	37	99	37
Mean Dep. Var.	73.60	77.53	41.07	42.47
Bandwidth	300	150	300	150

Notes: Standard errors clustered at the former owner level reported in parenthesis. *HH Earnings per capita* measures a household's monthly earnings per capita in dollars for agricultural workers in the El Salvador Household Surveys (EHPM). *Inter-Quartile Range* measures the difference between the 75th and 25th percentile in reported household earnings per capita within each property. *Above 500* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure 6: Quantile Estimates - Worker Income Levels



Notes: The figure presents the estimated quantile regression discontinuity coefficients where *Above500*, an indicator variable equal to one 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 incomes (in dollars per month) from the El Salvador household surveys (EHPM) as 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 properties 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.

6.4. Discussion

The results presented in this section reveal important differences between agricultural cooperatives and *haciendas*. Relative to *haciendas*, 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 5. 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.[67] However, cooperatives still choose to invest in producing cash crops due to 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.[68] 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

IInterestingly, this set of results is consistent with the limited empirical and non-causal literature comparing cooperatives to outside-owned firms in other settings. For example, reviews provided by Bonin et al. (1993) and Pencavel, ed (2013) on these studies highlight that these studies have generally found that cooperatives have more equitable compensation structures

[67] Interestingly, these results are consistent with Gafaro (2015), who examines differences between cooperatives and individual small-holder producers in Peru. While the counterfactual property rights regime is different in her setting, she also finds that cooperatives are less likely to produce cash crops.

[68] In addition, while the results in Table 3 do not contain information on input use (due 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 to buy and access inputs. I thank a referee for this observation.

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 where workers themselves are more of the residual claimants on their effort rather than the outside-owner. This finding on specialization is similar to the predictions of the model in Section 5 comparing staple crops to cash crops allocations.[69] This finding is also related to the observation by Abramitzky (2018) that profit-sharing seems to be more sustainable in cases where output is more observable.[70] Thus, while this set of studies do 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 datasets and settings where researchers have compared cooperatives to outside-owned firms.[71]

6.5. Robustness

6.5.1. Alternative RD Specifications

In this section, I describe additional robustness checks to regression discontinuity results presented in Section 6. One possible alternative explanation for the results is that the patterns found in the data exist for only 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 Appendix. Specifically, in Appendix M, 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 et al. (2015) in Appendix L. Overall, I find that the set of results discussed in Section 6 are robust to alternative specifications.

[69] Additionally, other work has highlighted that cooperative ownership may lead to stronger norms of cooperation and solidarity (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 (where profits get redistributed) and instead devote more land to staple crops compared to *haciendas*.

[70] Abramitzky (2018) also suggests a complementary interpretation (that I discuss in the conclusion) 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).

[71] Appendix Appendix K examines OLS estimates for the main outcomes presented in this section and discusses how these estimates compare to the RD results.

6.5.2. Temporal External Validity

The aggregate measures of productivity presented in Section 6.2 have a few important limitations. Aggregate measures of productivity may 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.[72] 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 2005-2015, holding constant quantities and crop choices. I then plot the estimated productivity differences to examine whether the differences in productivity examined in Section 6.2 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 (2016).

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 is provided in Ministerio de Agricultura y Ganadería (2005-2015b) while the production costs data is provided by Ministerio de Agricultura y Ganadería (2005-2015a).[73] 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 A9. The results suggest that the estimates presented in Section 6.2 are not particularly sensitive to the specific prices and costs from the census year.

7. 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,

[72] For example, sugar cane prices in 2007 were particularly high worldwide (see Figure A25), and sugar cane is one of the main cash crops of El Salvador.

[73] Importantly, the MAG reports domestic crop prices for El Salvador. This is important 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 sugar cane prices, only processed sugar markets; instead, I use FAO data on sugar cane prices for El Salvador.

productivities, and equity results in Section 6, aside from the agency mechanisms highlighted in the incomplete labor contracts model presented in Section 5. Specifically, I examine whether differences in credit access, crop risk, capital use, human capital investment, or worker migration can explain the differences observed on agricultural choices, productivities, and equity. Additionally, I then examine whether cooperatives that are more heterogeneous are less productive to test a secondary prediction of the model.

7.1. 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..[74] 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 approved. Cooperatives are not less likely to have applied for credit, and they tend to receive credit from similar sources as *haciendas*, consistent with the institutional features of cooperatives in El Salvador discussed in Appendix D, where cooperatives can legally use their land as collateral for loans. The results suggest that differences in credit access are unlikely to explain differences in crop choices.[75]

7.2. 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 5.4, this type of risk cannot be managed through the redistribution of earnings amongst cooperative members. Thus, if cash crops have more price volatility and cooperatives are more risk-averse than *haciendas*, this could explain

[74] 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.

[75] One additional possible reason for differences in crop choices is that because former landowners' connections were important for market access (Browning, 1971), then reform cooperatives may have lost market access and may not have been able to reestablish connections to the market post-reform. I thank a referee for this comment. In Appendix G, 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. Additionally, I find little evidence of heterogeneity in the main results by whether properties are close to markets or not. These results suggest cooperatives have been able to re-establish market access.

Table 6: Credit Access and Sources - RD Estimates

	Applied for Loan	Credit Approval Timely	Credit Source			
			State Bank	Private Bank	Credit Coop	NGO
	(1)	(2)	(3)	(4)	(5)	(6)
Above500	0.185	0.0328	0.629*	-0.305	-0.227	-0.0390
	(0.212)	(0.0377)	(0.340)	(0.444)	(0.189)	(0.0540)
Observations	297	32	27	39	75	28
Clusters	187	32	23	34	61	21
Mean Dep. Var.	0.309	0.975	0.276	0.465	0.107	0.0714
Bandwidth	140.2	76.81	60.43	79.40	127.7	75.20

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Applied for Credit* is an indicator variable equal to 1 if the property reported applying for a 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 the 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 ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

differences in crop choices. Using monthly crop price data from 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 (sugar cane and coffee) and plot the results in Figure A26. Staple crop prices seem to be just as volatile by this measure. To examine whether this result is driven by a particular crop, Figure A27 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, sugar cane and coffee – for periods of 1 year, 6 months, or 1 month in Figures A28, A29, and A30, respectively. There is little evidence that the returns on cash crops are more volatile than the returns to staple crops.[76]

[76]One additional possible hypothesis for differences in crop choice due to risk is that *if* cooperatives consume much of what they produce, then they aren't fully proportionately affected by market price changes for staple crops (whereas they would be fully affected by changes in cash crops which are never consumed). Relatedly, Fafchamps (1992) provides a model where small-scale farmers may be more likely to produce staple crops rather than cash crops due to 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 of staple crops needed solely for self-consumption). Thus, this explanation is unlikely to drive the differences in crop choices in this context.

7.3. Alternative Explanation: Capital Use

Another potential difference between cooperatives and *haciendas* is that cooperatives may be less likely to make capital investments due to hold-up 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 decide. To examine whether this alternative story is consistent with the results, I use agricultural census data on whether a property owns a number of capital goods such as machinery and equipment to compare differences in capital ownership.[77] 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 hold-up argument. In contrast, if cooperatives do not invest less in general agricultural capital, this would provide some evidence that is inconsistent with the hold-up problem. I present the estimated differences for these capital goods in Figure A15. 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.[78] The results suggest that capital hold-up is unlikely to explain differences across cooperatives and *haciendas* in this setting.

7.4. Worker Human Capital

One additional reason cooperatives may differ from *haciendas* is due to differences in human capital investment. As noted by Abramitzky (2018), cooperatives workers face opposing incentives for investing in human capital. On the one hand, compared to *hacienda* workers, cooperative workers 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.[79] 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

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

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

[79] In fact, many cooperatives often set up schools for their members using their shared profits as a form of redistribution across workers, see Appendix C.

increase workers' outside options and lead to brain drain (discussed in 7.5). 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 *haciendas* workers using household survey data in Appendix H. 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.

7.5. Worker Selection and Migration Patterns

In this section, I explore whether there are differences in migration patterns for cooperatives compared to *hacienda*. 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 C, cooperatives in El Salvador make joining difficult for prospective members: joining entails a long screening process and requires a supermajority approval by cooperative members.[80] 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.[81] Yet even with these rules in place, brain drain is potentially more of a problem for cooperatives.

To empirically examine the consequences of these incentive problems, I explore differences in worker characteristics and differences in worker migration patterns in Appendix I. 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,

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

[81] Again, this is quite similar to how *kibbutz* try to limit brain drain (Abramitzky, 2018, pg. 134). See Figure A31 for evidence that cooperatives provide more public goods than *haciendas*.

I proxy for differences in worker ability by examining differences in worker education, literacy, and age in Appendix H. I find that cooperative workers are more educated and literate compared to *hacienda* workers. Additionally, cooperative workers are not significantly older than *hacienda* workers.[82] This suggests that, even with adverse selection and brain drain problems, I find no evidence that cooperative workers are not of observable worse quality than *hacienda* workers.

Second, to examine whether there are different patterns of migration for cooperatives and *haciendas*, I compare migration patterns for cooperative and *haciendas* in Appendix I 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 Section 7.4), the differences in migration are not strong enough to lead to an overall lower quality workforce.[83]

7.6. Heterogeneity in Cooperatives

This section examines a secondary prediction of the theoretical framework outlined in Section 5. Namely, I examine the prediction that cooperatives with more heterogeneity in membership are less productive.

When measuring heterogeneity in membership in cooperatives, the ideal variable would have been the distribution of ability of all cooperative members. However, this data does not exist - there is not complete census of all cooperative members for El Salvador. Thus, 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*). While the census does not include questions on incomes or consumption for individuals, it provides information on demographics and occupational sector of all individuals in El Salvador. The census includes very detailed

[82] 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.

[83] This is potentially due to the rules in place in cooperatives meant to address these incentive issues (screening and lock-in) and the low levels of mobility for rural workers in El Salvador.

geographic information on the current residence of all individuals in El Salvador. Along with canton, municipality, and department, the census reports the *segmento censal* for each individual (roughly equivalent to neighborhoods). I use these geographic variables 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.[84]

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 worker for each cooperatives' census-neighborhood as a measure of the heterogeneity of a cooperative.

Table A8 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 ha 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 5.[85]

8. Conclusion

Property right 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

[84] 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*.

[85] Note that the results in Table A8 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).

of the El Salvador land reform program of 1980. I find that the reorganization of properties 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.[86] 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 or use data on social norms to understand how cooperatives change social norms. For instance, Abramitzky (2018) highlights how *kibbutzim* has 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 where 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 UN declared the year 2012 as the "International Year of Cooperatives".[87] Thus, understanding the long-run impacts of land reforms that reorganized firms from outside ownership towards cooperatives can provide important evidence on the implications of cooperative property rights on economic development.

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

[87]For more information on the UN "International Year of Cooperatives", see: http://www.un.org/en/events/coopsyear/

References

Abramitzky, Ran, "The Limits of Equality: Insights from the Israeli Kibbutz," *The Quarterly Journal of Economics*, 2008, *123* (3), 1111–1159.

_ , "Lessons from the Kibbutz on the Equality-Incentives Trade-Off," *Journal of Economic Perspectives*, 2011, *25* (1), 185–208.

_ , *The Mystery of the Kibbutz: Egalitarian Principles in a Capitalist World*, New York, USA: Princeton University Press, 2018.

Adamopoulos, Tasso and Diego Restuccia, "The Size Distribution of Farms and International Productivity Differences," *American Economic Review*, 2014, *104* (6), 1667–1697.

_ **and** _ , "Land Reform and Productivity: A Quantitative Analysis with Micro Data," 2019. NBER Working Paper 25780.

Albertus, Michael, *Autocracy and Redistribution: The Politics of Land Reform*, New York, United States: Cambridge University Press, 2015.

Alchian, Armen A. and Harold Demsetz, "Production, Information Costs, and Economic Organization," *American Economic Review*, 1972, *62* (5), 777–795.

Alston, Lee J., Samar K. Datta, , and Jeffrey B. Nugent, "Tenancy Choice in a Competitive Framework with Transactions Costs," *Journal of Political Economy*, 1984, *92* (2), 1121–1133.

Aragon Sanchez, Fernando M., Diego Restuccia, and Juan Pablo Rud, "Are Small Farms Really More Productive Than Large Farms?," 2019. NBER Working Paper 26331.

Banerjee, Abhijit V., Paul J. Gertler, and Maitreesh Ghatak, "Empowerment and Efficiency: Tenancy Reform in West Bengal," *Journal of Political Economy*, 2002, *110* (2), 239–280.

Belloc, Filipo, "What Deters Labor-Owned Firm Creation? Evidence from Italian Manufacturing Sectors," *Journal of Comparative Economics*, 2017, *45* (1), 139–153.

Besley, Timothy, "Property Rights and Investment Incentives: Theory and Evidence from Ghana," *The Journal of Political Economy*, 1995, *103* (5), 903–937.

_ **and Robin Burgess**, "Land Reform, Poverty Reduction, and Growth: Evidence from India," *The Quarterly Journal of Economics*, 2000, *115* (2), 389–430.

Bonin, John P., "Work Incentives and Uncertainty on a Collective Farm," *Journal of Comparative Economics*, 1977, *1* (1), 77–97.

_ **and Louis Putterman**, "Incentives and Monitoring in Cooperatives with Labor-Proportionate Sharing Schemes," *Journal of Comparative Economics*, 1993, *17* (1), 663–686.

_ **, Derek Jones, and Louis Putterman**, "Theoretical and Empirical Studies of Producer Cooperatives: Will Ever the Twain Meet?," *Journal of Economic Literature*, 1993, *31* (3), 1290–1320.

Browning, David, *El Salvador: Landscape and Society*, Oxford, U.K.: Clarendon Press, 1971.

_ , "Agrarian Reform in El Salvador," *Journal of Latin American Studies*, 1983, *15* (2), 399–426.

Burchardi, Konrad, Selim Gulesci, Benedetta Lerva, and Munshi Sulaiman, "Moral Hazard: Experimental Evidence from Tenancy Contracts," *Quarterly Journal of Economics*, 2018. *Forthcoming*.

Burdín, Gabriel, "Are Worker-Managed Firms More Likely to Fail Than Conventional Enterprises? Evidence from Uruguay," *Industrial and Labor Relations Review*, 2014, *67* (1), 202–.

_ , "Equality Under Threat by the Talented: Evidence from Worker-Managed Firms," *Economic Journal*, 2016, *126* (594), 1372–1403.

_ **and Andrés Dean**, "New Evidence on Wages and Employment in Worker Cooperatives Compared with Capitalist Firms," *Journal of Comparative Economics*, 2009, *37* (4), 517–533.

Calonico, Sebastian, Matias D. Cattaneo, and Rocío Titiunik, "Robust Data-Driven Inference in the Regression-Discontinuity Design," *Stata Journal*, 2014, *14* (4), 909–946.

_ **,** _ **, and** _ , "Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs," *Econometrica*, 2014, *82* (6), 2295–2326.

_ **,** _ **, Max H. Farell, and Rocío Titiunik**, "rdrobust: Software for Regression Discontinuity Designs," 2017. Working Paper, forthcoming *Stata Journal*.

Carter, Michael R., "Risk Sharing and Incentives in the Decollectivization of Agriculture," *Oxford Economic Papers*, 1987, *39*, 577–595.

Cattaneo, Matias D., Brigham R. Frandsen, and Rocío Titiunik, "Randomization Inference in the Regression Discontinuity Design: An Application to Party Advantages in the U.S. Senate," *Journal of Causal Inference*, 2015, *3* (1), 1–24.

_ **, Nicolás Idrobo, and Rocío Titiunik**, *A Practical Introduction to Regression Discontinuity Designs: Extensions*, Cambridge, U.K.: Cambridge University Press, 2020.

_ **, Rocío Titiunik, and Gonzalo Vasquez-Bare**, "Power Calculations for Regression Discontinuity Designs," 2017. Working Paper.

Cheung, Steven N. S., *The Theory of Share Tenancy*, Chicago, USA: University of Chicago Press, 1969.

Colindres, Eduardo, "La Tenencia de la Tierra en El Salvador," *ECA*, 1976, *31* (335), 465–472.

_ , *Fundamentos Económicos de la Burguesía Salvadoreña*, San Salvador, El Salvador: UCA Editores, 1977.

Craig, Ben and John Pencavel, "The Behavior of Worker Cooperatives: The Plywood Companies of the Pacific Northwest," *American Economic Review*, 1992, *82* (5), 1083–1105.

_ **and** _ , "Participation and Productivity: A Comparison of Worker Cooperatives and Conventional Firms in the Plywood Industry," *Brookings Papers on Economic Activity: Microeconomics*, 1995, *1* (1), 121–174.

de Janvry, Alain, *The Agrarian Question and Reformism in Latin America*, Baltimore, United States: The Johns Hopkins University Press, 1981.

De Janvry, Alain and Elizabeth Sadoulet, "Optimal Share Contracts with Moral Hazard on Effort and in Output Reporting: Managing the Double Laffer Curve Effect," *Oxford Economic Papers*, 2007, *59*, 253–274.

Delpierre, Matthieu, Catherine Guirkinger, and Jean-Philippe Platteau, "Risk as Impediment to Privatization? The Role of Collective Fields in Extended Agricultural Households," 2016. University of Namur Working Paper.

Domar, Evsey, "The Soviet Collective Farm as a Producer Cooperative," *American Economic Review*, 1958, *56* (4), 734–757.

Dow, Gregory K., *Governing the Firm: Workers' Control in Theory and Practice*, Cambridge, U.K.: Cambridge University Press, 2003.

Eswaran, Mukesh and Ashok Kotwal, "A Theory of Contractual Structure in Agriculture," *American Economic Review*, 1985, *75* (3), 352–367.

Fafchamps, Marcel, "Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World," *American Journal of Agricultural Economics*, 1992, *74* (1), 90–99.

Field, Erica, "Entitled to Work: Urban Property Rights and Labor Supply in Peru," *The Quarterly Journal of Economics*, 2007, *122* (4), 1561–1602.

Figueroa Aquino, Ana Gloria and Edgar Marroquín Mena, "La Fase II de la Reforma Agraria y la Estructura Oligepólica en el Agro Salvadoreño," 1991. Tesis, Universidad de El Salvador.

Friebel, Guido, Matthias Heinz, Miriam Krueger, and Nikolay Zubanov, "Team Incentives and Performance: Evidence from a Retail Chain," *American Economic Review*, 2017, *107* (8), 2168–2203.

Gafaro, Margarita, "Collective Property Rights and Agriculture," 2015. Working Paper.

Galan, Juan, "Tied to the Land? Intergenerational Mobility and Agrarian Reform in Colombia," 2018. Working Paper.

Galiani, Sebastian and Ernesto Schargrodsky, "Property Rights for the Poor: Effects of Land Titling," *Journal of Public Economics*, 2010, *94* (9), 700–729.

Gaynor, Martin and Paul Gertler, "Moral Hazard and Risk Spreading in Partnerships," *The RAND Journal of Economics*, 1995, *26* (4), 591–613.

Goldstein, Markus and Christopher Udry, "The Profits of Power: Land Rights and Agricultural Investment in Ghana," *The Journal of Political Economy*, 2008, *116* (6), 981–1022.

Gollin, Douglas, Stephen Parente, and Richard Rogerson, "The Role of Agriculture in Development," *American Economic Review: Papers and Proceedings*, 2002, *92* (2), 160–164.

Hansmann, Henry, *The Ownership of Enterprise*, Cambridge, US: Harvard University Press, 1996.

Hart, Oliver and John Moore, "The Governance of Exchanges: Members' Cooperative vs. Outside Ownership," *Oxford Review of Economic Policy*, 1996, *12* (4), 53–69.

_ and _ , "Cooperatives vs. Outside Ownership," 1998. NBER Working Paper No. 6421.

Heckman, James, "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator of Such Models," *Annals of Economic and Social Measurement*, 1976, *5* (4), 475–492.

Holmstrom, Bengt, "Moral Hazard in Teams," *The Bell Journal of Economics*, 1982, *13* (2), 324–340.

Hornbeck, Richard, "Barbed Wire: Property Rights and Agricultural Development," *The Quarterly Journal of Economics*, 2010, *125* (2), 767–810.

Ireland, Norman J. and Peter J. Law, "Efficiency, Incentives, and Individual Labor Supply in the Labor-Managed Firm," *Journal of Comparative Economics*, 1981, *5* (1), 1–23.

_ **and** _ , "Management Design under Labor Management," *Journal of Comparative Economics*, 1988, *12* (1), 1–23.

Israelseni, L. Dwight, "Collectives, Communes, and Incentives," *Journal of Comparative Economics*, 1980, *4* (2), 99–124.

Junta Revolucionaria de Gobierno, *Ley Basica de la Reforma Agraria*, San Salvador, El Salvador: Publicaciones del Ministerio del Interior, 1980.

Jurado Castillo, Alejandra Elizabeth, María Teresa Naves Medrano, and Loyda Abigail Robles Rosales, "Ley Especial para la Garantía de la Propiedad o Posesión Regular de Inmuebles," 1993. Thesis, Universidad de El Salvador, Facultad de Jurisprudencia y Ciencias Sociales.

Kandel, Eugene and Edward P. Lazear, "Peer Pressure and Partnerships," *Journal of Political Economy*, 1992, *100* (4), 801–817.

Kremer, Michael, "Why are Worker Cooperatives So Rare?," 1997. NBER Working Paper No. 6118.

Kung, James Kai-sing, "Transaction Costs and Peasants' Choice of Institutions: Did the Right to Exit Really Solve the Free Rider Problem in Chinese Collective Agriculture?," *Journal of Comparative Economics*, 1993, *17* (1), 485–503.

_ , "Egalitarianism, Subsistence Provision, and Work Incentives in China's Agricultural Collectives," *World Development*, 1994, *22* (2), 175–187.

_ **and Louis Putternman**, "China's Collectivization Puzzle: A New Resolution," *The Journal of Development Studies*, 1997, *33* (6), 741–763.

Lang, Kevin and Peter-John Gordon, "Partnerships as Insurance Devices: Theory and Evidence," *The RAND Journal of Economics*, 1995, *26* (4), 614–629.

MacLeod, W. Bentley, "The Role of Exit Costs in the Theory of Cooperative Teams: A Theoretical Perspective," *Journal of Comparative Economics*, 1993, *17* (2), 521–529.

Marroquín Mena, Edgar, *Evaluación Sobre la Reforma Agraria en El Salvador (1980-1987)*, San Salvador, El Salvador: Ciudad Universitaria, 1988.

Marshall, Alfred, *Principles of Economics* 1890.

McCrary, Justin, "Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test," *Journal of Econometrics*, 2008, *142* (2), 698–714.

Mennen, Tiernan, "Land Reform Revisited: Can Latin America Get It Right and Should It Even Try?," *International Affairs Review: Elliot School of International Affairs at George Washington University*, 2009.

Ministerio de Agricultura y Ganadería, *Tercera Evaluación del Proceso de la Reforma Agraria*, San Salvador, El Salvador: Universidad Centroamericana José Simón Cañas, 1983.

_ , *Informe Annual Sobre Costos de Producción de Cultivos Agrícolas*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2005-2015. http://www.mag.gob.sv/direccion-general-de-economia-agropecuaria/estadisticas-agropecuarias/informe-anual-sobre-costos-de-produccion-de-cultivos-agricolas/.

_ , *Retrospectiva Mensual de Precios de Productos Agropecuarios*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2005-2015.

_ , *Anuario de Estadísticas Agropecuarias - 2006-2007*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2007.

_ , *Informe Annual Sobre Costos de Producción de Cultivos Agrícolas*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2007. http://www.mag.gob.sv/direccion-general-de-economia-agropecuaria/estadisticas-agropecuarias/informe-anual-sobre-costos-de-produccion-de-cultivos-agricolas/.

North, Douglass, *Structure and Change in Economic Growth*, New York, United States: W. W. Norton & Company, 1981.

Otsuka, Keijiro, Hiroyuki Chuma, and Yujiro Hayami, "Land and Labor Contracts in Agrarian Economies: Theories and Facts," *Journal of Economic Literature*, 1992, *30* (4), 1965–2018.

Parliament, Claudia, Yacov Tsur, and David Zilberman, "Cooperative Labor Allocation under Uncertainty," *Journal of Comparative Economics*, 1989, *13* (1), 539–552.

Pencavel, John, "Worker Cooperatives and Democratic Governance," in Anna Grandori, ed., *Handbook of Economic Organization*, Northampton, US: Edward Elgar, 2013, pp. 462–480.

_ **and Ben Craig**, "The Empirical Performance of Orthodox Models of the Firm: Conventional Firms and Worker Cooperatives," *Journal of Political Economy*, 1994, *102* (4), 718–744.

_ **, ed.**, *The Economics of Worker Cooperatives*, Northampton, USA: Edward Elgar, 2013.

Putterman, Louis, "Voluntary Collectivization: A Model of Producers' Institutional Choice," *Journal of Comparative Economics*, 1980, *4* (1), 125–157.

_ , "On Optimality in Collective Institutional Choice," *Journal of Comparative Economics*, 1981, *5* (1), 392–403.

_ , *Peasants, Collectives, and Choice: Economic Theory and Tanzania's Villages*, Greenwich, US: JAI Press, 1986.

_ , "The Incentive Problem and the Demise of Team Farming in China," *Journal of Development Economics*, 1987, *26* (1), 103–127.

_ , "Agricultural Producer Co-operatives," in Pranab K. Bardhan, ed., *The Economic Theory of Agrarian Institutions*, Oxford, UK: Oxford University Press, 1991, pp. 319–339.

_ **and Gil Skillman**, "The Incentive Effects of Monitoring Under Alternative Compensation Schemes," *International Journal of Industrial Organization*, 1988, *6* (1), 109–119.

Restuccia, Diego, "Resource Allocation and Productivity in Agriculture," 2016. University of Toronto Working Paper.

_ **and Raul Santaeulalia-Llopis**, "Land Misallocation and Productivity," 2017. NBER Working Paper 23128.

_ **, Dennis Tao Yang, and Xiaodong Zhu**, "Agriculture and Aggregate Productivity: A Quantitative Cross-country Analysis," *Journal of Monetary Economics*, 2008, *55* (2), 234–250.

Roberts, Kevin W.S., "Voting Over Income Tax Schedules," *Journal of Public Economics*, 1977, *8* (3), 329–340.

Rosenzweig, Mark R. and Christopher Udry, "External Validity in a Stochastic World: Evidence from Low-Income Countries," 2016. Working Paper.

Sadoulet, Elizabeth, "Labor-Service Tenancy Contracts in a Latin American Context," *American Economic Review*, 1992, *82*, 1031–1042.

Seligson, Mitchell A., *Thirty Years of Transformation in the Agrarian Structure of El Salvador'*, San Salvador, El Salvador: Fundacion Dr. Guillermo Manuel Ungo, 1994.

Sen, Amartya K., "Labour Allocation in a Cooperative Enterprise," *The Review of Economic Studies*, 1966, *33* (4), 361–371.

Stiglitz, Joseph, "Incentives and Risk Sharing in Sharecropping," *Review of Economic Studies*, 1974, *41* (2), 219–255.

Velis Polío, Rolando Antonio, "La Reforma Agraria de 1980 en El Salvador: Lucha Política, Diseño y Ejecución," *Revista de Humanidades y Ciencias Sociales*, 2012, *3*, 95–120.

Ward, Benjamin, "The Firm in Illyria: Market Syndicalism," *American Economic Review*, 1958, *48* (4), 566–589.

Wietzman, Martin and Douglass Kruse, "Profit Sharing and Productivity," in Alan Blinder, ed., *Paying for Productivity: A Look at the Evidence*, Washington DC, US: Brookings Institution Press, 1991, pp. 95–140.

World Bank, "El Salvador Country Land Assessment," 2012. World Bank Report Number: 82312-SV.

Appendix for

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

Eduardo Montero

University of Michigan

12 May 2020

Contents

Appendix A. Data Sources and Variable Definitions

A.1. Geographic Data and Variables

- **Elevation:** The elevation data is provided by Lehner and Grill (2013) and available at WWW.HYDROSHEDS.ORG. This data provides elevation information in meters at the 30 arc-second resolution (approximately at the 1 km^2 level near the equator). The elevation measure is constructed using NASAs SRTM satellite images (http://www2.jpl.nasa.gov/srtm/). In this paper, I calculate elevation for each canton as the mean elevation for canton in El Salvador in meters.

- **Precipitation:** Precipitation data is provided by the Global Climate Database created by Hijmans et al. (2005) and available at http://www.worldclim.org/. This data provides monthly average rainfall in millimeters. We calculate the average rainfall for each month for each 20 km by 20 km grid cell and average this over the twelve months to obtain our yearly precipitation measure in millimeters of rainfall per year.

- **Land Suitability:** Land suitability is the soil component of the land quality index created by the Atlas of the Biosphere available at http://www.sage.wisc.edu/iamdata/ used in Michalopoulos (2012) and Ramankutty et al. (2002). This data uses soil characteristics (namely soil carbon density and the acidity or alkalinity of soil) and combines them using the best functional form to match known actual cropland area and interpolates this measure to be available for most of the world at the 0.5 degree in latitude by longitude level. (The online appendix in Michalopoulos (2012) provides a detailed description of the functional forms used to create this dataset.) This measure is normalized to be between 0 and 1, where higher values indicate higher soil suitability for agriculture. The Land Suitability variable used in the paper measures the average land suitability in each canton in El Salvador to provide a measure of land suitability that also ranges between 0 and 1, with higher values indicate higher land suitability for agriculture.

- **Crop-Specific Suitability:** Crop suitability refers to the average suitability for rain-fed, low-input crops provided by the FAO's Global Ecological Zones website: http://www.iiasa.ac.at/Research/LUC/GAEZ/index.htm. FAO crop suitability model uses data on elevation, precipitation, soil and slope constraints to construct estimates of crop suitability at the 1 km^2 level for different crops. This measure is normalized to be between 0 and 1, where higher values indicate higher crop suitability and is reported for grid-cells across the world of 5 arc-minutes by 5 arc-minutes (approximately 56 km by 56 km). This paper utilizes the crop suitability measures for coffee, sugar cane, cotton, rice, beans (phaselous beans), and sorghum. I calculate the average value of the suitability for each crop for each canton in El Salvador.

A.2. Census of Agriculture Data and Variables

- **Sugar Cane Yield:** Sugar cane yield is taken from section S07, question S07P24 (*rendimiento*), from the agricultural census and is measured as total amount of sugar cane produced by each producer, in tons, per total land used for sugar cane cultivation, in *manzanas* (mz).

- **Sugar Cane Producer:** Sugar cane producer is taken from section S07, question S07P01, from the agricultural census and is an indicator variable equal to 1 if the any positive amount of the crop was reported as produced in the last year.

- **Sugar Cane Share:** Sugar cane share takes the amount of land in mz used for sugar cane cultivation from section S07, question S07P21, and divides this amount by the total land in the property, question S02P05 in section S02.
- **Coffee Yield:** Coffee yield is taken from section S09, question S09C225MDSC, from the agricultural census and is measured as total amount of coffee produced by each producer, in *quintales* (QQ), per total land used for coffee cultivation, in *manzanas* (mz).
- **Coffee Producer:** Coffee producer is taken from section S09, question S09P01, from the agricultural census and is an indicator variable equal to 1 if the any positive amount of the crop was reported as produced in the last year.
- **Coffee Share:** Coffee share takes the amount of land in mz used for coffee cultivation from section S07, questions S09C225, S09C226, and S09C227, (coffee cultivation at different altitudes) and divides this amount by the total land in the property, question S02P05 in section S02.
- **Maize Yield:** Maize yield is taken from section S03, questions S03P03 and S03P07, from the agricultural census and is measured as total amount of maize produced by each producer, in *quintales*, per total land used for maize cultivation, in *manzanas* (mz).
- **Maize Producer:** Maize producer is taken from section S03, question S03C44, from the agricultural census and is an indicator variable equal to 1 if the any positive amount of the crop was reported as produced in the last year.
- **Maize Share:** Maize share takes the amount of land in mz used for maize cultivation from section S03, question S03P03, and divides this amount by the total land in the property, question S02P05 in section S02.
- **Bean Yield:** Bean yield is taken from section S03, questions S03P19 and S03P20, from the agricultural census and is measured as total amount of bean produced by each producer, in *quintales*, per total land used for bean cultivation, in *manzanas* (mz).
- **Bean Producer:** Bean producer is taken from section S03, question S03C46, from the agricultural census and is an indicator variable equal to 1 if the any positive amount of the crop was reported as produced in the last year.
- **Bean Share:** Maize share takes the amount of land in mz used for bean cultivation from section S03, question S03P19, and divides this amount by the total land in the property, question S02P05 in section S02.

A.3. Details on Census Enumeration & Institutional Context:

In practice, workers may not report truthful staple crop output amounts to census enumerators if (i) workers believe that enumerators would share reported output levels for staple crops with owners, or (ii) government enumerators themselves would expropriate their output. For the empirical results on staple crop yields and productivity, it is important that workers report reliable output quantities for staple crops and that (i) and (ii) do not hold.[1] This is likely a reasonable assumption for a few reasons.

First, key institutional details of the Ministry of Agriculture (MAG) make it unlikely that they would side with owners and share confidential worker information with owners, or directly

[1]Note that this is less of a concern for the empirical results on the share of land devoted to different crops, as this is directly observed by the enumerators when they visit producers.

expropriate worker output. The minister of agriculture in charge of the 2007 census – Manuel Sevilla – was part of the government that implemented the 1980 land reform this paper studies: he was the vice-minister of the economy during the revolutionary junta government that designed and implemented the reform.[2] This reform had the reduction of rural poverty for agricultural workers as one its main goals (Junta Revolucionaria de Gobierno, 1980).

Similarly, the ideology, mission & philosophy of the Ministry of Agriculture (MAG) prioritizes reducing rural poverty and improving conditions and quality of life for rural agricultural laborers. For example, when describing its Mission & Philosophy, the MAG is described as "an institution that promotes inclusive and equitable opportunities for the quality of life of Salvadoran families".[3] The first objective in its mission statement is to: "contribute to reduce extreme poverty and guarantee the availability of food in the rural zones of the country," and the first value listed is: "Equity: our services are oriented following principles of justice and social inclusion, with equality of opportunities y benefits for the whole sector."[4] Interviews during my visits to El Salvador with the director in charge of the census and subordinates in charge of the census made it clear that they prioritize workers' rights. Thus, the MAG is oriented towards helping poor rural workers, making it unlikely that they would share the workers' information with owners if this could reduce their rural incomes.

Second, for the 2007 agricultural census in particular, the Ministry of Agriculture (MAG) emphasized the production of high quality and technically sound census after years of not having a census.[5] The MAG partnered with the FAO and adopted their best practices for producing a high quality census (Ministerio de Agricultura y Ganadería, 2009). These practices included an emphasis on confidentiality. Census questionnaires stress the importance of the confidentiality of the collected data at the start of the questionnaires: "the goal of the information collected is for statistical analysis and its handling will be strictly confidential."[6] Sharing of information with owners would have compromised this goal and the partnership with the FAO.

For individual enumerators, these institutional details (ideological and contextual) mean that sharing confidential census information with owners would jeopardize the MAG's mission and reputation, and would put individual enumerators at serious risk for losing their job. Enumeration – conducted in person, in the field – involved extensive monitoring and data quality checks that gave enumerators incentives to collect accurate data. Enumerators had to report their data daily via a web app, and this data was checked by data quality supervisors (Ministerio de Agricultura y Ganadería, 2009, pg. 9, Section 2.5 and pg. 15, Section 2.7).[7] Additionally, the MAG conducted re-enumeration of enumerator's data for a sub-sample of producers to verify the data provided (Ministerio de Agricultura y Ganadería, 2009, pg. 9, Section 2.5.2.5).[8] Consistent with these data collection details, in A.8 below, I discuss a series of data manipulation checks I conduct using the reported output for different crops; I find no evidence that there re differences in the extent of data manipulation when reporting output to census enumerators across organizational forms.

[2]Source: Obituary in El Faro.

[3]In Spanish: *"Un institucion que promueve oportunidades incluyentes y equitativas para el buen vivir de las familias salvadoreñas."*

[4]In Spanish: *"Contribuir a reducir la pobreza extrema y a garantizar la disponibilidad de alimentos en las zonas rurales del país."*

[5]The last census, prior to the 2007 census, was conducted in 1971. The micro-data for the 1971 has been lost.

[6]In Spanish: *"El fin de la información brindada es para usos estadísticos y su manejo será estrictamente confidencial."*

[7]In English: "With regard to the quality of the information collected, a series of controls were established that began with the brigade supervisor, followed by the methodology assistants who gave the approval to the information collected based on the guidelines dictated during training and work meetings."

[8]In English: "One of the key processes executed in the field phase was re-enumeration; This process was created in order to control the quality of the field survey. The re-enumeration complements the quality control processes... by strengthening the robustness of the estimates of the census results."

A.4. Land Reform Data and Variables

- **Expropriation and Cooperative Formation:** 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 for the cooperative created in each property. In the analysis in the paper, *Expropriation* is defined as an indicator variable equal to one if the property is reported as an expropriated property in the 1983 MAG report.

- **Landholding in 1980 for Properties Over 100 ha:** There was no single source with the universe of landholdings before the reform for all of El Salvador. However, ISTA provided me with 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 in 1980 for all properties that were owned by landholders with above 100 ha in cumulative landholdings in 1980 that were not expropriated by ISTA.[9] Both these data sets include geographic information on the location of the property (at the canton level), the name of the owner, and, if available, the name of the property.

  Since there could be a concern that the use of two separate sources for the 1980 landholdings may not be ideal as there could be differences in reporting (though this is unlikely since both sources use data originating from the property registry of El Salvador), Colindres (1977) provides a similar list of properties owned by landholders with over 100 ha in cumulative landholdings for 1971 for a subset of districts in El Salvador. In particular, he provides this list for eight of the eighteen districts of El Salvador. I use this data from Colindres (1977) as a check on the pre-reform landholding distribution to ensure that the 1980 landholding data is reliable. Table A3 provides summary statistics for the land reform data.

A.5. Household Surveys Data and Variables

- **Household Income per Capita:** This variable measures the household income for a household in the last month in U.S. dollars divided by the number of household members. The variable name is *INGPE* in the *Encuestas de Hogares de Propósitos Múltiples* for El Salvador.

- **Household Consumption per Capita:** This variable measures the household consumption for a household in the last month in U.S. dollars divided by the number of household members. The variable name is *GASPER* in the *Encuestas de Hogares de Propósitos Múltiples* for El Salvador.

- **Cooperative or Hacienda Member:** I construct measures of whether an individual belongs to a cooperative or hacienda by using variable *R503A* in the *Encuestas de Hogares de Propósitos Múltiples* for El Salvador. A cooperative member reports a value equal to 4 for this question, while an hacienda laborer (*colono*) reports a value of 3 for this question. The size of the

[9] ISTA also provided the list of all *derechos de reservas*/reserve rights that were granted to former owners. Former owners were allowed to negotiate with ISTA to keep up to 100 or 150 ha of their land as a "reserve right" depending on the class of land (Class I-IV and Class V-VII land respectively). Owners had to apply within 12 months of the land reform passage to ISTA, who were given final authority to arbitrate and grant reserve rights. Reserve rights could be increased by twenty percent if the owner could show that they had properly maintained the property since the passage of the reform or otherwise improved the property, a move intended to discourage decapitalization (Wise, 1985). Approximately half of the owners applied for reserve rights, and ISTA granted these rights to 156 former owners and subtracted the value from the bond payments. Owners who did not apply received the full value of the bonds (Wise, 1985).

establishment in terms of number of other workers is taken from question *R420* and the geographic location of an individual is the canton (*R004*), municipality (*R005*), and the department (*R006*) for each individual.[10]

- **Inter-Quartile Range of Income per Capita for each Property:** This variable measures the inter-quartile range of household income per capita within each agricultural property.
- **Demographic Variables:** For each individual, the household surveys includes a person's age (*R106*), gender (*R104*), literacy status (*R202A*), years of education (*APROBA1*), and educational attainment (*NIVAPROB*) from the *Encuestas de Hogares de Propósitos Múltiples* for El Salvador.

A.6. Population Census Data and Variables

- **Geographic Variables:** The Population Census of El Salvador (2007) reports the geographic location of an individual. Specifically, it reports the canton (*CANID*), municipality (*MUNID*), and the department (*DEPID*) for each individual. Additionally, the census reports the census neighborhood (*Segmento Censal*, *SEGID*) for each individual.[11]
- **Basic Demographic Variables:** The Population Census of El Salvador (2007) includes a person's age (*S06P03A*), gender (*S06P02*), ethnicity (*S06P06A*), literacy status (*S06P09*), years of education (*S06P11A*), and educational attainment (*S06P11B*) for each individual.
- **Occupation Variables:** The Population Census of El Salvador (2007) includes a person's main occupation sector (*S06P20*) and occupation work type (*S06P21*) for each individual that reports employment in El Salvador.
- **Migration Variables:** The Population Census of El Salvador (2007) reports an indicator variable equal to 1 if a person lives in the same canton as his/her birth canton (*S06P07A*) and, if not, the municipality (*S06P07B2*) and department (*S06P07B3*) of birth for individuals who have moved since their birth and were born in El Salvador.[12]

A.7. Linking Land Reform Records and the 2007 Census

The 2007 census collected the size of each property, name of many properties, 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 3.1 to the corresponding property today using the name, municipality, department and the size of the property in ha. I perform the match using the following steps.

First, to match cooperatives, the census includes an indicator variable for whether a property is a cooperative and the name for each cooperative. 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 in World Bank (2012) to study the reform cooperatives.

Second, to match *haciendas*, the name for the *hacienda* is usually not included because many *haciendas* do not have a formal name. However, the census includes information on the size of

[10] I use the name of the establishment, question *R418-R419*, to confirm my matching to cooperatives and haciendas in household surveys for which these questions were included in the dataset.

[11] I thank Carlos Schmidt-Padilla for generously sharing the shapefiles of the census neighborhoods of El Salvador.

[12] The census data does not include the canton of birth for individuals. This question was asked in the census but the responses were not digitized due to incompleteness and recall problems during enumeration. I thank Carlos Schmidt-Padilla for detailing this issue.

each property and the geographic location of each property. Thus, I use these two variables to match *haciendas*. I consider a 2007 property a match if the property is in the same geographic area as the 1980 non-reform property (municipality and department) and if the size of the 2007 property is within 50 ha of the size of the 1980 non-reform property. I use 50 ha to account for measurement error in the size of properties.[13] I use the variable containing the name of the property, when available, to verify the quality of each match.

Across the threshold, I am able to match approximately 70% of the pre-reform landholdings to a modern-day agricultural producer from the census.[14] Importantly, as demonstrated in Figure A8 – the RD plot of the probability of existing today – I find that 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.

However, one additional possible concern with this matching procedure is that the reasons for not finding a match may differ systematically across the threshold. In particular, one might be concerned that properties that have relatively poor geographic endowments, or are closer to urban centers, might be more likely to dissolve or be sold, and that this probability of dissolution differs at the threshold.

To explore whether this is the case, I explore whether there is heterogeneity by key geographic features in the probability of matching across the threshold. I estimate the following empirical equation:

$$y_{po} = \alpha + \gamma Above500_o + \phi G_{c(p)} + \delta Above500_o \times G_{c(p)} + f(holdings_o) + \epsilon_{po} \quad for \quad o \in RS \qquad \text{(A1)}$$

where y_{po} is the indicator equal to 1 if the 1980 property p owned by owner o before the reform has a match in the 2007 census, $G_{c(p)}$ is a geographic characteristic for the location of property p (where $c(p)$ is a function mapping properties p to cantons $c(p)$), and $Above500_o$ is an indicator variable for whether owner o had over 500 ha in cumulative landholdings before the reform. The rest of the terms follow the notation defined in (1). The coefficient of interest in δ: whether the probability of finding a match at the threshold varies systematically by $G_{c(p)}$. I examine a number of different $G_{c(p)}$'s, including suitability for the main cash and staple crops in El Salvador, precipitation, elevation, distance to the country capital, and distance to the district capital.

I present the coefficient estimates for δ in Figure A10 for a number of important geographic characteristics. I find no evidence of heterogeneity in the probability of matching at the threshold for these geographic characteristics (including distance to urban centers). These results provide some evidence that the probability of matching is not systematically different due to key observable features across the threshold.

A.8. Census Data: Data Manipulation Tests

A possible concern with the census data is that workers do not report truthful amounts of staple crop output to enumerators, and that this misreporting differs across ownership structure. In this sub-section, I conduct a series of data manipulation checks using the reported output for different crops across both ownership forms. First, I test whether there is more or less bunching at multiples of 5 or 10 across ownership forms by estimating equation (1) on indicator variables

[13] The main results of the paper are very similar when using 100 ha instead of 50 ha. I use 50 ha to be conservative.

[14] The lack of a match for a cooperative or an *hacienda* could occur for several reasons: (i) urban census segments were not sampled, (ii) properties refused to answer or were absent at the time of the interview (which occurred with some cooperatives, as they exist according to online information by CONFRAS – Association of Reform Cooperatives – but not in the census), or (iii) properties were abandoned or without production (not all of the pre-reform *haciendas* or cooperatives exist today).

equal to 1 if a property reports an output amount that is a multiple of 5 and/or 10 for various crops. I present the results in Figure A11. I find no difference in the extent of bunching at multiples of 5 or 10 across organizational forms. Additionally, the rates of bunching are similar for cash crops and staple crops.

Second, I conduct tests for differences in the distributions of the first-order and second-order digits (the digit distributions used to test Benford's law, see Nigrini, 2012) for crop output across ownership forms and I present the results in Table A5. I fail to reject the null hypothesis that the distributions are the same across ownership for all crops.[15] These results provide some evidence that there is not more or less data manipulation across organizational forms when reporting output to census enumerators.[16]

A.9. Constructing Farm Productivity Measures ($ln(s_i)$)

This section details the construction of Farm Productivity used in Table 4 following the methodology developed in Restuccia and Santaeulalia-Llopis (2017) and Aragon Sanchez et al. (2019) to estimate a farm-specific component of total factor productivity.

Following the notation in Aragon Sanchez et al. (2019), let Y_{ij} be total revenue for producer i in region j, T_{ij} be the amount of land used by producer i (in ha), and L_{ij} be the amount of labor used (in terms of number of workers). Building on the standard model of farm size and input allocation developed in Adamopoulos and Restuccia (2014), Aragon Sanchez et al. (2019) consider the case where there are n heterogenous farmers producing a single homogenous good according to the production function: $Y_{ij} = s_i A_{ij}(T_{ij}^{\alpha} L_{ij}^{1-\alpha})^{\gamma}$. In this framework, Total Factor Productivity (TFP) for a farm is equal to $s_i A_{ij}$, where A_{ij} is a common productivity shock (e.g. weather) and s_i is the producer-specific output shifter. Aragon Sanchez et al. (2019) call this s_i "farm productivity".

To estimate s_i, Aragon Sanchez et al. (2019) estimate the production function, $Y_{ij} = s_i A_{ij}(T_{ij}^{\alpha} L_{ij}^{1-\alpha})^{\gamma}$, by assuming that the common productivity shock is $A_{ij} = exp(\delta \times \text{weather}_j + \eta_j + \epsilon_{ij})$, where *weather* is a set of temperature and precipitation variables in region j, η_j are region fixed effects, and ϵ_{ij} is the error terms. Taking logs, the production function becomes:

$$\ln Y_{ij} = ln s_i + \ln A_{ij} + \alpha\gamma \ln T_{ij} + (1-\alpha)\gamma ln L_{ij} + \delta \text{weather}_j \eta_j + \epsilon_{ij})$$

Thus, assuming ϵ has mean zero, then, in this setting, $\ln s_i$ can be approximated as the residual for this estimation. I follow Aragon Sanchez et al. (2019)'s preferred specification and use a Cobb-Douglass production function with land and labor inputs and the same parameters across regions. For the case of El Salvador, using weather controls at the canton level and municipality fixed-effects, the estimated production function parameters are $\hat{\alpha} = 0.4427$ and $\hat{\gamma} = 0.5204$. These values are very close to the values estimated in other contexts: Adamopoulos et al. (2017) and Restuccia and Santaeulalia-Llopis (2017) calibrate $\gamma = 0.54$, while Aragon Sanchez et al. (2019) estimate $\hat{\alpha} = 0.526$ and $\hat{\gamma} = 0.709$. For the paper, I denote the estimates for $\ln s_i$ as the Farm Productivity measure used in the paper.

[15] The p-values from the Kolmogorov-Smirnov Tests are all above 0.70.

[16] Importantly, workers were interviewed in person in the field. Misreporting, even under no threat of harm, would still be possible but would be inconsistent with recent empirical evidence by Abeler et al. (2019) who summarize that, when the material payoffs are small, people have a preference for truth-telling. Individual workers reporting truthful outputs is consistent with this literature (if they are not concerned about owners gaining access to the data).

Appendix B. Model Appendix

B.1. Model Tables

Table A1: Model Set-up Summary

	Hacienda (h)	**Cooperative** (c)
Players:	Owner (o) and Workers (i)	Workers (i)
Decisions:	**1)** Owner: Share of land allocated to cash crops (γ_h)	**1)** Vote on share of land in to cash crops (γ_c)
	Assumptions I: Cash crop output is contractible, Staple crop output is non-contractible	
	2) Owner: Share of cash crop output kept by owner (τ_h) **3)** Owner: Rent for staple crop production (R^h) **4)** Workers: Effort between cash crops and staple crops (e^i)	**2)** Vote on the share of cash crop output redistributed equally to all members (τ_c) **3)** Effort between cash crops and staple crops (e^i)
	Assumptions II: Worker effort is unobservable; Workers have limited liability; Workers are heterogeneous: receive production shocks A^i, where shocks $A^i \sim [A^{min}, A^{max}]$ with $A^m < \bar{A}$	
Payoffs:	**Owner:** Share of cash crop output kept + staple crop rent; **Workers:** Share of cash crop output kept $(1-\tau_h)$ + staple crop output - staple crop rent	**Workers:** Share of cash crop output kept $(1-\tau_c)$ + Share of cash crop output redistributed equally (τ_c) + staple crop output

Table A2: Summary of Decisions by Ownership Type

	Cooperative	***Hacienda***	Comparison
	(1)	(2)	(3)
Worker Effort: Amount of effort, e_c, in cash crop production	Workers individually choose effort such that marginal product of effort on cash crops (taking into account τ_c) is equal to marginal product of staple crop production, $(1-\tau_c)G' = f'$.	Similarly, workers individually choose effort such that marginal product of effort on cash crops (taking into account τ_h) is equal to marginal product of staple crop production, $(1-\tau_h)G' = f'$.	Differences in worker effort depend on the differences between τ_c and τ_h. If $\tau_c > \tau_h$, cooperative workers will be less productive at cash crops than *hacienda* workers.[17]
Wage Rates: Share of cash crop output, τ, kept by workers	If the member with a median shock has less than mean shock, the cooperative will vote for $\tau_c > 0$, setting $(\bar{A} - A^m)\gamma_c L = e'(\tau_c)(f_e - G_e)$.	The *hacienda* owner will set $\tau_h > 0$ to maximize his/her profits, where increasing τ_h increases the share kept by the owner at the expense of lower cash crop incentives for his/her workers but higher staple crop rental rates, $e'(\tau_h)(\tau_h G_e + (1-\tau_h)G_e^{min} - f_e^{min}) = G - G^{min} + \bar{A} - A^{min}$.	The difference between is *ex-ante* unclear and depends on the distribution of shocks. Both τ_c and τ_h are decreasing the amount of land devoted to cash crops, γ.
Crop Choices: Share of land, γ, devoted to cash crops over staple crops	Median voter equalizes marginal product of cash crop with the marginal product of their staple plot, $G_L = A^m f_L$.	Owner will set the marginal product of cash crop output equal to the marginal product of the staple crop plot of the lowest productivity member, $G_L = f_L^{min}$.	Cooperative will devote less land to staple crop production than the *hacienda* owner.
Worker Earnings: Total worker earnings	Each cooperative worker will receive an equal share τ_c of cash crop output. Additionally, they will keep $(1-\tau_c)$ of their cash crop output and all their staple crop earnings.	Workers will received $(1-\tau_h)$ of their cash crop output and a portion of their staple crop earnings (the surplus above the lowest productivity member).	Cooperative workers will have more compressed incomes because they redistribute a share of cash corp output equally. Whether cooperative members have higher incomes than *hacienda* workers is not clear *ex-ante*.

Notes: G denotes the production of cash crop, $G = \sum_i^N G(e_c^i, \gamma L) + A^i$. f denotes the production of staple crops individually, $f = f'(e_s^i, \frac{(1-\gamma)L}{N})$. R^h denotes the rent charged by the hacienda, $R^h = (1-\tau_h)(G^{min} + A^{min}) + f^{min} - \bar{U}$. $\bar{U}$ denotes the outside wage for workers. $G^{min} = e_c^{min}, \gamma L)$ and $f^{min} = (e_s^{min}, \frac{(1-\gamma)L}{N})$. For more details, see Section 5.1.

B.2. Model Figures

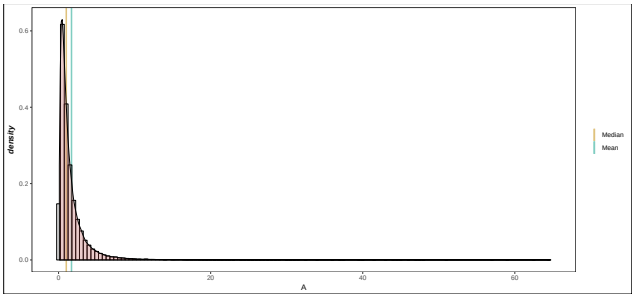
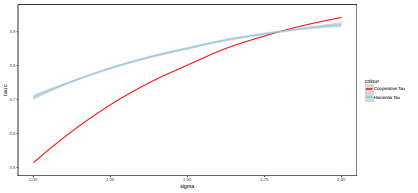


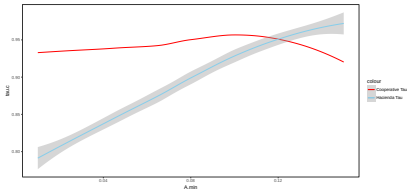
Figure A1: Example of a Skewed Shock Distribution, A

$A \sim LogN(\mu = 0, \sigma^2 = 1)$ with $A^{min} = \frac{1}{10}$ (i.e. truncated lognormal), meaning $A^m < \bar{A}$.

- **Example**: if $A \sim LogN(\mu = 0, \sigma^2)$ with $A^{min} > 0$ (i.e. truncated lognormal):
- Difference in wage rates depends on difference between mean and median, σ^2, and amount owner can extract from staple crop production, A^{min}.



Effect of σ on τ_c and τ_h



Effect of A^{min} on τ_c and τ_h

B.3. Theoretical Framework – Modeling Hiding & Contract Choice

I extend the model to include the ability to hide of staple crop output and derive the conditions when staple crop output becomes non-contractible due to the threat of hiding.[18] In the model, crop output can be hidden by workers, *but*, that this hiding is (i) costly, and (ii) that the benefit to hiding varies by crop type. With these changes, the model formalizes the idea that, under certain situation, workers are willing to pay a cost to hide output depending on the benefit to hiding.[19]

[18] The spirit of the model extension follows work by De Janvry and Sadoulet (2004), who provide empirical motivations and a model to study how the threat of hiding shared output affects the design of agricultural contracts in developing countries.

[19] And that this benefit of hiding is different for hiding from owners vs enumerators.

The general motivation for (i) and (ii) is that: cash crop output must be centrally processed before it can be hidden from others (either directly consumed or side-sold), but staple crop output need not be centrally processed to be hidden. This means that the benefits of hiding staple crop output are higher than for cash crops.

Given these differences in hiding benefits between staple crops and cash crops, owners may find it not worthwhile to contract on staple crop output in certain cases. That is, when the cost of hiding staple crop output is low, staple crop output becomes non-contractible because of the threat of hiding output. The intuition is as follows: if the costs of hiding excess staple crop output are low enough, then the owner is better off not contracting on staple crop output.

Set Up: Allowing For Hiding

For this extension, to keep the model as simple as possible while still capturing this general intuition, I make the following additions to the model set-up:[20]

- Owners can choose to attempt to contract on staple crop output or charge a fixed rent. If the owner chooses to contract on staple crop output, he/she sets share τ_s^h. For the case of the *hacienda*, τ_s^h is the share of staple crop output that the owner gets to keep from the worker. For the case of the *cooperative*, τ_s^h is the share of staple crop output that gets redistributed to all workers equally to workers in the cooperative.

- If the owner chooses to contract on staple crop output, workers can pay an "iceberg" cost c to hide output: if the workers choose to hide, the worker is able to conceal part of the output produced above the lowest possible production amount for that crop for a cost. Specifically, if worker i chooses to hide, then he/she keeps $(1-c)[f(1-e_c^i,\gamma_h) - f(1-e_c^{min},\gamma_h)]$.[21] The remaining amount that is not hidden and can be contracted on is: $f(1-e_c^{min},\gamma_h)$.[22]

Given this set-up, I formalize conditions under which workers will hide output, and owners will choose to not contract on staple crop output:

[20] Unless otherwise noted, I use the same notation from the Theoretical Framework Section of the paper.

[21] e_c^{min} represents the output produced by a worker with the lowest ability shock A^{min}. Consistent with focus group evidence (see Appendix C), I assume that owners have to pay a high monitoring cost $m > 0$ if they choose to expropriate excess output. As I show below, even without this assumption, owners choose not to contract on staple crop output.

[22] To simplify the case of cash crops vs staple crops, I assume that $c = 1$ for cash crops and $0 < c < 1$ for staple crops.

- If the owner sets a share contract on staple crop output, the worker will choose to hide staple crop output if:

$$(1-c)[f(1-e_c^i,\gamma)-f(1-e_c^{min},\gamma)]-(1-\tau^h)f(1-e_c^{min},\gamma)>(1-\tau^h)f(1-e_c^i,\gamma)$$

$$\Rightarrow c<\tau^h<1$$

- If this is the case, then the owner will be better off not contracting on staple crop output and charging a fixed rent instead because:

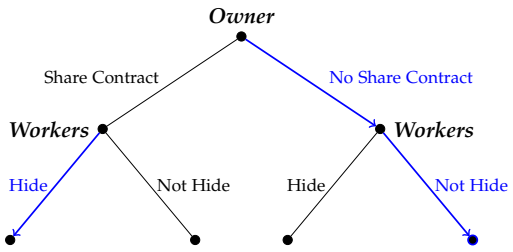
$$\tau^h f(1-e_c^{min},\gamma)<f(1-e_c^{min},\gamma)$$

- Since $\tau^h<1$ by definition, this means that there is no τ^h in which the owner is better off attempting to contract on staple crop output given the ability to hide.

- These assumptions effectively means that staple crop output is non-contractible in practice for the owners as long as $c<1$.

Figure A2 provides a stylized summary of the choices made in equilibrium by owners and works for staple crop output under this extension.

Figure A2: Equilibrium Choices by Owners and Workers – Staple Crop Output



Notes: The game tree above presents a stylized summary of equilibrium choices by owners and workers for staple crop output under the modified assumption. **??** formalizes the details of the model and the payoffs in more detail.

Modeling Enumerator Visits

Given the set-up explained in the previous, I formalize conditions under which workers will hide output from enumerators, and then whether owners will choose to contract on staple crop output:

- When the enumerators visits, for the choice of hiding, the worker will weigh the cost to hiding output against the probability that, if no hiding occurs, the enumerator tells the owner the true output and the owner sets a share contract on staple crop output based on this (while still satisfying the participation constraints given liquidity constraints for workers). Let p denote the probability in the worker's mind that the enumerator will report the staple crop output level (if it is above the minimum level) to the owners. Then, the worker will choose to not hide staple crop output from the enumerator but continue to hide it from the owner if:

$$(1-c)[f(1-e_c^i,\gamma) - f(1-e_c^{min},\gamma)] < p[(1-\tau^h)f(1-e_c^i,\gamma) - f(1-e_c^{min},\gamma)]$$

$$\Rightarrow p\tau_h < c < 1$$

- This condition highlights that the incentive to hide output from the enumerator for the worker is lower than when considering only the owner, and depends crucially on the probability of the enumerator informing the owner. As I argue in the paper and the data appendix, this probability is likely very low. Additionally, as shown in the section above, the owner will be better off not contracting on staple crop output and charging a fixed rent instead because:

$$\tau^h f(1-e_c^{min},\gamma) < f(1-e_c^{min},\gamma)$$

and since $\tau^h < 1$ by definition, this means that there is no τ^h in which the owner is better off attempting to contract on staple crop output given the ability to hide. Thus, if $p < c < 1$, then workers choose to hide output from owners but not enumerators.

- These assumptions imply that while staple crop output is non-contractible for the owners in practice, the output will not be hidden from census enumerators.

Appendix C. Internal Organization of Cooperatives and *Haciendas* in El Salvador

This section provides a detailed description of how cooperatives and *haciendas* to summarize important organization details of cooperatives and *haciendas* in El Salvador. The information in this section is based on a combination of qualitative evidence gathered in focus groups with agricultural workers in El Salvador, and academic and historical accounts from El Salvador on cooperatives and *haciendas*. I first provide a description of the focus groups conducted before explaining a number of key details of how cooperatives and *haciendas* operate in El Salvador, including: (i) land allocation, (ii) payment schemes in practice, and (iii) decision making in for both cooperatives and *haciendas*.

Background on Focus Groups:

During two visits to El Salvador in 2013 and 2014, I conducted focus groups with members of seven former reform cooperatives. The focus groups were coordinated via *CONFRAS*, the confederation of agricultural reform cooperatives of El Salvador. The focus groups included physical visits to three cooperatives and interviews in San Salvador with members of four other cooperative leaders (who were visiting San Salvador for the annual *CONFRAS* meeting). During my physical visits, I interviewed at least five members. During the San Salvador focus groups, I was often able to talk to at least two members of each cooperatives.[23]

Unfortunately, I was unable to interview *hacienda* owners; I reached out to three families in El Salvador, but they declined to discuss the topic. These are quite wealthy families who wished to avoid discussions about their wealth and landholdings (especially given the high levels of organized crime in El Salvador). However, discussions with cooperatives members (and with two *hacienda* workers visiting the ministry of agriculture during one of my visits) did provide information on the internal workings of *haciendas*, since many members had previously worked in *haciendas* prior to the reform and were quite informed about the workings of nearby *haciendas*.

During the focus group discussions, I attempted to gather qualitative evidence on (i) the individual histories of each worker, (ii) if applicable, their experiences prior to the reform and following the reform, (iii) the internal organization of their cooperative/*hacienda*, and (iv) their general outlook on their life and what things could be improved in their cooperative/*hacienda*. I attempted to keep the questions as open as possible. The individual workers were very open to discussing their lives, the reform, and their experiences (similar to the experiences recounted in Wood (2003)). Part of the openness to discussing the reform was due to the timing of my visit. Shortly around the time I visited, the government decreed March 6th as "National Land Reform Day" (Decree 289). This made workers particularly interested in remembering the reform.

Land Organization in Cooperatives & Haciendas:

In this sub-section, I describe how land is organized and split across workers in each ownership structure. I discuss both qualitative evidence from focus groups and historical accounts of land organization choices.

Cooperatives: In focus group conversations, cooperative workers discussed that they see their land split in two different ways. For staple crop production, cooperative members discussed seeing them as individual-worker crops; therefore, for any staple crop land, cooperatives will split land equally into small plots of equal size for all members. This was the case in all cooperatives I visited. I asked why they split the land equally, and they said this is done for equity reasons: it

[23] I avoid mentioning the name of each cooperative for privacy reasons. As well, some of the statements made about owners/internal-decisions were made under the assumption of anonymity, and I do not want to violate this trust.

is not clear who deserves more land (as cropping staple crops can be unpredictable . people face shocks, and it is not ex-ante fair). This type of land division was evident when physically visiting the cooperatives: staple crop plots were very uniform in their size.[24]

In contrast, for cash crops such as coffee and sugar cane, cooperative members said they not split this land into smaller plots and, instead, use central land to produce cash crops (below I explain how workers get paid for work on cash crop in more detail). The cooperatives usually choose this land to be centrally located and easy to access by the main roads. This is done for two reasons: a central and accessible location makes it easier to commercialize the product, and it makes it easier for all workers to bring cash crop output to central processing plants. (Note: two of the cooperatives I visited had central cash crop processing operations on their property, one for coffee and the other for sugar cane. For the third cooperative, they would outsource production to a neighboring non-reform cooperative.)

In Figure A5, I present satellite imagery of a modern reform cooperative from google earth to provide an example of how the land is organized in a cooperative. As can be seen in the image, The map shows the division of most of the land into small worker plots. However, in the middle right side of the map, there is one large central plot (that is not divided up into small plots) for cash crops. As can be seen in the image, this cash crop (undivided) land is near the main roads and cooperative houses to make it easier for all workers to access and work on cash crops (and transport it for processing).

This type of land organization in cooperatives is also evident when reading historical accounts. The best evidence comes from Wood (2003), on her cooperative maps on land use before and after the 1980 reform, which I discuss in more detail below.

Haciendas: Similarly, focus group conversations with former *hacienda* workers highlighted that if *haciendas* produce staple crops, then this was almost always exclusively done through individual-level plots rented to their workers. These workers sometimes would reside on the *hacienda* property if there main village in the region was very far. They would reside close to their plots. However, in some cases, when the *hacienda* is not remotely located, workers rent the staple crop land but reside in villages outside the property.

For cash crop land, this land is not divided and is produced by workers hired for cash crop land work. (I discuss remuneration for this work below.) The amount of land devoted to cash crops (and the crops that will be farmed on that land) is chosen by the owner. In terms of focus group evidence, conversations with three workers (from 2 cooperatives) who were alive during the reform mentioned how the former *hacienda* lifestyle was very difficult for them: the previous *hacienda* production focused strongly on cash crop production, and they did not have a lot of land for their staple crop production. This meant that if they fell sick and could not work much on the cash crops, they would struggle to feed their families. In contrast, after the reform, workers mentioned that they were able to switch to different crop allocations – cash crop production was still important, but the workers wanted more land for staple crops (where they were the residual claimants on their effort).[25]

Wood (2003) Maps on Land Use Before and After the 1980 Land Reform: To provide some qualitative evidence on changes in land use and organization following the land reform in cooperatives compared to *haciendas*, I present maps from Wood (2003) drawn by cooperative members that show, in their view, how the land changed before and after the 1980 land reform Wood (2002) describes the process of the making of the maps by cooperative workers:

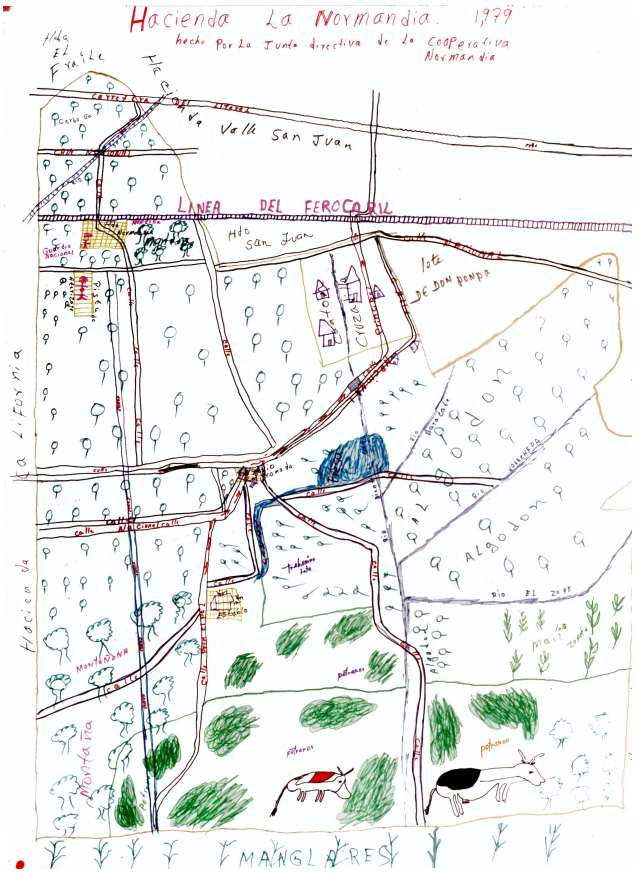
[24] On which individual plot a worker gets within the cooperative, some cooperatives mentioned having a rotation system for equity reasons. Other cooperative members described either an initial lottery or more informal assignment process shortly after the reform that has roughly persisted until today.

[25] These comments motivated key aspects of the model.

> "I asked representatives of a dozen cooperatives to draw on large sheets of butcher paper with marker pens maps of their localities showing property boundaries and land use before and after the civil war. Drawn collaboratively by at least two and usually several members, the resulting maps document how campesino collective action literally redrew the boundaries of class relationships through their depiction of changes in de facto property rights and patterns of land use in the case study areas during the war. The accuracy of the claims by these cooperative leaders to occupy extensive areas of land in 1992 was confirmed by my own travel and observation in the case-study areas, and by examination of the archives of landholding and land claims data maintained by the FMLN, the government, and the United Nations during the postwar process of adjusting property titles.
>
> The willingness of insurgent campesinos to draw the maps reflected their assertion of contested property rights at the end of the civil war. Drawing such maps involved considerable sacrifice of work time on the part of individuals and foregone opportunities on the part of the campesino organizations: each pair of maps took two full days to draw, given the unfamiliarity of the task. Given this time commitment, cooperative members participated with remarkable enthusiasm; only one of twelve pairs of maps was not completed." Wood (2002).

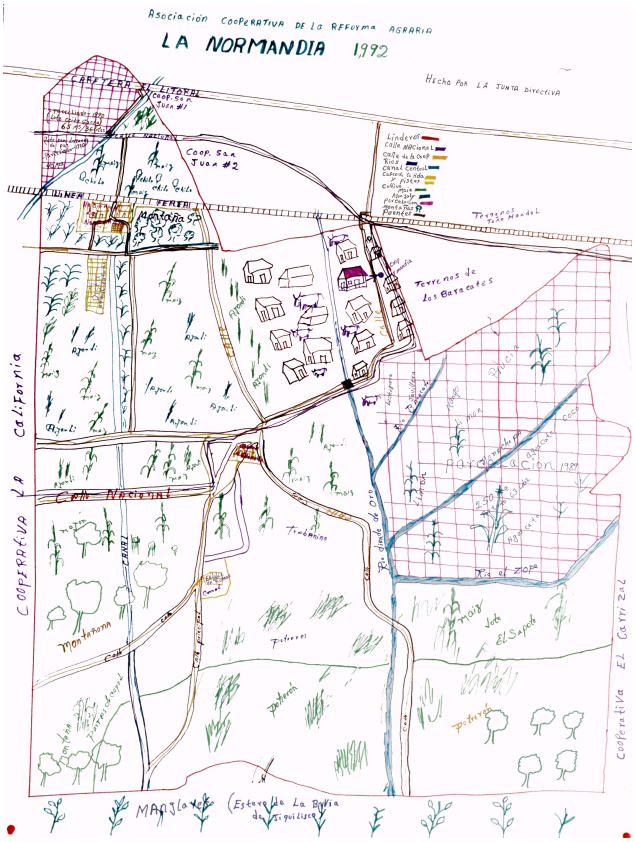
Note that not all the cooperative maps are from reform cooperatives. However, Wood (2003) does contain maps for one reform *hacienda* and cooperative, which I reproduce below. These maps show how land shifted away from cash crops towards more staple crops in this one cooperative.

Figure A3: *Hacienda La Normandía* - Before the 1980 Land Reform



Notes: The maps are reproduced from Wood (2003). Information on the map from Wood (2002): *"[The figure]shows the Hacienda La Normandía, a very large property (1,500 hectares) along the coastal plain south of Tierra Blanca. Before the war, the farm was owned by the Del'Pech family, a major coffee-producing family. Cotton was the principal crop, as indicated by the lollipop symbol."*

Figure A4: *Cooperativa La Normandía* - After the 1980 Land Reform



Notes: The maps are reproduced from Wood (2003). Information on the map from Wood (2002): "*The farm was expropriated in 1980 as part of the agrarian reform and a cooperative of former employees was named by the military officer present... As shown in [the figure], at the close of the war, the approximately 175 reform cooperative members cultivated individual plots of corn, sesame, and, near the old farmhouse, chile.*"'

Modern Cooperative Land Allocation:

Figure A5: *Cooperative Land Allocation Today*

Notes: The map uses google satellite data to show the land allocation in a reform cooperative today. (The name of the cooperative is suppressed.) The map shows the division of most of the land into worker plots except for cash crop land (middle right of the map).

Payment Schemes:

I describe how cooperative and *haciendas* workers are paid in practice and how they organize their work on each type of crop.

Cooperatives: Something that was very common in my focus group discussions with cooperatives was that there was no formal payment for worker's labor on staple crops. Workers produce these on their individual plots. Sometimes, workers individually commercialize the staple crop output in local markets as well. In other cases, workers engage in some cooperation to commercialize staple crops. For example, workers discussed being able to borrow trucks from the cooperative (if it owned one) to transport and sell their individual staple crops to wholesalers. One cooperative's workers discussed a system where members sell part of their production to a few members who then sell the output to wholesalers. There was variation in the way staple crops are sold by

workers, but workers are consistently not paid for their time working on staple crop lands or always centrally paid their output.

The payment system is very different for cash crop production. In particular, workers are paid piece rates for cash crop work. Workers highlighted that piece rate pay is especially true and frequent (daily) for cash crop harvest. Harvest tends to be the largest labor expenditure when producing cash crops according to focus group conversations. For this harvest work, workers collect the cash crops – coffee or sugar cane in cooperatives I visited – and bring it at the end of the day (or twice a day) to a central location on the property to be processed. For example, for coffee, processing involves processing the cherries to remove pulp and then drying the beans. Workers get paid based on how much cash crop they brought in a given day, using the volume of the crops brought for processing to link output to pay. Some workers would then get paid an extra amount for their hours spent processing the cash crop output (all at an equal wage rate).

For non-harvest work for cash crops, such as field preparation and maintenance, cooperative workers discussed a system of general zones (*zonas de trabajo*) that they then mostly tend to maintain. One cooperative leader described the importance of this process: the zones are important because they make workers assume more individual responsibility (and that, without the $zonas$, workers might not feel responsible until harvest time). Thus, informal zoning is done to try to link worker pay and effort throughout the agricultural calendar. When discussing their time allocation between their staple crop land and their cash crop $zones$, cooperative workers stressed that it was important not to ignore your zone in non-harvest times. This was because good work throughout the year means that they would reap the benefits to proper field maintenance and preparation during harvest (through the piece rate payment). For these non-harvest times, there was variation in how often workers get paid for their work. The majority of members mentioned being paid daily based on showing up in the central land and working on their *zonas*. Some cooperative attempted to keep track of hours worked, while others paid solely on being present on the central land (where there are often workers around to verify presence). Thus, payment for non-harvest work requires some level of supervision, but workers said that the amount of supervision is relatively minor and that workers have acquired a strong sense of self-responsibility for their zone work. (Note, in the next point, I discuss how monitoring works in each ownership form.) Workers said that the piece rates are known and are determined at the start of each agricultural season via voting. (I discuss voting in more depth later on.)

Cooperatives use cash crop earnings for profit-sharing. The cooperative workers discussed calculating the cash crop output value to be shared as first deducting processing costs (e.g. electricity, water), commercialization costs (e.g. gasoline, truck rental), and then payments made to workers as their piece rate for cash crop production. (This was the case in all cooperatives I visited except one; this cooperative did not make any net earnings due to drought and would therefore not be able to share earnings. But they said they would resume sharing in the future if things improved.) This net-earnings value was distributed broadly in two ways, according to workers. First, net-earnings could be distributed after harvest as equal payment (sometimes called $dividendos$ by workers) to all members following harvest and commercialization. Second, some larger cooperatives allocate part of the shared earnings in a central cooperative fund that is used to build things like schools or housing, or to improve working conditions (including upgrading processing machinery or buying inputs to distribute to workers). Cooperative members in these larger cooperatives stressed that the use of these funds was always done in a way that is equitable (i.e. benefits all members relatively equally) and sometimes involved voting by members to determine the exact use of these sources. While this is qualitative evidence from focus groups, these payment systems are very similar to accounts on cooperatives from academics in El Salvador (Perez Riva and Chavez Castro, 1986; Marroquín Mena, 1988; McReynolds, 1988; González and Romano Martínez, 2000, e.g. see).

In terms of the timing of these payments, some cooperative workers mentioned that, while

they are in theory paid in work, due to periods of low liquidity in the cooperative, they get paid part of what they are owed shortly after cash crops are sold along with their shared-earnings (often called *dividendos*).

Finally, one critical point to note is that cooperatives consistently mentioned the serious difficulty of including staple crop earnings in the sharing of earnings. When asked why they don't share staple crop earnings, workers discussed that it was not worth the trouble and that is just too difficult.[26] They mentioned many reasons, including: staple crops are not processed, they can be consumed individually, they are easy to side-sell without the help or supervision of the cooperative, and staple crop plots are often not centrally located. (I discuss monitoring more in the next sub-section.) Thus, staple crop earnings were not shared in all of the cooperatives of members I interviewed.

Haciendas: In *haciendas*, workers rent plots of land from the owner for the production of staple crops (and sometimes to reside on the property). This is similar to other *haciendas* in Latin America (De Janvry and Sadoulet, 1988; Sadoulet, 1992). In El Salvador, workers who resided on *haciendas* and had to rent land for staple crops and work on cash crop land were sometimes called *colonos* (Browning, 1971; Montes, 1980). A common thing mentioned by cooperative workers who were alive during the reform was that this *colonato* system was very difficult, as owners often did not give workers a lot of land for their staple crop production so they had to work very hard on cash crop land at times to make sure they could feed their families.

For cash crop lands, workers are paid piece rates for their work. Workers have to collect the cash crops during harvest and carry it to a central location on the *hacienda* to be processed. For most *haciendas*, this processing is done on the property. Workers then paid based on how much cash crop they brought in each drop-off, using the volume of the crops brought for processing to link output to pay. For tasks like field preparation and maintenance, workers who had worked in *haciendas* mentioned either having a manager tell them each day what area to work on, but that the specific area of the plot worked on tended to stay quite consistent. Some workers mentioned that there would be much less work during non-harvest and that this was the best time to work on staple crops (since it was very difficult during harvest). They also mentioned that this payment was sometimes made by the number of hours worked in the central plot, and sometimes by the day depending on the owner. In *haciendas*, workers still reap some benefit to good field maintenance and preparation during harvest if they are assigned the same area of the plot, as some workers said they get informal first-rights to this land during harvest (and then get a piece rate payment). The piece rate paid to workers is determined by the owner prior to planting and prior to harvest. Workers mentioned that the announced rate often would be consistent (and similar to neighboring properties), but that there were occasions when the owner paid slightly less than announced if prices were lower than anticipated. For more information on the *hacienda* system in El Salvador, see Browning (1971); Colindres (1977); Montes (1980); McReynolds (1988); González (1999).

Monitoring:

In this sub-section, I discuss qualitative evidence from focus group conversations on how worker monitoring operates in practice and the difficulties of perfect monitoring in the properties. Agricultural workers described that monitoring cash crop output is relatively simple during harvest. As described above, workers get paid based on the volume of cash crops collected and brought in for processing (using standard measuring units), and this is quite easy to observe. Worker discussed that processing produces a complete picture of cash crop output (because cash crops, like coffee and sugar cane, require processing to be of any real value when selling, and they

[26] This question tended to make cooperative members smile and often led to some funny accounts of efforts to share or contribute staple crop earnings.

also spoil quickly if not processed). However, focus group conversations suggest that intensive monitoring is costly and difficult in non-harvest times (for both ownership structures) due to features of the properties. The properties are very large in terms of hectares per worker, as was clear when visiting. According to the reform records, the average property is over 350 ha – approximately equal to six 18-hole golf courses – and has about 100 members. This means that each worker tends to about 3.5 ha of land – equivalent to one standard par-four golf hole – split into two parts: staple crop land and, elsewhere, a "zone" of the cash crop land. For this reason, members said that worker-monitoring (in cooperatives) or owner monitoring (in *haciendas*) is difficult in practice given the size of the land. As well, former *hacienda* workers mentioned that the owners were often not around (abstentee owners) and would instead spend a lot of time in San Salvador or other cities; they would sometimes hire managers, but these managers were described as disinterested when the owner was gone (and not always willing to travel around the property to check on workers). The focus group conversations provided evidence that monitoring is even more costly for staple crops. Workers said that going around to check individuals' staple crop production is not only costly due the distances across plots and the size of plots but also almost impossible due to the ability to side-sell or consume output when not being monitoring (and then claiming a mistake in the monitoring records or bad luck in production). Along these lines, cooperative workers mentioned that crop production is inherently volatile and noisy; this makes the signal inferred from monitoring plots (rather than output) quite noisy and unreliable. This reduces the benefits of paying the monitoring costs (and disagreement costs between workers and owners).

Eligibility, Joining & Exiting:

Cooperatives are bound to a number of rules for members joining and exiting cooperatives, and whether the use of non-member labor is allowed. These are determined by each cooperative unless otherwise noted below. In particular, the cooperative members I met with had the following general rules:

- **Member Eligibility:** Cooperatives determine their own eligibility criteria (as formally specified in the cooperative legal framework in El Salvador, (see Perez Riva and Chavez Castro, 1994)). In the focus groups I conducted, the cooperative workers interviewed said they limited applicants to be above 17 years of age but did not place other strict eligibility rules/ This is because the cooperative members conduct a long screening process with prospective members.

- **Member Joining:** Joining a cooperative in all cases required a super-majority of members' approval (67% of members) and that voting to allow a new member in follows a long screening period (similar to the setting described in Abramitzky, 2018). These screening and joining rules are sometimes informal, but they sometimes are codified in their formal constitutions. The cooperatives mentioned that these joining guidelines are adopted following the *cooperative constitution* rules in El Salvador ((see Perez Riva and Chavez Castro, 1994)) and suggestions from CONFRAS *Princípios y Valores*).

- **Member Exit:** Workers mentioned that, in all cases, exiting a cooperative means losing all value of membership (specifically land and public goods). Workers who decide to exit can only transfer their membership to one person within their family. In this case, a minority of cooperatives also require a vote for allowing the family member to join. In all cooperatives I interviewed, if a worker passes away, their closest member of kin inherits the membership. No cooperative I met with discussed requiring a vote for this family-joining following a member death.

- **Member Land Restrictions:** In all cooperatives, individuals are not allowed to sell or rent their land individually to non-members (and most of the cooperatives interviewed bar rentals across members as well on equity grounds). The sale of individual land is prohibited legally by rule regulating cooperatives since 1994 (see Perez Riva and Chavez Castro, 1994). Cooperatives are able to sell land collectively. The sale of land occurs through a public auction process requiring approved by two-thirds of the cooperative members and oversight by government ministries (to ensure the land doesn't go back to former owners). I discuss this more in Appendix D, where I provide more information on the legal rules governing cooperatives in El Salvador, including the regulations governing the selling of cooperative land, and the main cooperative-specific laws passed by the government since the 1980 land reform.

- **Member Credit:** Cooperatives are legally allowed to post their collective land as collateral for loans, but individuals may not use their parcels as collateral for land as members said banks would not accept this as collateral. Members mentioned that many cooperatives have informal within-cooperative credit programs (where members help each other out with access to credit).

- **Temporary Worker Rules:** Cooperatives are sometimes able to hire temporary laborers for work or services (such as tractor drivers, for example) depending on the internal cooperative rules. This is generally is done collectively (e.g. workers get hired by the cooperative). Workers said that it is possible that members may informally hire workers individually, to help them with either cash crop land or staple crop land; however, cooperative members mentioned this is frowned upon: that if you need help, you need to ask other cooperative members for help instead. In addition, cooperative members are allowed to have their family members work their land and help with their cash crop land.

Voting & Decision-Making:

I elaborate on how voting occurs in cooperatives, how often, and on what topics. Cooperatives in El Salvador have to agree to a *cooperative constitution*, which specifies that decision-making must be democratic, on a one-member, one-vote basis (see Perez Riva and Chavez Castro, 1994). This constitution requires a super-majority to be ratified. This constitution formalizes many of the rules discussed above, and, in general, there is a lot of discretion on what gets codified and what does not. Unless formally specified, decision-making requires a simple majority.

Members are often called to vote at the start and end of the agricultural season. At the start of the season, cooperative workers mentioned voting on land allocation (though it was rare that this gets changed unless there is a drastic change, as reorganizing land each season can be costly), crops to be farmed, how workers will get paid for cash crops (and how much), and, if applicable, on member joining, exit, and eligibility. At the end of the season, cooperatives often discuss the earnings that will be shared, and whether to distribute earnings as dividends or to use them for public goods (and, if so, which public good).

Interestingly, there is a lot of variation across cooperatives in how formal and frequent these voting sessions occur. Some cooperatives conduct votes constantly throughout the calendar on minor details, and members are expected to show up to every vote. In other cooperatives, members-only show up for major votes (e.g. dividend discussions) or voting is not done at a consistent frequency (i.e. unless enough members organize, decisions from the previous season carry forward to the next). As well, the voting process varies a lot. The cooperative laws in El Salvador do not mandate that voting needs to be private (see Perez Riva and Chavez Castro, 1994). However, most of the cooperatives I met discussed using paper ballots to respect privacy.

Two cooperatives mentioned using vocal roll calls for voting as their default, but that if a majority preferred a secret ballot, they would vote using informal paper ballots.

One point worth mentioning is that the large cooperatives I met with do not hold votes for every topic and, instead, have members vote on the election of a board of directors comprised of cooperative members (also discussed in motivating the model of Kremer, 1997). In these cooperatives, members who get elected sometimes get 1-2 year terms (one cooperative discussed having five-year terms), but members of the board of directors can be removed if a majority of the cooperative organizes to call another vote if they are unsatisfied with a director. These directors then serve as representatives for their workers and make the major decisions for cooperatives regarding land allocation, payment schemes (e.g. how much to pay workers and how much to use for the cooperative), and member screening.

Cultural Norms:

I now briefly discuss the changes in cultural norms associated with cooperative ownership that I gathered in focus groups. I mention this because it was evident that cooperative members had adopted very specific and interesting cultural norms on the importance of equity, member values, and responsibilities. Focus group conversations with cooperative workers make it clear that the land reform did have a large impact on their views.

In particular, the cooperative workers have strong norms of solidarity, equity, and mutual aid across workers.[27] In fact, some of these values are also often codified in their formal constitutions; the Federation of Reform Cooperatives (CONFRAS) cites these norms as part of their main principles and values (see CONFRAS *Princípios y Valores*). These cultural norms in cooperatives (that emphasize solidarity and cooperation) have also been noted in other settings, most notably by Abramitzky (2018).

For cooperatives in El Salvador, members mentioned that there is a lot of trust across workers (e.g. that there is not a need to monitor everything for cash crops, and that if a worker needs help, other workers will step up without questioning the reasons). Workers though are expected to share in the good times, and are expected to invest in education and in their family.[28] This includes passing on these values to their children and younger cooperative members.[29]

Cooperative workers also have very strong views on the success of the land reform. A ubiquitous refrain I heard from three separate cooperative workers is that "on March 5th, 1980, we went to bed poor; on March 6th, 1980, we woke up rich, as landholders". They express a lot of gratitude for the reform and cooperative model because they say it has allowed them to be less dependent on the elites in El Salvador. They say there are now more responsible and free for their success and failure.

Additional Organizational Details:

Appendix D elaborates on the legal governance of cooperatives and *haciendas* in El Salvador, including the regulations governing the selling of cooperative land, and the main laws passed by the government since the 1980 land reform.

[27] This is consistent with work on motivated reasoning, see Benabou and Tirole (2016).

[28] Section 7 also discusses this regarding changes in culture for educational investment.

[29] Some cooperative members discussed that recent changes in El Salvador, namely gang violence and new technologies, have made it harder to keep younger members interested in these values and in the agricultural way of life.

Appendix D. Institutional Details of Cooperatives and *Haciendas* in El Salvador

In this section, I summarize the main institutional details of cooperatives in El Salvador. In particular, I explain the regulations governing the selling of cooperative land, and the main laws passed by the government since the 1980 land reform that may have affected the governance of cooperatives.

Land Transactions in Cooperatives: Initially, the land reform cooperatives were not allowed to sell or rent their land. However, these restrictions were eased in the mid-1990s through the changes to the regulation of cooperatives as part of the *Programa Promoción de la Reactivación Económica y Social* (see Perez Riva and Chavez Castro, 1994). The selling of cooperative land (to non-members) became possible but only through a non-judicial public auction process requiring approval by two-thirds of the cooperative members. The auctions require the participation of representatives of the Attorney General and the Ministry of Agriculture, and the sale price cannot be lower than a reference price as evaluated by a local expert. Finally, the auction has to be open to the public at large through specific notice requirements. The notice of the auction needs to be approved by ISTA, the Ministry of Agriculture, the Attorney General, and unanimously by the cooperative's board. The notice can then be published in two of the main newspapers at least seven days before the auction (World Bank, 2012).

Given these regulations and this process, the sale of land non-members is relatively rare. World Bank (2012) reports that there have 78 public auctions between 1997 and 2006 (and two between 2006 and 2012, when the World Bank report was published). The average size of plots successfully auctioned was 68 hectares, and the average sale price per hectare was US$8,459 (in 2005 dollars). The majority of the auctions only had one bidder, and the sale price in the auction was often much lower than the average sale price for equivalent properties in the municipality (World Bank, 2012).

Other Government Regulations Applying to Cooperatives: In the mid-1990s, the government passed a series of laws aimed at improving the governance of cooperatives through the *Programa Promoci'on de la Reactivación Econ'omica y Social*. In particular, the government felt that the cooperatives struggled with organizational matters (World Bank, 2012). The government provided some assistance to the cooperatives after the reform in the 1980s in the form of technical assistance. However, after the end of the civil war and the change in government, technical assistance to the cooperatives stopped in the early 1990s. Due to the struggles of some cooperatives, in 1996, the government passed some reforms aimed at reducing cooperative debt and eliminating some of the restrictions on land sales (as detailed above). First, the government passed Decree 747, where members of cooperatives could decide if they wanted to retain the cooperative model or to parcel out lots to its members for housing and production (full parcelization as modeled in Section 5). The law also allowed members to sell land through the auction process detailed above (though at first this option was limited in that cooperative land could only be sold, or rented only to landless individuals for a total land area of up to 7 hectares per individual). Second, in 1998, the government condoned 85% of the debt accrued by land reform beneficiaries (World Bank, 2012).

Land Transaction Regulations for *Haciendas* Prior to the Reform: There was one important statue that affected *haciendas* prior to the reform. In particular, there was a freeze on all land transaction in El Salvador from October 1979 (prior to the 1980 land reform) to 1982:

The military junta period in El Salvador was comprised of three different sets of juntas. The first junta period started in October 1979. These military rulers – known as the *Primera Junta Revolucionaria de Gobierno* – instituted a freeze on all land transactions in El Salvador on October

15th, 1979 (Decree 43, Jurado Castillo et al., 1993, pg. 32). This freeze applied to all land over 100 ha (Velis Polío, 2012, pg. 99).

These first junta leaders preceded and differed the reform implementers – the second junta leaders, who were known as the *Segunda Junta Revolucionaria de Gobierno*. The first junta government passed this land freeze to determine the best course of action for future land reform plans (Velis Polío, 2012). However, the second junta took over on January 9th, 1980, and they implemented the land reform I study in the paper by passing decree 153. Due to this historical detail, formal land transactions were frozen before the land reform (and the Phase I threshold) was announced and were not allowed until 1982 (see next point).[30]

Land Transaction Regulations for *Haciendas* Following the Reform: Phase II of the reform was officially called off in March 1982 following a reorganization of the government leadership (Figueroa Aquino and Marroquín Mena, 1991). This announcement was then followed by other important land regulations in the following year.

The second military junta government was replaced by the third junta military government in December 1980, after the ouster of pro-land reform leaders. In particular, Colonel Majano – the colonel who pushed for land reform after joining the second junta government on March 3rd, 1980 – was removed from the government. After taking power, the third junta called for elections. Following elections in 1982, the junta military leadership was replaced by a civilian government in 1982 led by a former banker (Álvaro Magaña). This civilian government was anti-land reform and called off Phase II (Velis Polío, 2012).[31]

The civilian government ratified a new constitution in 1983. This constitution included, in Article 105, new legal rules for land transactions. This article: (1) recognizes private property rights for land transactions – thereby unfreezing land transaction – for land below a maximum of 245 ha in size, and (2) allowed properties that were above the 245 ha land ceiling *but* were created prior to 1983 to remain above the ceiling (Polanco Mazariego, 1994, chapters II & III).[32]

This 1983 constitution is still the current constitution of El Salvador. This means that land transactions are still regulated by Article 105. Thus, if any large *hacienda* (over 245 ha) attempted to get larger or slightly smaller (but remain above 245 ha), then legally this would not be allowed and would be blocked (Polanco Mazariego, 1994, chapter IV).[33] This means that most *haciendas* over the 245 ha have tended to persist to avoid the legal complications of this land ceiling (Polanco Mazariego, 1994).

Tax Differences Between *Haciendas* and *Cooperatives*: Following the end of the civil war, the right-wing government that took over tended to neglect the cooperatives (World Bank, 2012). For this reason, leading up the 2007 census, cooperatives historically tended to faced similar tax burdens in El Salvador compared to *haciendas* (Cooperativas de las Américas, 2019). One important difference, however, is that the 1994 law regulating cooperatives in El Salvador allows cooperatives to apply for a tax exception for a five-year period from municipal and property taxes (Perez Riva and Chavez Castro, 1994). This exception has to be approved by the treasury

[30] In terms of the empirical strategy, this land freeze means that land owners would not have been able to formally transfer or sell land (and have it recorded in the national registry) in the lead up to the reform even if they had connections to leaders of the second junta government.

[31] For the empirical strategy, this detail implies that expectations for the control group only changed for a period of 2 years.

[32] The inclusion of this article made any future land reforms very difficult to pass since this ownership limit for land acquisition was in the constitution (Figueroa Aquino and Marroquín Mena, 1991).

[33] For the empirics, most of the optimal bandwidths for the regression discontinuity sample tend to exclude the single-owner properties below the 245 ha ceiling and could, therefore, expand slightly.

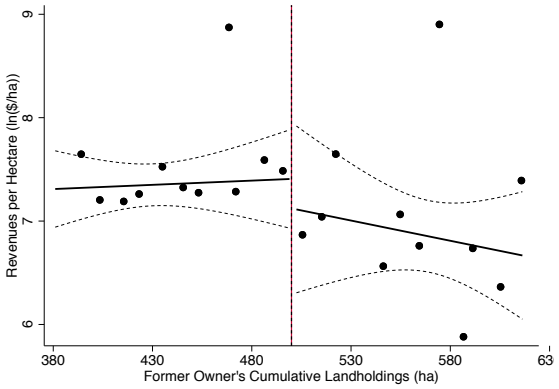
ministry. Importantly, this is a temporary tax *benefit* for cooperatives.[34]

Appendix E. Additional Tables and Figures

E.1. RD Plots

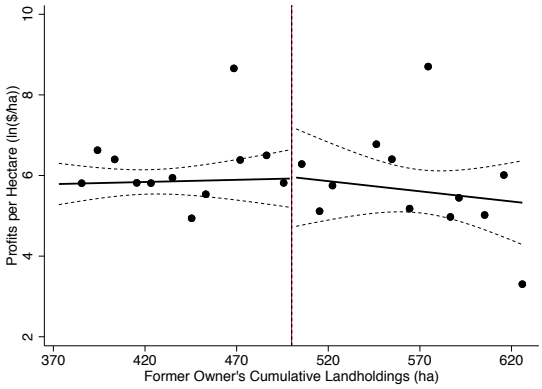
[34]For the empirics, this means that the government's taxation does not weigh more severely on cooperatives. Therefore, this tax difference is unlikely to unlikely to explain the main results of the paper.

Figure A6: RD Plots - Agricultural Productivity



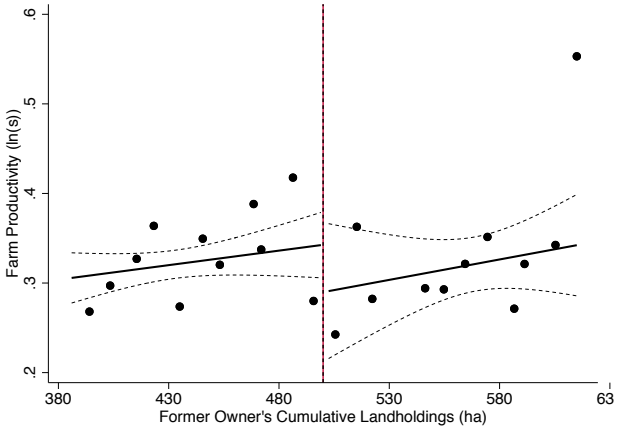
(a) Revenues per Hectare - ln($/ha)

Notes: The figure presents the estimated regression discontinuity plot on aggregate revenues per hectare using the 2007 agricultural census of El Salvador.



(b) Profits per Hectare - ln($/ha)

Notes: The figure presents the estimated regression discontinuity plots on profits per hectare using the 2007 agricultural census of El Salvador.

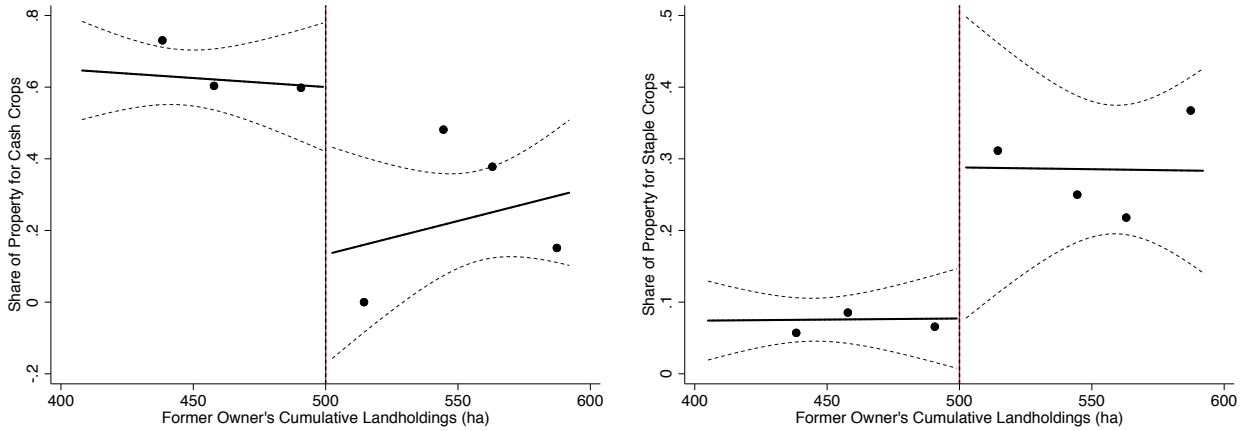


(c) Farm Productivity - ln($/ha)

Notes: The figure presents the estimated regression discontinuity plot on aggregate farm productivity using the 2007 agricultural census of El Salvador.

Notes: The figures present the estimated regression discontinuity plots for various outcomes. The points represents the average value of the outcome variable in bins of width of 10 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Figure A7: RD Plots - Crop Choices



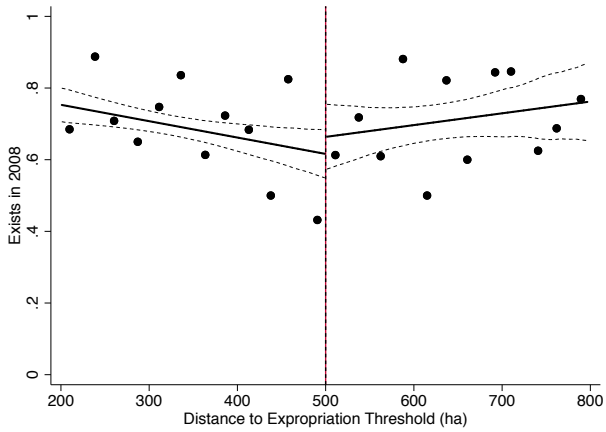
(a) Share of Property Devoted to Cash Crops

Notes: The figure presents the estimated regression discontinuity plot on the share of land in a property devoted to cash crop production (coffee or sugar cane) using the 2007 agricultural census of El Salvador. The points represents the average value of the outcome variable in bins of width of 25 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

(b) Share of Property Devoted to Staple Crops

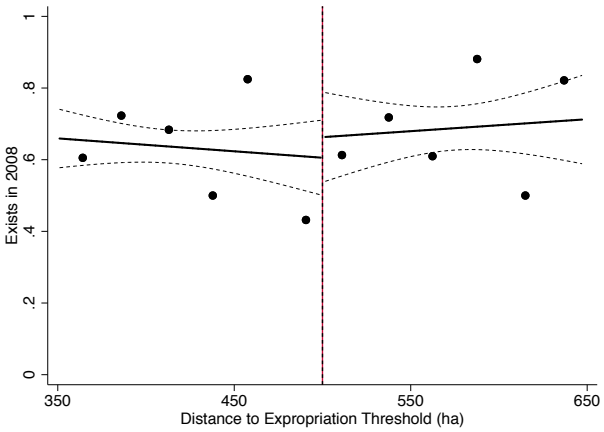
Notes: The figure presents the estimated regression discontinuity plots on the share of land in a property devoted to staple crop production (maize and/or beans) using the 2007 agricultural census of El Salvador. The points represents the average value of the outcome variable in bins of width of 25 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Figure A8: RD Plots - Existence in 2007



(a) Exists in 2007 Census

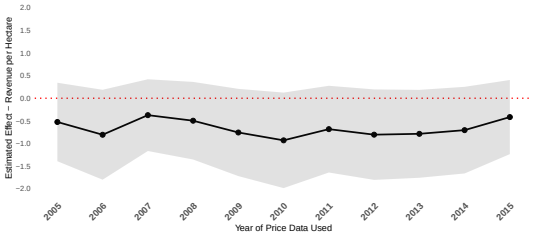
Notes: The figure presents the estimated regression discontinuity plot on an indicator variable equal to 1 if the 1980 property exists in the 2007 census of agriculture of El Salvador. The points represents the average value of the outcome variable in bins of width of 25 ha. The regressions are estimated using local linear 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 an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.



(b) Exists in 2007 Census

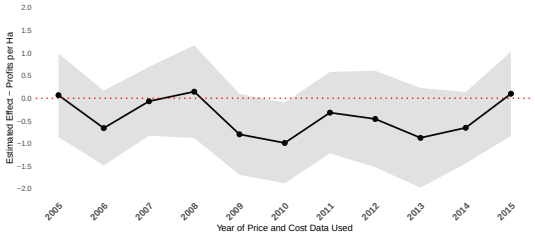
Notes: The figure presents the estimated regression discontinuity plot on an indicator variable equal to 1 if the 1980 property exists in the 2007 census of agriculture of El Salvador. The points represents the average value of the outcome variable in bins of width of 25 ha. The regressions are estimated using local linear 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 150 ha and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Figure A9: Temporal External Validity Exercise - Agricultural Productivity



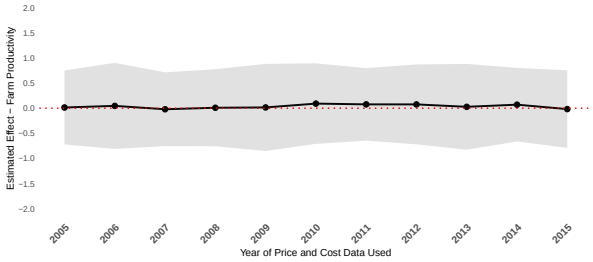
(a) Revenue per Hectare

Notes: The figure presents the estimated regression discontinuity coefficients on revenue per hectare using crop prices from 2005 to 2015 provided by the MAG while holding the crop mix and quantities produced constant at their 2007 level. Gray areas represent the 95% confidence intervals



(b) Profits per Ha

Notes: The figure presents the estimated regression discontinuity coefficients on profits per ha using crop prices and production costs from 2005 to 2015 provided by the MAG while holding the crop mix, labor, and quantities produced constant at their 2007 level. Gray areas represent the 95% confidence intervals.



(c) Farm Productivity

Notes: The figure presents the estimated regression discontinuity coefficients on farm productivity using crop prices and production costs from 2005 to 2015 provided by the MAG while holding the crop mix, labor, and quantities produced constant at their 2007 level. Gray areas represent the 95% confidence intervals.

E.3. Additional Figures and Tables

Table A3: Summary Statistics - Property Sizes in 1980 and Ownership Amounts

	mean	sd	p50	p25	p75
	Panel A: All Properties				
Property Size (ha)	537.83	818.23	371.00	275.00	537.00
Owner: Cumulative Holdings (ha)	565.40	818.89	386.00	282.00	586.40
Owner Owned Multiple Properties	0.58	0.49	1.00	0.00	1.00
Number of Properties Owned by Owner	3.91	4.24	2.00	1.00	4.00
Observations	1482				
	Panel B: Owner had <500 ha				
Property Size (ha)	321.31	85.31	310.00	248.50	386.00
Owner: Cumulative Holdings (ha)	322.02	85.42	311.50	248.50	387.00
Owner Owned Multiple Properties	0.57	0.50	1.00	0.00	1.00
Number of Properties Owned by Owner	4.26	4.52	2.00	1.00	5.00
Observations	1052				
	Panel C: Owner had >500 ha				
Property Size (ha)	524.13	572.16	389.05	151.60	688.85
Owner: Cumulative Holdings (ha)	1086.22	1391.48	699.40	583.70	875.10
Owner Owned Multiple Properties	0.60	0.49	1.00	0.00	1.00
Number of Properties Owned by Owner	3.05	3.31	2.00	1.00	3.00
Observations	430				

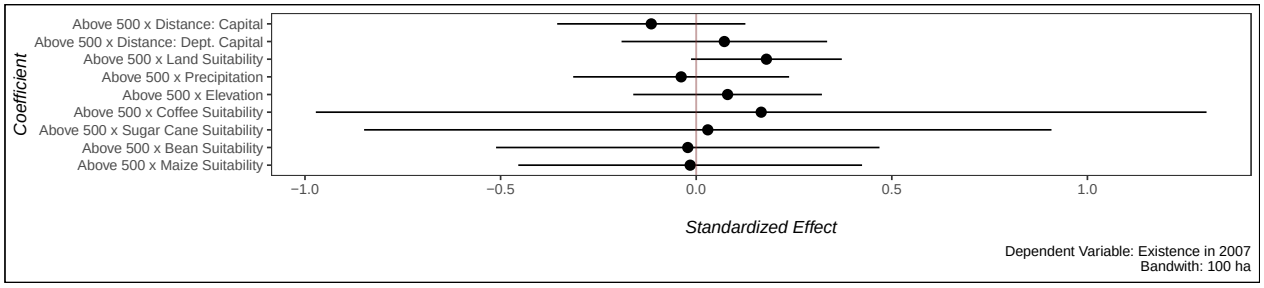
Notes: *Owner Owned Multiple Properties* is an indicator variable equal to 1 if the owner in 1980 owned more than 1 property.

Table A4: Summary Statistics - Property Sizes in 2007 and Ownership Amounts

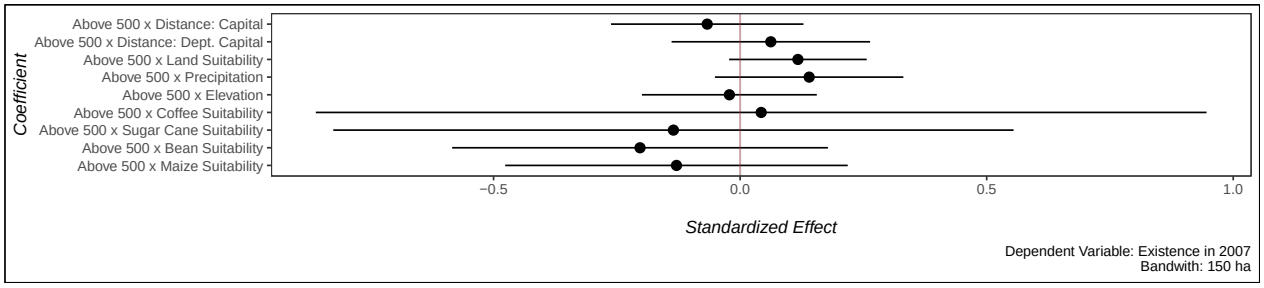
	mean	sd	p50	p25	p75
	Panel A: All Properties				
Property Size (ha)	363.76	254.91	314.00	246.00	401.00
Owner: Cumulative Holdings (ha)	425.68	574.17	334.00	254.00	424.00
Owner Owned Multiple Properties	0.39	0.49	0.00	0.00	1.00
Number of Properties Owned by Owner	2.09	2.10	1.00	1.00	2.00
Observations	901				
	Panel B: Owner had <500 ha				
Property Size (ha)	316.79	83.34	307.00	245.00	379.00
Owner: Cumulative Holdings (ha)	317.47	82.97	307.00	246.00	379.00
Owner Owned Multiple Properties	0.48	0.50	0.00	0.00	1.00
Number of Properties Owned by Owner	2.42	2.35	1.00	1.00	3.00
Observations	662				
	Panel C: Owner had >500 ha				
Property Size (ha)	654.30	573.13	563.00	262.10	825.00
Owner: Cumulative Holdings (ha)	1082.83	1341.90	659.70	588.10	1021.80
Owner Owned Multiple Properties	0.32	0.47	0.00	0.00	1.00
Number of Properties Owned by Owner	1.39	0.64	1.00	1.00	2.00
Observations	239				

Notes: *Owner Owned Multiple Properties* is an indicator variable equal to 1 if the owner in 1980 owned more than 1 property.

Figure A10: Coefficient Estimates For Existence in 2007 - Heterogeneity by Geographic Characteristics



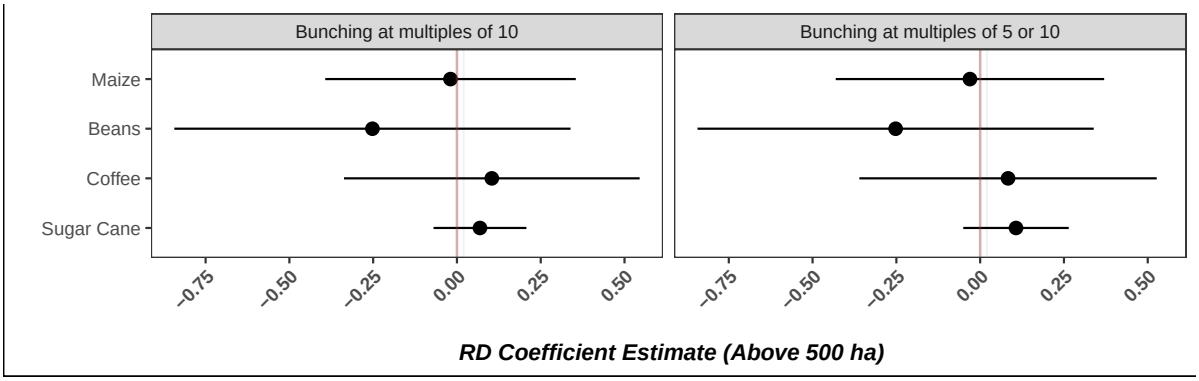
(a) Bandwidth: 100 ha from the reform threshold



(b) Bandwidth: 150 ha from the reform threshold

Notes: The figure presents the estimated coefficients for *Exists in 2007*, an indicator variable equal to 1 if the 1980 property exists in the 2007 census of agriculture of El Salvador. The coefficients are for the interaction term between a given geographic characteristic times *Above500*, where *Above500* is an indicator variable equal to one if the property was owned by a landholder with over 500 ha in cumulative landholdings in 1980. Black lines represent the 95% confidence intervals. The regressions include linear polynomials for the cumulative landholding amount of a properties owner in 1980 estimated separately on each side of the 500 ha threshold within a bandwidth. Standard errors are clustered at the former owner level.

Figure A11: Testing for Differences in Bunching in Crop Output Across Ownership Types



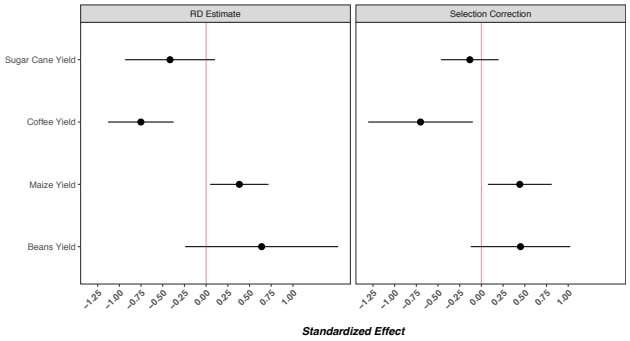
Notes: The figure plots the regression discontinuity coefficients for *Above500*. The dependent variables are indicators equal to 1 if the crop output reported (for the crop listed on the y-axis) for a property is a multiple of 10 in the left-hand side panel or a multiple of 5 in the right-hand panel. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017).

Table A5: Testing for Differences in the Distribution of Digits for Reported Crop Outputs

	Output:							
	Maize		*Beans*		*Coffee*		*Sugar Cane*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
KS Test Statistic	0.0956	0.0966	0.168	0.234	0.0648	0.112	0.107	0.229
p-value:	(0.854)	(0.853)	(0.686)	(0.274)	(1)	(0.988)	(0.999)	(0.648)
Digits Distribution:	First-Order	Second-Order	First-Order	Second-Order	First-Order	Second-Order	First-Order	Second-Order

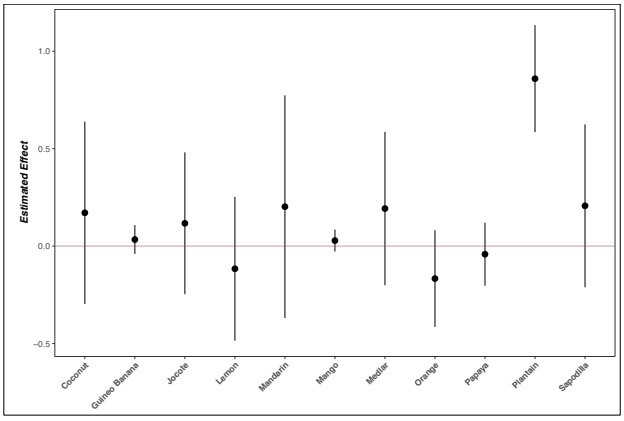
Notes: p-values in parenthesis. *KS Test Statistic* is the Kolmogorov-Smirnov Test Statistic to test the null hypothesis of no differences in distributions. The test compares the digit distribution of reported crop output between properties where the former owner of the property had over 500 ha. in cumulative landholdings in 1980 compared to properties where the former owner of the property did not have over 500 ha. in cumulative landholdings in 1980. *First-Order* digit distribution is the distribution of the left-most digit of the reported output. *Second-Order* digit distribution is the distribution of the two left-most digits of the reported output. Data is from the 2007 census of agriculture for El Salvador. $^{*}\ p < 0.1; ^{**}\ p < 0.05; ^{***}\ p < 0.01$

Figure A12: Yield Results: Correcting for Possible Selection Bias



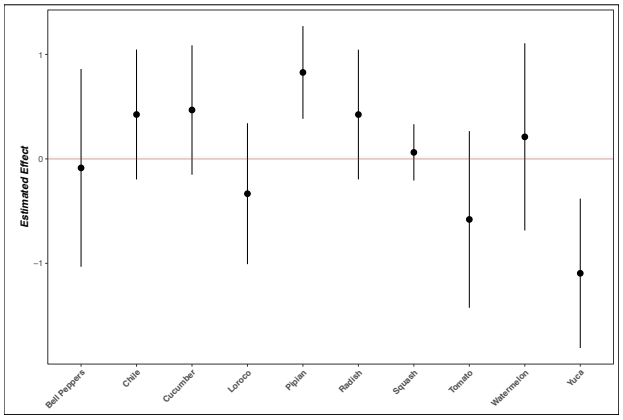
Notes: The figure plots the estimated RD coefficient for a property being owned in 1980 by an owner above the ownership threshold on the yield of each crop using the the 2007 Census of Agriculture of El Salvador correcting for selection into the production of the crop using the suitability of the crop from the FAO as the first-stage predictor in Heckman Selection Correction methods (Heckman, 1976).

Figure A13: Production of Minor Crops - Fruits



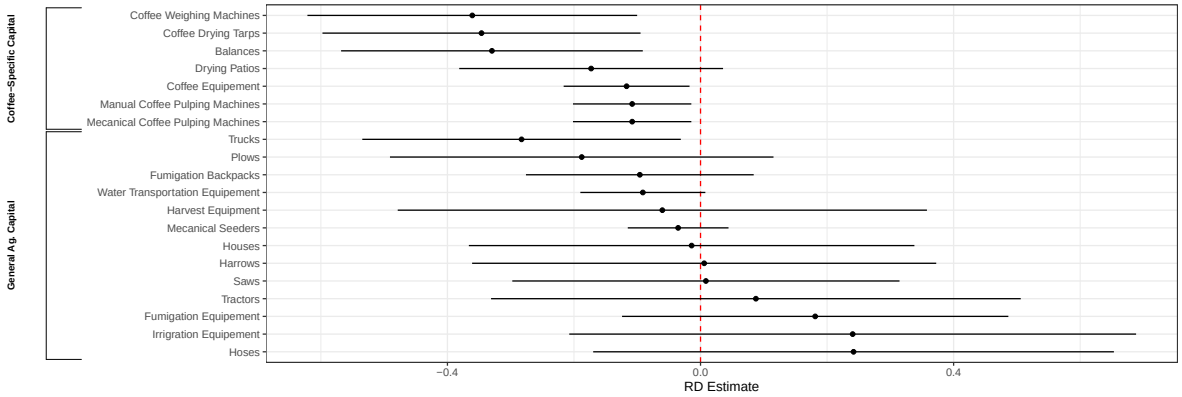
Notes: The figure plots the estimated RD coefficient for a property being owned in 1980 by an owner above the ownership threshold on the probability of using each minor fruit reported in the 2007 Census of Agriculture of El Salvador. The dependent variables are indicator variables equal to 1 if the property produced a positive amount of a given minor fruit.

Figure A14: Production of Minor Crops - Vegetables



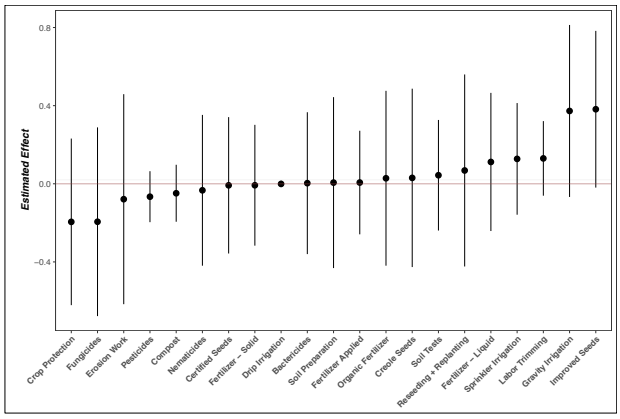
Notes: The figure plots the estimated RD coefficient for a property being owned in 1980 by an owner above the ownership threshold on the probability of using each minor vegetable reported in the 2007 Census of Agriculture of El Salvador. The dependent variables are indicator variables equal to 1 if the property produced a positive amount of a given minor vegetable.

Figure A15: Capital Ownership



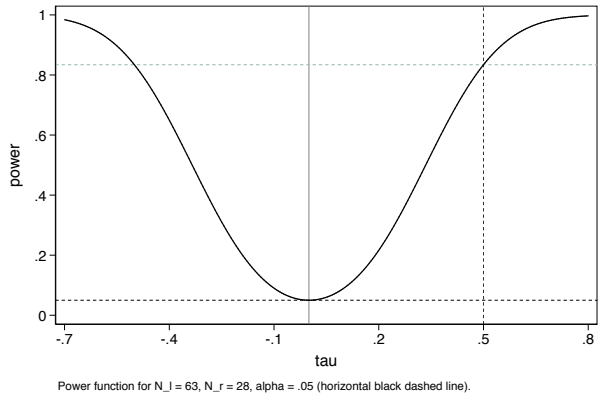
Notes: The figure plots the estimated RD coefficient for a property being owned in 1980 by an owner above the ownership threshold on the probability of owning each type of capital owned included in the 2007 Census of Agriculture of El Salvador. The dependent variables are indicator variables equal to 1 if the property owns a positive amount of each capital type. The census only reports indicators for ownerships but not the quantity owned of each capital type. The top bracket denotes estimates for *Coffee-Specific Capital*, capital stocks mostly used for the production and processing of coffee; the lower bracket denotes estimates for *General Agricultural Capital*, capital that can be useds for any type of agricultural production.

Figure A16: Input Use



Notes: The figure plots the estimated RD coefficient for a property being owned in 1980 by an owner above the ownership threshold on the probability of using each type of agricultural input included in the 2007 Census of Agriculture of El Salvador. The dependent variables are indicator variables equal to 1 if the property used a given input type. The census only reports indicators for input use but not the quantity used of each input type.

Figure A17: RD Power Calculations - Revenues per Hectare



Notes: The figure plots the power function for the RD using standardized values of revenues per hectare in the 2007 Census of Agriculture of El Salvador on a property being owned in 1980 by an owner above the ownership threshold. *tau* represents the standardized treatment effect. See Cattaneo et al. (2017) for more details.

Table A6: Impact of Ownership Structure on Earnings Differences - Sensitivity to Land Value Return

	HH Earnings per capita (previous month)					
	(1)	(2)	(3)	(4)	(5)	(6)
Above500	30.32	4.655	1.659	-42.94	-42.10	-115.6
	(42.58)	(56.73)	(60.08)	(72.37)	(90.68)	(99.52)
Land Value ($ per ha)	57.17	57.17	114.2	114.2	201.1	201.1
Bandwidth	300	150	300	150	300	150
Observations	6280	2262	6280	2262	6280	2262
Clusters	99	37	99	37	99	37
Mean Dep. Var.	72.03	75.61	70.45	73.70	68.05	70.78

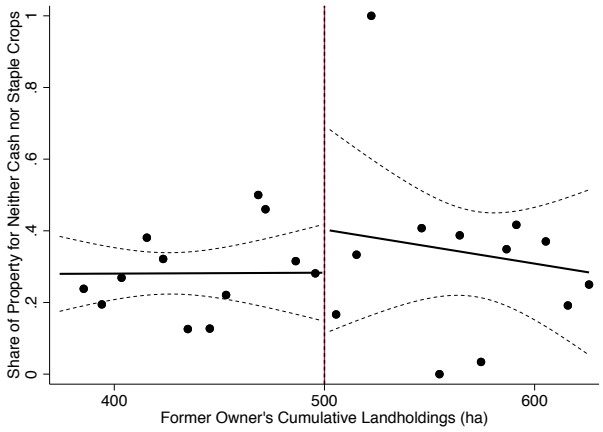
Notes: Standard errors clustered at the former owner level reported in parenthesis. *HH Earnings per capita* measures a household's monthly earnings per capita in dollars for agricultural workers in the El Salvador Household Surveys (EHPM). *Land Value* measures the assumed value per ha reported by the Ministry of Agriculture for 2007 for different levels of land quality. *Above 500* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A7: Consumption and Consumption Distributions

	HH Consumption per capita (previous month)			
	Levels		*Inter-Quartile Range*	
	(1)	(2)	(3)	(4)
Above 500	21.92**	8.648	-12.20***	-5.103
	(9.492)	(11.60)	(4.621)	(7.000)
Observations	8861	4412	421	134
Properties	421	134	421	134
Clusters	108	35	108	35
Mean Dep. Var.	47.15	47.41	15.97	15.55
Bandwidth	300	150	300	150

Notes: Standard errors clustered at the former owner level reported in parenthesis. *HH Consumption per capita* measures a household's monthly consumption per capita in real 2007 dollars for agricultural workers in the El Salvador Household Surveys (EHPM). *Inter-Quartile Range* measures the difference between the 75th and 25th percentile in reported household consumption per capita. *Above 500* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure A18: RD Plot - Share of Land Not Devoted to Staple or Cash Crops in 2007



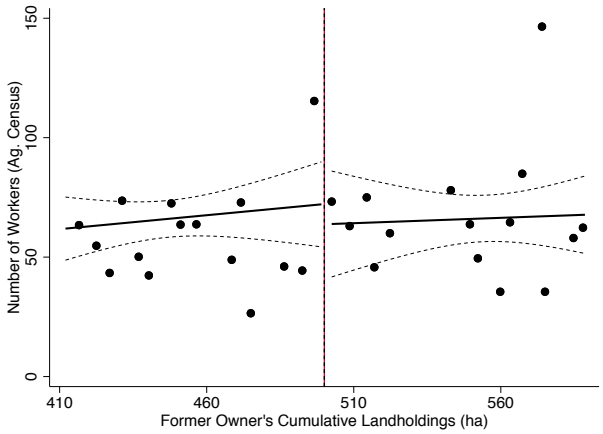
Notes: The figure presents the estimated regression discontinuity plot on the share of the property that does not farm either cash or staple crops for each property in the 2007 agricultural census of El Salvador. The points represents the average value of the outcome variable in bins of width of 10 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Table A8: Heterogeneity in a Cooperatives' Census Neighborhoods

	Revenue per Hectare		**Profit per Hectare**	
Cooperatives with IQR Ages:	$>$ Median (1)	$<$ Median (2)	$>$ Median (3)	$<$ Median (4)
Above 500	-0.430	-0.192	-0.696*	-0.255
	(0.326)	(0.376)	(0.411)	(0.504)
Observations	231	232	223	225
Clusters	161	161	156	156
Mean Dep. Var.	7.282	7.282	6.965	6.965
Bandwidth	150	150	150	150

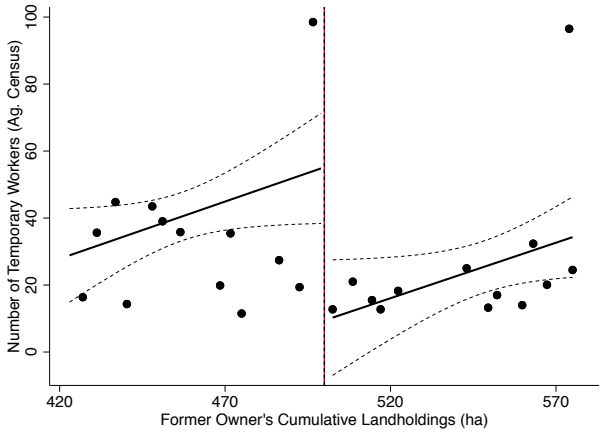
Notes: Standard errors clustered at the former owner level reported in parenthesis. *Median* $(IQRage)$ is calculated as the median of the IQR for the ages for agricultural workers residing in census neighborhoods in the 2007 El Salvador Census of Population within a 100 ha buffer of the cooperative centroid. *Revenues per Hectare* and *Profits per Hectare* are presented as the log of dollars per hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha. in cumulative landholdings in 1980. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure A19: RD Plots - Full-Time Workers in 2007



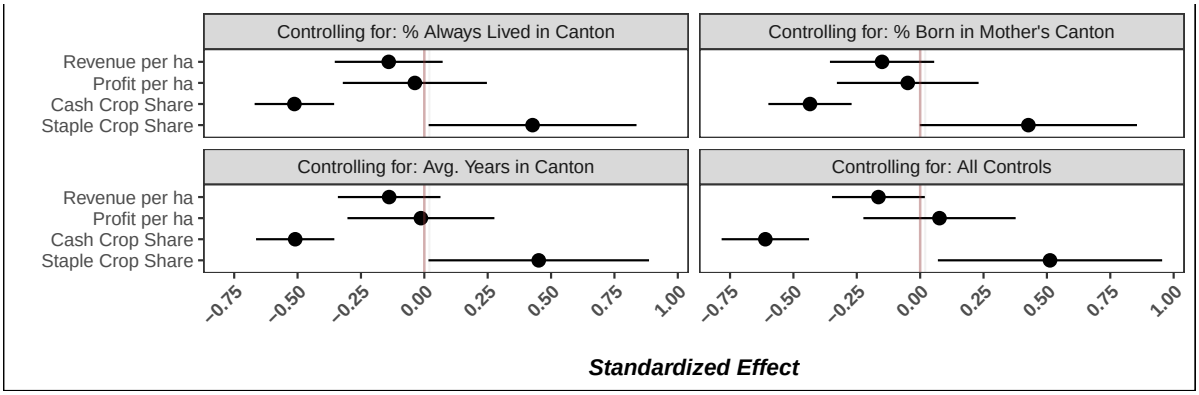
Notes: The figure presents the estimated regression discontinuity plot on total number of full-time workers reported for each property in the 2007 agricultural census of El Salvador. The points represents the average value of the outcome variable in bins of width of 5 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Figure A20: RD Plots - Temporary Workers in 2007



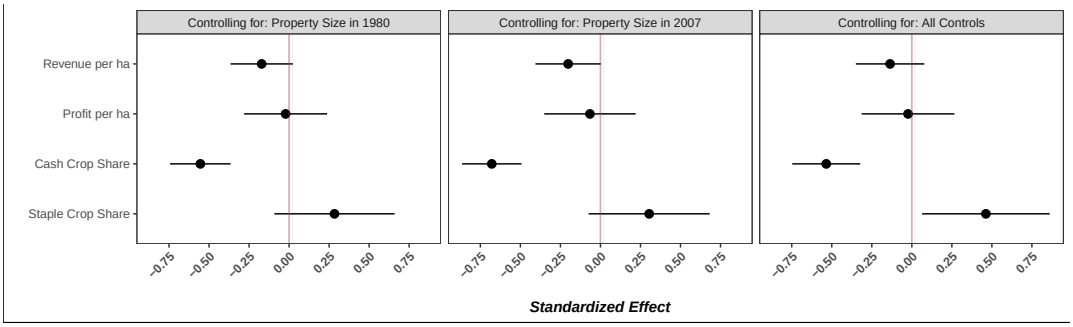
Notes: The figure presents the estimated regression discontinuity plot on total number of temporary workers reported for each property in the 2007 agricultural census of El Salvador. The points represents the average value of the outcome variable in bins of width of 5 ha. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated plot in dashed lines.

Figure A21: Controlling for Migration Rates – Main Outcomes



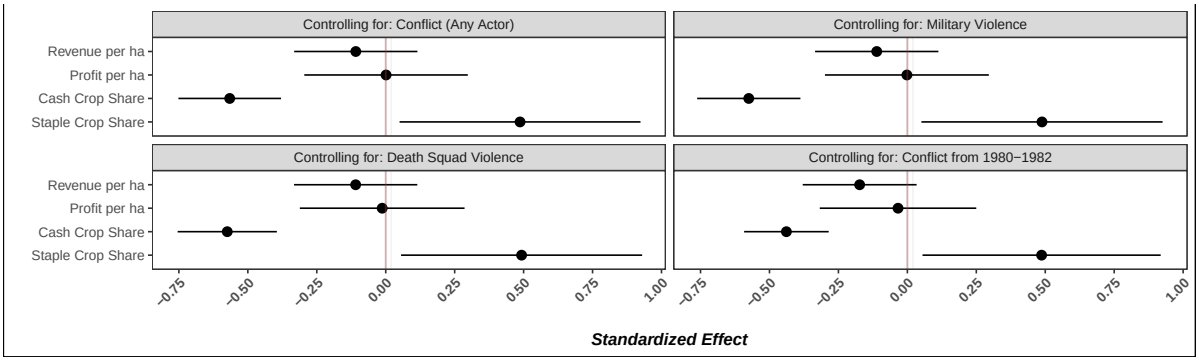
Notes: Figure plots standardized (beta) regression discontinuity coefficients while including the set of controls listed above each plot in the gray boxes. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017).

Figure A22: Main Results - Controlling for Property Size



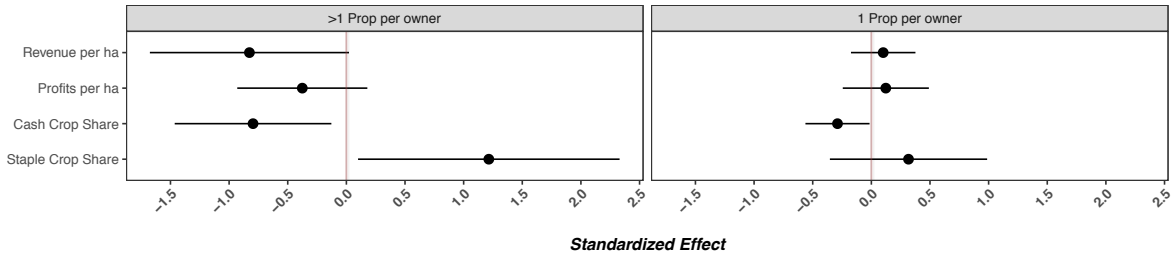
Notes: The figure presents the estimated standardized (beta) regression discontinuity coefficients for the main outcomes for different sets of controls. *All Controls* controls for the property size in 1980 and the property size in 2007. The regressions are estimated using local linear polynomials in the total landholdings of the former owner estimated separately on each side of the reform threshold on the sample within the optimal single-sided MSE bandwidth from Calonico et al. (2017) and use an uniform kernel. Standard errors are clustered at the former owner level. The figure presents the 95% confidence intervals around the estimated coefficient.

Figure A23: Controlling for Conflict During the Civil War – Main Outcomes



Notes: Figure plots standardized (beta) regression discontinuity coefficients while including the set of controls listed above each plot in the gray boxes. Data on conflict is from Commission on the Truth (1993). Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017).

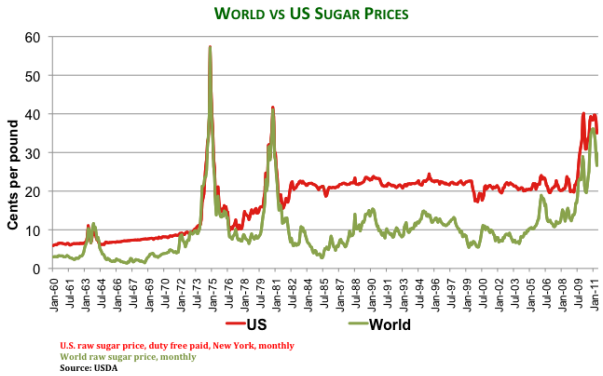
Figure A24: Heterogeneity by Number of Plots Owned By Previous Owner – Main Outcomes



Notes: Figure plots standardized (beta) regression discontinuity coefficients for the sub-sample listed above each plot in the gray boxes. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017).

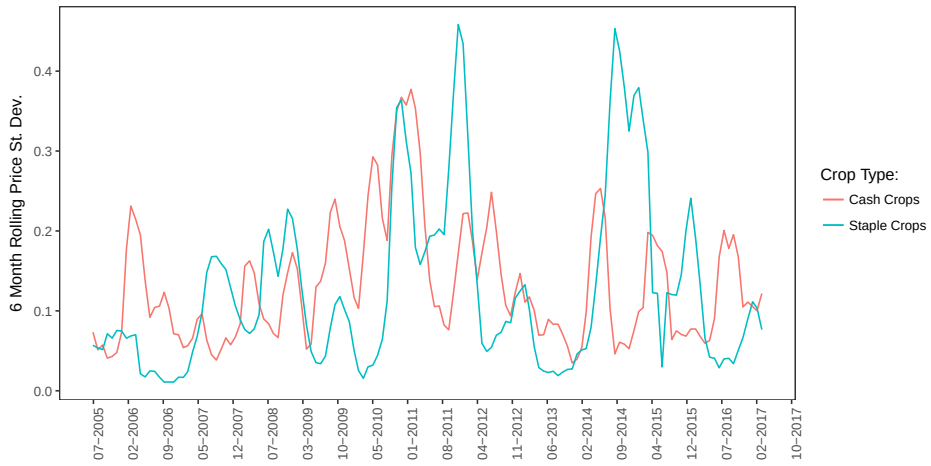
E.4. Crop Price Variation

Figure A25: World Sugar Cane Price by Year



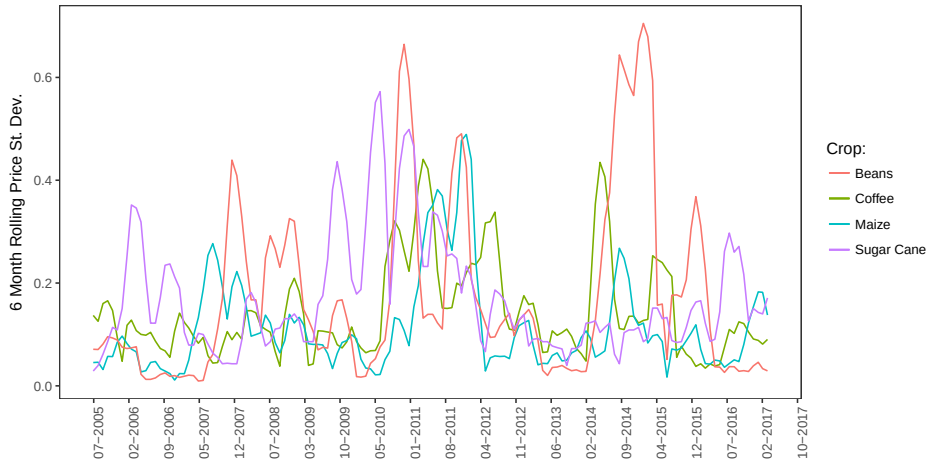
Notes: The figure presents world sugar prices from 1980 to 2016 from the USDA. Source: http://sugarcane.org/internal/images/world-vs-us-sugar-prices/view

Figure A26: 6-Month Rolling Standard Deviation of Prices for Cash Crops and Staple Crops in El Salvador



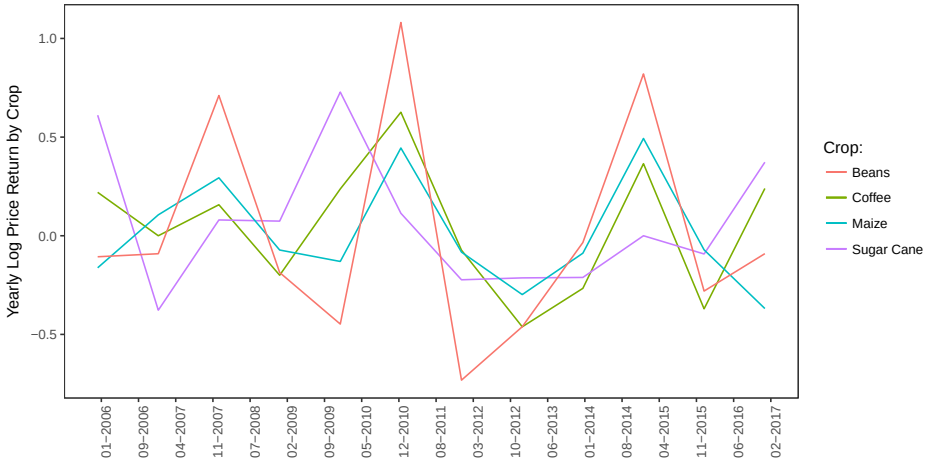
Notes: The figure presents the 6-month rolling standard deviation for cash crop prices (sugar cane and coffee) and staple crop prices (maize and beans) from 2005 to 2015 in El Salvador. The prices are normalized to be equal to 1 at the start of the period (January, 2005) and each portfolio weighs crops equally when calculating the rolling standard deviation. Source for monthly prices in El Salvador: Ministerio de Agricultura y Ganadería (2005-2015b)

Figure A27: 6-Month Rolling Standard Deviation of Crop Prices in El Salvador



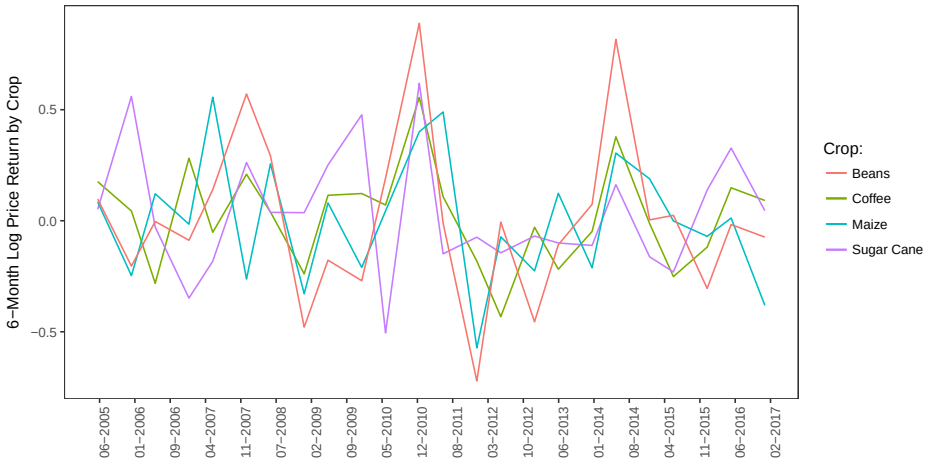
Notes: The figure presents the 6-month rolling standard deviation for sugar cane, coffee, maize, and bean prices from 2005 to 2015 in El Salvador. The prices are normalized to be equal to 1 at the start of the period (January, 2005). Source for monthly prices in El Salvador: Ministerio de Agricultura y Ganadería (2005-2015b)

Figure A28: Yearly Log-Price Return of Crops in El Salvador



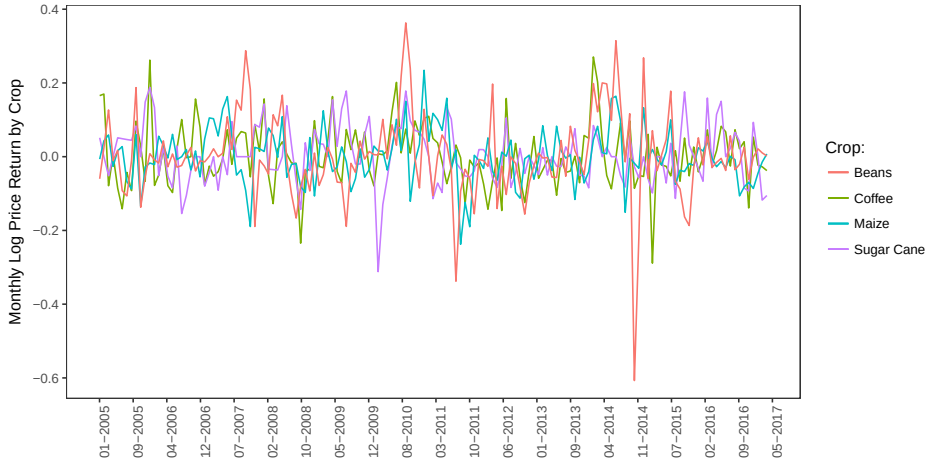
Notes: The figure presents the yearly crop return (log price return) for sugar cane, coffee, maize, and bean prices from 2005 to 2015 in El Salvador. Source for monthly prices in El Salvador: Ministerio de Agricultura y Ganadería (2005-2015b)

Figure A29: 6-Month Log-Price Return of Crops in El Salvador



Notes: The figure presents the 6-month crop return (log price return) for sugar cane, coffee, maize, and bean prices from 2005 to 2015 in El Salvador. Source for monthly prices in El Salvador: Ministerio de Agricultura y Ganadería (2005-2015b)

Figure A30: Monthly Log-Price Return of Crops in El Salvador



Notes: The figure presents the monthly crop return (log price return) for sugar cane, coffee, maize, and bean prices from 2005 to 2015 in El Salvador. Source for monthly prices in El Salvador: Ministerio de Agricultura y Ganadería (2005-2015b)

Table A9: Earnings and Earning Distributions - Sensitivity to Land Value Return

	HH Earnings per capita (previous month)					
	(1)	(2)	(3)	(4)	(5)	(6)
Above500	30.32	4.655	1.659	-42.94	-42.10	-115.6
	(42.58)	(56.73)	(60.08)	(72.37)	(90.68)	(99.52)
Land Value ($ per ha)	57.17	57.17	114.2	114.2	201.1	201.1
Bandwidth	300	150	300	150	300	150
Observations	6280	2262	6280	2262	6280	2262
Clusters	99	37	99	37	99	37
Mean Dep. Var.	72.03	75.61	70.45	73.70	68.05	70.78

Notes: Standard errors clustered at the former owner level reported in parenthesis. *HH Earnings per capita* measures a household's monthly earnings per capita in dollars for agricultural workers in the El Salvador Household Surveys (EHPM). *Land Value* measures the assumed value per ha reported by the Ministry of Agriculture for 2007 for different levels of land quality. *Above 500* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A10: Consumption and Consumption Distributions

	HH Consumption per capita (previous month)			
	Levels		*Inter-Quartile Range*	
	(1)	(2)	(3)	(4)
Above 500	21.92**	8.648	-12.20***	-5.103
	(9.492)	(11.60)	(4.621)	(7.000)
Observations	8861	4412	421	134
Properties	421	134	421	134
Clusters	108	35	108	35
Mean Dep. Var.	47.15	47.41	15.97	15.55
Bandwidth	300	150	300	150

Notes: Standard errors clustered at the former owner level reported in parenthesis. *HH Consumption per capita* measures a household's monthly consumption per capita in real 2007 dollars for agricultural workers in the El Salvador Household Surveys (EHPM). *Inter-Quartile Range* measures the difference between the 75th and 25th percentile in reported household consumption per capita. *Above 500* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix F. Differences in Public Good Access

The results presented in Section 6.3 examined differences in worker earnings; however, workers may also care about levels of public good access. Thus, the earnings results may paint an incomplete picture of worker well being. Theoretically, both cooperatives and *haciendas* have incentives to provide some public goods to their workers.[35] Cooperatives have a number of reasons to provide public goods to workers (Abramitzky, 2011, 2018). First, cooperatives may invest in public goods a form of "lock-in" from members that increase exit costs (as suggested in Abramitzky 2018, pg. 107). Second, providing public goods to workers may serve as a less transparent form of redistribution across workers (Kremer, 1997). Third, cooperatives may provide public good due to a greater sense of community within cooperatives (Abramitzky, 2018, pg. 97). However, in cooperatives, public good provision may suffer from free-rider problems that may not exist in the *hacienda*. *Haciendas* might also invest in public goods do so to maintain loyalty and reduce monitoring costs (see Alston and Ferrie, 1993, for a similar argument for the US South). Therefore, ex-ante it is unclear which ownership structure would have higher access to public goods.

To examine whether cooperatives or *haciendas* have more access to public goods, I use data from household surveys for El Salvador from 2002-2013. The household survey data includes questions on the time it takes each individual to access various public goods.[36] I use these questions to estimate specification (1) at the individual level to analyze differences in public good access between cooperative workers and *hacienda* workers.[37]

Figure A31 presents the estimated differences in the time it takes individuals to access a number of different public goods. I find evidence that cooperative workers have more access to public goods: across most of the public goods included in the survey, cooperative workers

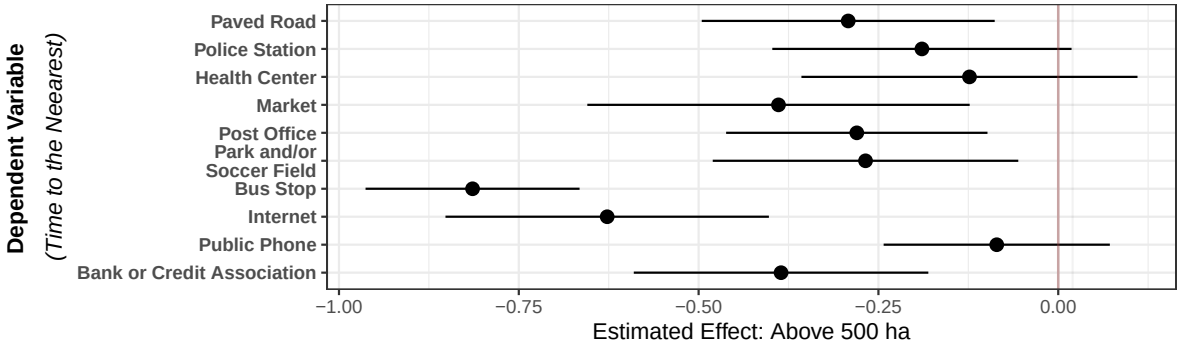
[35] Historically, both cooperatives and *haciendas* have provided some level of public goods for their workers (Browning, 1971).

[36] The data also includes information on the means of transportation used by individuals to arrive at each public good. I take into account differences in the means of transportation (either walking or driving) to calculate the time it takes to walk to the nearest public good.

[37] I examine all the public goods included in the household survey questionnaire.

have lower travel times compared to *hacienda* workers. Importantly, some of these public goods are likely provided directly by the cooperative or *hacienda*, while some are likely provided by the government. The results in Figure A31 suggest that cooperatives and *haciendas* are more likely to differ on public goods provided directly by the owners: for public goods like paved roads, soccer fields, internet, markets, and credit associations, cooperatives workers have higher access to these public goods compared to *hacienda* workers. For public goods that are likely provided in partnership with the local government (or exclusively by the local government), cooperatives and *haciendas* still differ but the differences are not as large or precisely estimated. The results show that while cooperative workers have significantly more access to bus stops and post offices, and the estimated differences are imprecisely estimated for access to police stations, health centers, and public phones.[38] Thus, the results presented in Figure A31 show that cooperatives workers tend to have higher access to public goods compared to *hacienda* workers, particularly for public goods that are likely provided by owners.

Figure A31: Public Good Access – Time to Nearest Public Good – Estimated Differences



Notes: Figure plots standardized (beta) regression discontinuity coefficients and the 95% confidence intervals for regressions on each of the dependent variables denoted on the y-axis. The dependent variables measure the time to the nearest specified public good. Regressions use local linear polynomials and a bandwidth of 300 ha from the reform threshold. All regressions include survey round fixed effects. Data is for agricultural workers in the El Salvador Household Surveys (EHPM) for survey waves that included question on distances to public goods (2007-2011).

Appendix G. Differences in Market Access and Commercialization

One additional possible reason for differences in crop choices is that, *since* former landowners' connections were important for market access (Browning, 1971), then reform cooperatives may have lost market access and may not have been able to reestablish connections to the market post-reform.[39] In this section, I examine whether cooperatives have been able to establish these connections in the years since the 1980s reform and the end of the civil war in 1992:

[38]The differences in some of the goods provided by the government suggest that cooperatives might also be better at lobbying their local government for these goods compared to *haciendas*.

[39]Importantly, the civil war led to the outmigration of many wealthy Salvadorians; this included owners of many wholesalers, exporters, and banks (González, 1999; González and Romano Martínez, 2000). This means that both cooperatives and *haciendas* likely lost market access and connections due to the civil war. However, *haciendas* still likely had more connections even with this historical point in mind.

- **Exploring Differences in Commercialization:** I empirically explore this open question using data from the 2007 census of agriculture. In particular, I use questions in the census that ask producers whether they commercially sell their products, and what sources of commercialization they use. The possible avenues of commercialization in the census are: wholesaler, retailer (smaller than wholesaler), direct exporting, or other. Importantly, all properties in the sample commercialize their production. I estimate equation (1) using these variables and present the estimates in Table A11. I do not find statistically significant differences in the commercial sale types across cooperatives and *haciendas*.

  Interestingly, the coefficients do reveal some interesting patterns even though they are not statistically significant. In particular, cooperatives are much more likely to use wholesalers to sell their products, while *haciendas* are more likely to directly export. Importantly, direct exporting is rare in El Salvador, with only 6% of properties directly exporting, making this difference an unlikely driver of crop choices. In general, while the differences are not statistically significant, the results are consistent with the crop choice results. First, the main export crop of El Salvador is coffee, consistent with the large relative effect for *haciendas* exporting (even exporting rates are quite small in absolute terms). Second, staple crops, non-exported coffee and sugar cane are sold domestically, and cooperatives are more likely to use wholesalers compared to *haciendas*. These points suggests that cooperatives have in fact been able to establish market connections since the reform.

- **Exploring Heterogeneity by Access to Cities:** One short coming of the results above is that they are imprecisely estimated. I complement the empirical exercise above by exploring whether there is important heterogeneity in the main results by access to cities. Being closer to large cities may have made it easier for cooperatives to re-establish market access. To explore this possible source of heterogeneity, in Figure A24 I present the RD estimates for the main outcomes of the paper splitting properties for whether they are close or far to (i) the capital city or (ii) district capitals. I define being close to a city as being within 50 km, about an hour driving distance and close the median in the sample. The results in Figure A32 highlight that the results are very similar for both sets of properties: cooperatives devote more land to staple crops and less land to cash crops regardless of their distances to cities. These results suggest that access to markets are unlikely to fully explain the patterns in the data.

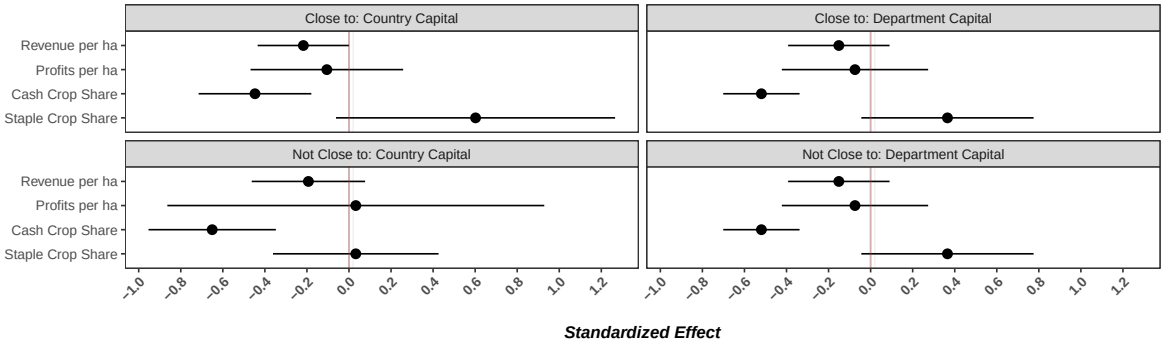
These results suggest cooperatives have been able to reestablish market access following the reform.

Appendix H. Worker Human Capital Differences

In this section, I explore whether there are differences in educational outcomes for cooperative workers relative to *hacienda* workers. As noted by Abramitzky (2018, pg. 161), cooperatives workers face opposing incentives for educational investment that might induce different patterns of human capital investment. On the one hand, due to the redistribution of earnings in cooperatives, workers might have lower incentives to invest in education as there is a lower return to their investment compared to *hacienda* workers. On the other hand, as owners, cooperative workers collectively may benefit from a more educated workforce, so cooperatives may decide to use some of the shared profits to provide education as a form of redistribution.[40] However, cooperative owners might not want to induce too much investment in educations, as this might increase workers' outside options; this could make redistribution harder to maintain or lead to

[40] In fact, many cooperatives often set up schools for their members using their shared profits, see Appendix C.

Figure A32: Heterogeneity by Access to Cities – Main Outcomes



Notes: Figure plots standardized (beta) regression discontinuity coefficients for the sub-sample listed above each plot in the gray boxes. *Closeness* is defined as being within 25 km of the type of city explored. Regressions use local linear polynomials and the MSE optimal bandwidth from Calonico et al. (2017).

Table A11: Commercialization Avenues - RD Estimates

	Commercialization Source			
	Wholesaler	Retailer	Export	Other
	(1)	(2)	(3)	(4)
Above500	0.197	0.242	-0.130	-0.0537
	(0.178)	(0.191)	(0.0953)	(0.152)
Observations	145	251	180	365
Clusters	89	157	113	239
Mean Dep. Var.	0.662	0.277	0.0667	0.161
Bandwidth	89.89	131	109.9	182.2

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Commercialization Source* variables are an indicator variable equal to 1 if the commercialization/selling of products by the property happens via wholesalers, retailers, directly exporting, and/or other sources 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 ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

more brain drain (discussed in Appendix I). *Hacienda* owners might have reasons to provide education to improve the productivity of their workforce, but also fear raising the outside options of their workers and also leading to brain drain. Thus, ex-ante it is unclear whether cooperative workers or *hacienda* workers will invest more in education.

To test these hypotheses, I compare education outcomes for cooperative workers and *haciendas* workers using household survey data. In particular, the household survey includes questions on the years of education for individuals and whether an individual is literate. I use these questions to estimate specification (1) at the individual level to estimate differences in human capital investment between cooperative workers and *hacienda* workers.

Table A12 presents the estimated differences in education outcomes for workers in reform cooperatives relative to workers in *haciendas*. I find that cooperative workers have higher levels of human capital investment on average: cooperative workers have about two more years of education, and they are 28 p.p. more likely to be literate relative to workers on *haciendas*. The table also reports the mean of each dependent variable for the sample. These means demonstrate that, in general, this is a population with low levels of human capital investment: that average worker only has three years of education, and 30% of the sample is illiterate. Thus, the estimated differences in education are quite large relative to the mean levels of human capital investment for agricultural workers in El Salvador.[41] The results suggest that cooperative workers have higher levels of human capital investment compared to *hacienda* workers.[42]

Table A12: Impact of Ownership Type on Education Outcomes

	Years of Education	*Literate*
	(1)	(2)
Above500	2.061*	0.282**
	(1.217)	(0.120)
Observations	8799	8799
Clusters	115	115
Mean Dep. Var.	3.011	0.691
Bandwidth	300	300

Notes: Standard errors clustered at the former owner level reported in parenthesis. Data is for agricultural workers in the El Salvador Household Surveys (EHPM). *Literate* is an indicator variable equal to 1 if the individual is literate. *Years of Education* measures the number of years of education reported by each individual. *Above 500* 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, local linear polynomials in distance to the reform cut off, and control for age, age squared, and sex. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

[41] The differences are unlikely to be due to differences in the age profile of workers: Table A13 presents differences in age and household size and show that cooperative workers are not significantly older (nor are they from smaller households). The estimated coefficients are imprecisely estimated but of small magnitude: cooperative workers are estimated to be 0.46 years older relative to a mean age of 39 years.

[42] Unfortunately, the household survey data does not include questions on access to the nearest school, meaning I cannot disentangle whether these differences are due to higher access to schools for cooperative workers or, even with similar access, higher incentives to invest in education or a stronger culture of education within cooperatives, As mentioned earlier, many cooperatives have schools on their properties, and the results in Figure A31 suggest that cooperative workers have higher access to public goods. Thus, having more access to schools would be consistent with these public good results and the education differences, but it is not the only explanation for the differences in education.

Table A13: Differences in Age and Household Size

	Respondent Age	*HH Size*
	(1)	(2)
Above500	0.456	0.255
	(4.182)	(1.398)
Observations	12749	12749
Clusters	116	116
Mean Dep. Var.	38.74	4.384
Bandwidth	300	300

Notes: Standard errors clustered at the former owner level reported in parenthesis. Data is for agricultural workers in the El Salvador Household Surveys (EHPM). *HH Size* is the number of members in each respondent's household. *Respondent Age* is the age of each individual. *Above 500* 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, local linear polynomials in distance to the reform cut off, and control for age, age squared, and sex. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix I. Migration Differences

In this section, I explore whether there are differences in migration patterns for cooperatives compared to *hacienda* workers. As noted by Abramitzky (2018, pg. 105), cooperatives face two different incentive problems that might induce different patterns of worker selection.

First, cooperatives may face adverse selection issues. In particular, given the income results presented in Figure 6 and the profit-sharing that occurs in cooperatives, less motivated workers might be more willing to join a cooperative to free-ride and take advantage of the redistribution. As detailed in Appendix C, cooperatives in El Salvador make joining the cooperative quite difficult: joining requires a long screening process and a subsequent supermajority approval by the cooperative members.[43] However, even with these mechanisms in place, cooperatives may still face adverse selection.[44] Therefore, it is important to explore differences in migration patterns empirically.

Second, cooperatives may suffer from brain drain: high ability workers have a higher incentive to quit the cooperative 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 (due to communal ownership and not private ownership) and their share of any cooperative public goods.[45] Yet even with these rules in place, brain drain is potentially still a problem for cooperatives. For the case of *haciendas*, brain drain is also potentially a problem because high ability workers may be more likely to quit and migrate to urban centers, and *haciendas* do not have communal ownership to limit this brain

[43] Interestingly, these screening mechanisms are quite similar to the rules put in place by Kibbutz to address adverse selection (Abramitzky, 2018). Kibbutz however also included train periods before joining, whereas this is rare for cooperatives in El Salvador (aside from the case of member's children applying to join, where there has been a de facto trial period).

[44] As well, cooperatives may have a hard time dismissing adversely-selected workers, as dismissal requires a supermajority. Firing costs in *haciendas* are also quite high, as workers tended to reside on the *hacienda* and have labor law protections (e.g. high severance payment requirements).

[45] Again, this is quite similar to how Kibbutz try to limit brain drain (Abramitzky, 2018, pg. 134). See Figure A31 for evidence that cooperatives provide more public goods than *haciendas*, often providing them as a form of redistribution across members.

drain. Thus, ex-ante, it is unclear whether brain drain will be worse in cooperatives than in *haciendas*.

To test these hypotheses, I compare migration patterns for cooperative and *haciendas* and use data from both the 2007 population census and household surveys. Unfortunately, unlike the econometric tests of adverse selection and brain drain in Abramitzky (2018), I do not have access to linked survey data and instead have to rely on cross-sectional differences. Yet, I deal with this shortcoming by using two different datasets to study this as best as possible. I first explore migration patterns at the individual worker level using the household survey data and then explore migration patterns at a more aggregate level using the population census.

I.1. Migration Differences – Household Survey Data

I use household survey data to examine whether there are differences in migration patterns for cooperatives compared to *haciendas*. The household survey data has the advantage of comparing *individuals* in cooperatives vs. *haciendas*. However, the household survey data does not provide many questions on migration. For instance, it does not include questions on cantons of birth or questions on internal migration. The household survey instead contains questions related to international migration and remittances.[46] The survey asks (1) whether a household has any family members abroad, (2) the number of household members abroad if so, and (3) the years since the last household member abroad migrated. While international migration is a different type of migration to the migration studied in other settings (e.g. Abramitzky (2018)) and does not capture internal migration, international migration is an important type of migration outcome to explore as it is a common migration decision made by individuals in El Salvador. I estimate equation (1) for these outcomes for individuals in cooperatives and *haciendas*.

I present the results in Table A14. The results show a complex picture: while cooperative households tend to be less likely to have household members abroad (column (1)), if cooperatives do have household members abroad they tend to have more members abroad (column (2)) and these members moved abroad more recently (column (3)). The results suggest that cooperative members are not more likely to migrate abroad, but migration abroad for cooperative members seems to be more recent, likely reflecting younger and more able household members moving abroad. These results suggest that cooperatives do face more brain drain when exploring differences in international migration. However, as noted in Section 7.4, cooperative workers tend to have more education and similar age profiles as *hacienda* workers, suggesting that the extent of brain drain is not large enough to lead to an overall less-educated workforce in cooperatives.

I.2. Migration Differences – Population Census Data

In this section, I explore differences in migration for cooperatives and *haciendas*. Unfortunately, individuals in the population census cannot be matched to specific cooperatives and *haciendas*. Instead, I utilize the cross-sectional variation in the intensity of the land reform across cantons (shown in Figure A33) to examine the effects of the land reform on canton-level income distributions. I continue to utilize the discontinuous nature of the reform but modify the empirical strategy from Section 4 so that it can be estimated for outcomes that are measured at the canton-level rather than at the plot-level.[47]

[46] El Salvador has one of the highest remittance rates in the world, and these remittances from migrants in the US makes up approximately 17% of El Salvador's GDP in 2016.

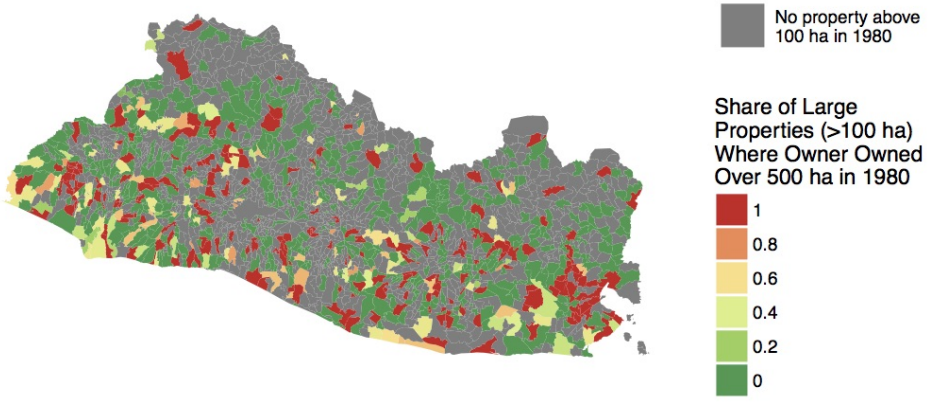
[47] Cantons are the lowest administrative unit in El Salvador, equivalent to approximately one village in rural areas. There are over 1,500 cantons in El Salvador.

Table A14: Migration Outcomes - Household Survey Data

	HH Member is Abroad	*Number Abroad*	*Yeas Since Member Migrated*
	(1)	(2)	(3)
Above500	-0.322**	1.306**	-3.429**
	(0.150)	(0.522)	(1.423)
Observations	8845	1089	1088
Clusters	94	30	29
Mean Dep. Var.	0.123	1.707	6.352
Bandwidth	300	300	300

Notes: Standard errors clustered at the former owner level reported in parenthesis. Data is for agricultural workers in the El Salvador Household Surveys (EHPM). *HH Member is Abroad* is an indicator variable equal to 1 if a household has a household member abroad. *Number Abroad* measures the number of household members that are reported to be living abroad. *Year HH Member Migrated* measures the year when the most recent household member who lives abroad migrated. *Above 500* 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, local linear polynomials in distance to the reform cut off, and control for age, age squared, and sex. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure A33: Share of Properties Above Threshold by Canton - El Salvador



Notes: The figure presents the share of large properties (over 100 ha) in a canton that were owned by an owner with over 500 ha in cumulative landholdings in 1980 for cantons in El Salvador.

I.2.1. Empirical Strategy for Canton-Level Migration Outcomes

The intuition for the modified design is that, *conditional* on having at least some large properties (owned by an individual near the cumulative ownership threshold), cantons that happen to have relatively more properties owned by owners with over 500 ha in cumulative landholdings are unlikely to be systematically different from cantons that happen to have relatively fewer properties owned by owners below the reform threshold. Thus, for any given canton, I use the share of properties in a canton that was above the reform threshold rule of 500 ha in cumulative landholdings as a source of variation in the extent of a canton's exposure to the land reform. The empirical specification for canton-level outcomes is as follows:

$$y_{ct} = \alpha + \beta ShareAbove500_c + X_{ct}\Gamma + \epsilon_{ct} \tag{A2}$$

where y_{iv} is the outcome of interest for canton c at time t, X_{ct} is a vector of controls, and $ShareAbove500_c$ is the total size in ha of properties in 1980 where the owner had over 500 ha in landholding, conditional on the canton c having at least one large property (i.e. a property of size greater than 100 ha). The coefficient of interest is β, the effect on development outcomes of having had more properties subject to the reform and becoming cooperatives (relative to cantons that had a lower share of properties above the reform threshold). Figure A33 plots the variable $ShareAbove500_c$ across El Salvador to highlight the spatial distribution of this variable. I use this empirical strategy to examine whether there are differences in migration across areas more or less affected by the land reform. Note that equation (A2) does not provide causal estimates of the reform but instead provides exploratory conditional correlations, unlike equation (1).[48]

I.2.2. Migration Results – Population Census:

Using the 2007 population census of El Salvador, I examine differences in outcomes related to migration for households by comparing cantons that had a higher share of properties above the ownership threshold to cantons with a lower share of properties above the ownership threshold. The 2007 population census includes the following questions on migration: (1) whether an individual has always lived in the same canton since birth, (2) the year when an individual started living in the canton he/she currently resides in, and (3) whether an individual lives in the same canton as where their mother resided at the time of their birth. (The census does not ask about their father's canton.)

To examine whether there is more migration into areas with more cooperatives and, therefore, potentially more adverse selection, I present the coefficient estimates when estimating equation (A2) for these outcomes in Table A15. I do not find evidence of significant or large differences in migration patterns for cantons more or less affected by the reform. However, the coefficient estimates are negative, suggesting that areas with more cooperatives are more likely to have more in-migration, consistent with adverse selection being more likely in cooperatives. Importantly, the magnitude of the estimated coefficients is small and close to zero for these outcomes.

To examine whether there is more outmigration by highly educated individuals and potentially more brain drain from areas with more cooperatives, I examine the same outcomes as above but limit the sample to individuals who have finished at least high school. If areas with more cooperatives experience more brain drain, then we would expect that educated individuals will have resided in their current canton for less time if they are in cooperatives. I present the coefficient estimates when estimating equation (A2) for this subset in Table A16. Looking at educated individuals, I do not find significant differences in migration patterns for cantons more or less

[48] However, as shown in Section Appendix J, I find similar income distribution results as in Table **??** when estimating equation (A2) on income data in the census: namely, I find the reform led to more equitable income distributions in cantons with relatively more cooperatives.

Table A15: Migration Outcomes - Population Census

	% Always Lived in Same Canton	*Year Started Living in Current Canton*	*% Same Canton as Mother*
	(1)	(2)	(3)
ShareAbove500	-0.0009	−0.7712	-0.0082
	(0.0119)	(0.5236)	(0.0126)
Cantons	639	632	639
Mean Dep. Var.	0.853	1992	0.834

Notes: Data is from the 2007 Population and Household Census of El Salvador. *% Always Lived in Same Canton* is the share of the canton's population that reports that they have always lived in the same canton. *Year Started Living in Current Canton* is the average year for when the canton's population reports they started living in the current canton conditional on not having lived in the same canton since birth. *% Same Canton as Mother* is the share of the canton's population that reports that they live in the same canton as where their mother resided at the time of their birth. (The census did not ask about father's canton.) *ShareAbove500* represents the share of land in properties in 1980 where the owner owned over 500 ha. in total landholdings, restricted to ownership amounts within the reported bandwidth around 500. Robust standard errors in parenthesis. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

affected by the reform; the magnitude of the estimated coefficients is small and close to zero for these outcomes. The coefficient in column (2) is negative, meaning that educated individuals have lived in areas with cooperatives for less time (suggesting people have out-migrated, consistent with brain drain in cooperatives). However, the estimated coefficient is small and close to zero. This provides some evidence that there may be more selective outmigration in places with more cooperatives, but the evidence is weak and inconclusive.

Table A16: Migration Outcomes - Individuals that Completed High School - Population Census

	Sample: Individuals that Completed High School:		
	% Always Lived in Same Canton	*Year Started Living in Current Canton*	*% Same Canton as Mother*
	(1)	(2)	(3)
ShareAbove500	0.0054	−0.5718	0.0004
	(0.0171)	(0.5811)	(0.0181)
Cantons	637	521	637
Mean Dep. Var.	0.825	1996	0.807

Notes: Data is from the 2007 Population and Household Census of El Salvador. *% Always Lived in Same Canton* is the share of the canton's population that reports that they have always lived in the same canton. *Year Started Living in Current Canton* is the average year for when the canton's population reports they started living in the current canton conditional on not having lived in the same canton since birth. *% Same Canton as Mother* is the share of the canton's population that reports that they live in the same canton as where their mother resided at the time of their birth. (The census did not ask about father's canton.) *ShareAbove500* represents the share of land in properties in 1980 where the owner owned over 500 ha. in total landholdings, restricted to ownership amounts within the reported bandwidth around 500. Robust standard errors in parenthesis. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

I.3. Migration Differences – Discussion

The evidence presented in the section examining differences in migration patterns for cooperatives vs. *haciendas* is weakly consistent with the evidence on migration patterns of kibbutz members (relative other rural workers) in Abramitzky (2018): cooperatives areas seem to face slightly more in-migration (consistent with adverse selection), weakly more outmigration by educated households (consistent with brain drain), and more recent international migration. However, most of the estimated differences tend to be small in magnitude. Importantly, given the higher levels of human capital in cooperatives (see Section 7.4), the differences in migration are not large enough to lead to an overall lower quality workforce. This is perhaps due to (i) the rules in place in cooperatives meant to address these incentive issues, or (ii) the low levels of mobility for rural workers in El Salvador. Therefore, the evidence presented in this section suggests that, while differences in migration do exist for cooperatives vs. *haciendas*, the differences are small and unlikely to explain the differences in crop choices, productivity, and earnings presented in Section 6.

Appendix J. Validating the Canton-Level Empirical Strategy: Income Inequality

Using household survey data for El Salvador, I examine whether there are differences in incomes and income distributions in cantons that had a higher share of properties above the ownership threshold to cantons with a lower share of properties above the ownership threshold. I construct a canton-level measure of household income per capita in the last month using the household survey data from El Salvador. Table A17 presents the estimates from estimating equation (A2) using the average income per capita (in dollars in the last month) in cantons as the dependent variable in column (1) and using the inter-quartile range of household incomes per capita in cantons as the dependent variable in column (2). Cantons with more exposure to the land reform have a more equitable distribution of income. These canton-level results are consistent with the property-level estimates, which also suggested that the reorganization of *haciendas* into cooperatives leads to more equitable income distributions.

Table A17: Land Reform and Incomes

	HH Income Per Capita	IQR of Income
	(1)	(2)
ShareAbove500	−11.560	−14.566*
	(8.859)	(7.817)
Survey-Year FEs	Y	Y
Mean Dep. Var.	144.8	111.0
Observations	1,402	1,402

Note: Data is from the 2005 Population and Household Census of El Salvador. *% in Agriculture* is the share of the canton's population that reports that their main sector of employment is in agriculture. *% in Manufacturing* is the share of the canton's population that reports that their main sector of employment is in manufacturing. *% in Services* is the share of the canton's population that reports that their main sector of employment is in services. *ShareAbove500* represents the share of land in properties in 1980 where the owner owned over 500 ha. in total landholdings, restricted to ownership amounts within the reported bandwidth around 500. Robust standard errors in parenthesis. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix K. Similarities between RD and Full-Sample Estimates

I next examine whether the RD estimates from Sections 6.2 and 6.1 – estimated limiting the sample to observations close to the reform threshold – differ from estimates using the entire sample of *haciendas* and cooperatives in the agricultural census for which I have 1980 landholdings information. I do this for two reasons. One concern with RD estimates is that since they are estimated with a small sample of observations near the threshold, they may not generalize to other observations away from the threshold. For instance, it may be the case that the observed differences in choices between cooperatives and *haciendas* are only present for the type of properties I am examining in this paper - properties usually in the hundreds of hectares. Additionally, if the RD estimates differ considerably from the OLS estimates, it may be informative of the direction of omitted variable bias when comparing cooperatives to *haciendas* in other contexts.

The analysis from Sections 6.1 and 6.2 are replicated with the full sample in Tables A18, A19, and A20. The estimated OLS coefficient on *Reform Cooperative* tends to be of the same sign and similar magnitude as the RD estimate for *Above 500*. Specifically, the OLS differences in productivity and in the share of land devoted to different crops are generally similar to the RD estimates. Additionally, the OLS estimates for differences in yields for cash crops in Table A19 have the same sign as the estimates in Table 2 but are generally smaller. However, the OLS

Table A18: Agricultural Productivity - OLS Estimates

	Revenues per Hectare *ln($/ha)*	**Profits per Hectare** *ln($/ha)*	**Farm Productivity** *ln(s_i)*
	(1)	(2)	
Reform Cooperative	-0.660***	-0.270	-0.027**
	(0.104)	(0.173)	(0.011)
Observations	642	612	728
Clusters	461	439	517
Mean Dep. Var.	7.249	5.728	0.312

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Revenue Per Hectare* is measured as total value in 2007 dollars of all 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 the total number of workers. *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). *Reform Cooperative* is an indicator variable equal to 1 if the property became a cooperative following the 1980 land reform. Regressions examine all properties that have information on the total landholdings of the former owner. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A19: Agricultural Choices and Productivity: Cash Crops - OLS Estimates

	Cash Crops	**Sugar Cane**			**Coffee**		
	Share	Producer	Share	Yield	Producer	Share	Yield
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Reform Cooperative	-0.459***	-0.179***	-0.142***	-2.791	-0.303***	-0.291***	-11.19***
	(0.037)	(0.029)	(0.022)	(3.126)	(0.033)	(0.027)	(0.487)
Observations	849	849	772	185	849	849	287
Clusters	584	584	543	153	584	584	207
Mean Dep. Var.	0.544	0.219	0.165	70.19	0.337	0.304	10.64

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Share* for *Cash Crops* measures the share of land in a property devoted to cash crop farming (coffee or sugar cane). *Producer* is an indicator variable equal to 1 if the 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 sugar cane, and in quintales (QQ) per area in manzanas (mz) for coffee. *Reform Cooperative* is an indicator variable equal to 1 if the property became a cooperative following the 1980 land reform. Regressions examine all properties that have information on the total landholdings of the former owner. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A20: Agricultural Choices and Productivity: Staple Crops - OLS Estimates

	Staple Crops	Maize			Beans		
	Share	Producer	Share	Yield	Producer	Share	Yield
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Reform Cooperative	0.311***	0.589***	0.467***	-1.966	0.348***	0.154***	-1.098
	(0.0269)	(0.0415)	(0.0394)	(2.269)	(0.0493)	(0.0267)	(1.228)
Observations	772	849	772	275	849	772	98
Clusters	543	584	543	237	584	543	91
Mean Dep. Var.	0.120	0.324	0.204	47.21	0.115	0.0357	14.96

Notes: Standard errors clustered at the former owner level reported in parenthesis. *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 the 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 (QQ) per area in manzanas (mz). *Reform Cooperative* is an indicator variable equal to 1 if the property became a cooperative following the 1980 land reform. Regressions examine all properties that have information on the total landholdings of the former owner. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

estimates for differences in yields for staple crops in Table A20 differ from the RD estimates in Table 3: the magnitudes are much smaller and have the opposite sign.

Overall, while the estimates on shares of land devoted to different crops and aggregate productivity levels are similar, the OLS estimates for yield differences by crop are not consistently similar. One reason for this could be that yield estimates for very large properties tend to be very different than yield estimates for smaller properties due to the inverse farm size-productivity relationship often found in agriculture (Carter, 1984; Prosterman and Riedinger, 1987; Foster and Rosenzweig, 2017). By not limiting the estimates to properties that were similar before the reform, we are including many very large properties in the OLS estimates. This could have the effect of biasing downwards any differences in yields between cooperatives and *haciendas* for other contexts, in particular for settings where the size of properties under each ownership structure differ considerably.

Appendix L. Robustness Tables: Randomization Inference Approach

Table A21: Robustness to Alternative RD Method - Randomization Inference Approach - Crop Choices Productivity

	Cash Crop Share			Staple Crop Share		
	(1)	(2)	(3)	(4)	(5)	(6)
Randomization Estimate	-0.527	-0.539	-0.523	0.451	0.431	0.401
Randomization P-Value	0.001	0.001	0.001	0.001	0.001	0.001
Observations	89	89	89	89	89	89
Mean Dep. Var.	0.540	0.540	0.540	0.199	0.199	0.199
Right Window	60.20	60.20	60.20	60.20	60.20	60.20
Left Window	-60.20	-60.20	-60.20	-60.20	-60.20	-60.20
Polynomial Degree	0	0	0	0	0	0
Kernel	Uniform	Triangular	Epanechnikov	Uniform	Triangular	Epanechnikov

Notes: Standard errors clustered at the former owner level. *Cash Crop Share* is the share of land in a property devoted to cash crop production (coffee or sugar cane). *Staple Crop Share* is the share of land in a property devoted to staple crop production (maize or beans). *Randomization Estimate* reports the local randomization estimate on *Above 500*, an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Bandwidth window chosen by procedure suggested by Cattaneo et al. (2015) using land suitability as the balance covariate to choose the optimal local randomization inference window. Columns vary the kernel choice for the local randomization estimate. Windows are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A22: Robustness to Alternative RD Method - Randomization Inference Approach - Agricultural Productivity

	Revenue Per Hectare (ln($/ha))			Profits Per Hectare (ln($/ha))			Farm Productivity (ln(s_i))		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimate	-0.245	-0.328	-0.337	-0.0766	-0.0892	-0.156	-0.0261	-0.0256	-0.0255
Randomization P-Value	0.310	0.400	0.403	0.862	0.810	0.847	0.350	0.506	0.497
Observations	70	70	70	67	67	67	77	77	77
Mean Dep. Var.	7.249	7.249	7.249	5.728	5.728	5.728	0.312	0.312	0.312
Right Window	61.20	61.20	61.20	61.20	61.20	61.20	61.20	61.20	61.20
Left Window	-61.20	-61.20	-61.20	-61.20	-61.20	-61.20	-61.20	-61.20	-61.20
Polynomial Degree	0	0	0	0	0	0	0	0	0
Kernel	Uniform	Triangular	Epanechnikov	Uniform	Triangular	Epanechnikov	Uniform	Triangular	Epanechnikov

Notes: Standard errors clustered at the former owner level. *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). *Randomization Estimate* reports the local randomization estimate on *Above 500*, an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Bandwidth window chosen by procedure suggested by Cattaneo et al. (2015) using land suitability as the balance covariate to choose the optimal local randomization inference window. Columns vary the kernel choice for the local randomization estimate. Windows are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix M. Robustness Tables: Varying RD Parameters

Table A23: Robustness to Alternative RD Specifications - Share of Land Devoted to Cash Crops

	Cash Crop Share											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Local Polynomial Order 0											
Above 500	-0.538***	-0.381***	-0.576***	-0.358***	-0.364***	-0.336***	-0.538***	-0.381***	-0.576***	-0.358***	-0.364***	-0.336***
	(0.0971)	(0.133)	(0.0932)	(0.0932)	(0.0888)	(0.0945)	(0.0971)	(0.133)	(0.0932)	(0.0932)	(0.0888)	(0.0945)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	57	53	38	136	114	120	57	53	38	136	114	120
Clusters	37	34	30	160	123	136	37	34	30	160	123	136
Mean Dep. Var.	0.496	0.477	0.448	0.616	0.596	0.598	0.496	0.477	0.448	0.616	0.596	0.598
Bandwidth	47.38	45.29	40.12	63.41	51.10	56.08	47.38	45.29	40.12	63.41	51.10	56.08
	Panel B: Local Polynomial Order 1											
Above 500	-0.628***	-0.468***	-0.640***	-0.393***	-0.343***	-0.380***	-0.651***	-0.589***	-0.636***	-0.403***	-0.379***	-0.385***
	(0.127)	(0.148)	(0.128)	(0.131)	(0.126)	(0.130)	(0.146)	(0.150)	(0.146)	(0.148)	(0.145)	(0.147)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	57	53	38	136	114	120	57	53	38	136	114	120
Clusters	103	103	96	532	530	531	65	65	59	311	314	301
Mean Dep. Var.	0.550	0.550	0.556	0.578	0.579	0.579	0.567	0.567	0.575	0.598	0.600	0.597
Bandwidth	92.56	93.56	88.35	131.4	123.9	133.8	67.19	67.91	64.13	95.39	89.90	97.13
	Panel C: Local Polynomial Order 2											
Above 500	-0.712***	-0.672***	-0.705***	-0.437***	-0.443***	-0.430***	-0.742***	-0.798***	-0.665***	-0.415**	-0.394**	-0.410**
	(0.159)	(0.199)	(0.166)	(0.160)	(0.166)	(0.161)	(0.198)	(0.246)	(0.215)	(0.184)	(0.197)	(0.184)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	276	182	237	402	314	402	168	113	155	260	212	257
Clusters	167	111	146	542	536	542	103	70	92	531	523	530
Mean Dep. Var.	0.563	0.535	0.547	0.573	0.576	0.573	0.550	0.572	0.562	0.578	0.583	0.579
Bandwidth	134.6	101.5	124.9	170.5	135.5	171	93.34	70.35	86.57	118.2	93.97	118.5

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Cash Crop Share* is the share of land in a property devoted to cash crop production (coffee or sugar cane). *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Panels vary the local RD polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details. Bandwidths are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A24: Robustness to Alternative RD Specifications - Share of Land Devoted to Staple Crops

	Staple Crop Share											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Local Polynomial Order 0											
Above 500	0.237***	0.204**	0.237**	0.214***	0.221***	0.210***	0.237***	0.204**	0.237**	0.214***	0.221***	0.210***
	(0.0894)	(0.0861)	(0.0924)	(0.0460)	(0.0417)	(0.0449)	(0.0894)	(0.0861)	(0.0924)	(0.0460)	(0.0417)	(0.0449)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	104	90	97	155	132	148	104	90	97	155	132	148
Clusters	66	53	60	304	265	265	66	53	60	304	265	265
Mean Dep. Var.	0.113	0.118	0.116	0.0942	0.0937	0.0952	0.113	0.118	0.116	0.0942	0.0937	0.0952
Bandwidth	74.79	63.73	67.77	77.22	54.96	75.72	74.79	63.73	67.77	77.22	54.96	75.72
	Panel B: Local Polynomial Order 1											
Above 500 0.241**	0.211	0.220*	0.203***	0.197***	0.196***	0.289**	0.324**	0.274*	0.211**	0.217***	0.214**	
	(0.121)	(0.147)	(0.122)	(0.0725)	(0.0704)	(0.0710)	(0.139)	(0.147)	(0.142)	(0.0834)	(0.0788)	(0.0833)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	295	155	281	315	202	331	180	102	172	215	155	228
Clusters	185	97	174	498	486	499	113	64	107	487	475	488
Mean Dep. Var.	0.114	0.120	0.113	0.0969	0.0921	0.0968	0.133	0.115	0.130	0.0931	0.0875	0.0936
Bandwidth	150.1	96.73	143.4	145.8	95.24	155.4	109.4	70.47	104.5	106.2	69.39	113.2
	Panel C: Local Polynomial Order 2											
Above 500	0.372**	0.352**	0.364**	0.213**	0.238**	0.206**	0.476***	0.428**	0.453***	0.216*	0.211*	0.215*
	(0.156)	(0.164)	(0.161)	(0.0957)	(0.0971)	(0.0979)	(0.151)	(0.170)	(0.160)	(0.115)	(0.114)	(0.116)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov	Triangular	Uniform	Epanechnikov
Observations	284	224	270	380	300	384	164	144	155	246	201	252
Clusters	175	139	167	501	494	501	101	88	97	491	486	491
Mean Dep. Var.	0.112	0.122	0.112	0.0985	0.0962	0.0985	0.127	0.109	0.120	0.0952	0.0921	0.0952
Bandwidth	144.8	126.8	139.5	172.6	137.3	176.6	100.8	88.27	97.14	120.2	95.58	123

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Staple Crop Share* is the share of land in a property devoted to staple crop production (maize or beans). *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Panels vary the local RD polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details. Bandwidths are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A25: Robustness to Alternative RD Specifications - Revenue per Hectare

	Land Productivity *ln($/ha)*											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Local Polynomial Order 0											
Above 500	-0.373*	-0.256	-0.390*	-0.490**	-0.546**	-0.514**	-0.373*	-0.256	-0.390*	-0.490**	-0.546**	-0.514**
	(0.223)	(0.263)	(0.211)	(0.209)	(0.222)	(0.210)	(0.223)	(0.263)	(0.211)	(0.209)	(0.222)	(0.210)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	85	42	88	137	99	128	85	42	88	137	99	128
Clusters	54	27	56	122	94	131	54	27	56	122	94	131
Mean Dep. Var.	7.269	7.356	7.282	7.352	7.341	7.356	7.269	7.356	7.282	7.352	7.341	7.356
Bandwidth	68.52	48.72	69.35	86.23	62.73	83.36	68.52	48.72	69.35	86.23	62.73	83.36
	Panel B: Local Polynomial Order 1											
Above 500	-0.313	-0.259	-0.292	-0.439	-0.360	-0.452	-0.303	-0.185	-0.273	-0.486	-0.388	-0.476
	(0.363)	(0.343)	(0.374)	(0.326)	(0.291)	(0.339)	(0.379)	(0.415)	(0.402)	(0.359)	(0.334)	(0.389)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	141	186	141	214	282	206	89	125	89	161	197	149
Clusters	90	119	90	410	399	408	57	79	57	246	250	284
Mean Dep. Var.	7.222	7.263	7.222	7.318	7.329	7.320	7.281	7.235	7.281	7.353	7.339	7.353
Bandwidth	100.6	121.5	100.3	124.6	157.3	115.1	73.89	89.26	73.68	91.52	115.6	84.60
	Panel C: Local Polynomial Order 2											
Above 500	-0.361	-0.240	-0.199	-0.410	-0.481	-0.446	-0.437	0.339	-0.479	-0.483	-0.538	-0.480
	(0.419)	(0.490)	(0.434)	(0.367)	(0.393)	(0.367)	(0.398)	(0.605)	(0.432)	(0.393)	(0.435)	(0.415)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	220	179	266	368	293	371	132	105	161	256	194	257
Clusters	138	116	171	425	417	424	84	69	105	414	409	414
Mean Dep. Var.	7.295	7.249	7.302	7.308	7.316	7.310	7.247	7.305	7.242	7.318	7.316	7.315
Bandwidth	134	117.9	158.8	198	156.5	197.1	94.22	82.91	111.6	139.2	110	138.6

Notes: Standard errors clustered at the former owner level reported in parenthesis. *Land Productivity* is measured as total value in 2007 dollars of all crops produced net of production costs for each crop divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Panels vary the local RD polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details. Bandwidths are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A26: Robustness to Alternative RD Specifications - Profits per Hectare

	Profits per Hectare *ln($/ha)*											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Local Polynomial Order 0											
Above 500	-0.0892	-0.0766	-0.156	-0.131	-0.165	-0.112	-0.0892	-0.0766	-0.156	-0.131	-0.165	-0.112
	(0.448)	(0.558)	(0.476)	(0.398)	(0.380)	(0.388)	(0.448)	(0.558)	(0.476)	(0.398)	(0.380)	(0.388)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	114	55	86	133	107	131	114	55	86	133	107	131
Clusters	72	32	56	106	146	103	72	32	56	106	146	103
Mean Dep. Var.	5.803	5.893	5.725	5.888	5.849	5.876	5.803	5.893	5.725	5.888	5.849	5.876
Bandwidth	87.05	50.98	74	94.34	65.50	91.59	87.05	50.98	74	94.34	65.50	91.59
	Panel B: Local Polynomial Order 1											
Above 500	-0.0864	0.0364	0.00721	-0.102	-0.238	-0.0894	-0.394	-0.00991	-0.262	-0.247	0.0754	-0.152
	(0.731)	(0.683)	(0.690)	(0.622)	(0.532)	(0.573)	(0.812)	(0.780)	(0.804)	(0.706)	(0.644)	(0.682)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	177	195	215	226	253	250	118	125	133	153	169	165
Clusters	114	121	136	379	399	397	76	81	86	236	247	298
Mean Dep. Var.	5.845	5.796	5.809	5.758	5.755	5.755	5.786	5.810	5.834	5.808	5.797	5.757
Bandwidth	121.7	127.9	136.3	132.7	148.7	143.5	89.65	94.19	100.4	97.77	109.6	105.7
	Panel C: Local Polynomial Order 2											
Above 500	-0.497	-0.167	-0.469	-0.237	-0.147	-0.193	0.250	0.266	-0.00551	-0.395	-0.358	-0.488
	(0.884)	(0.960)	(0.940)	(0.760)	(0.794)	(0.759)	(0.760)	(0.905)	(0.824)	(0.825)	(0.887)	(0.848)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	170	178	184	294	254	277	101	113	118	194	161	181
Clusters	111	115	119	402	399	400	68	71	76	393	333	392
Mean Dep. Var.	5.862	5.841	5.823	5.754	5.751	5.754	5.841	5.825	5.786	5.760	5.770	5.757
Bandwidth	117.8	122.4	126.4	166.3	146.4	157.6	83.10	86.35	89.16	117.3	103.3	111.1

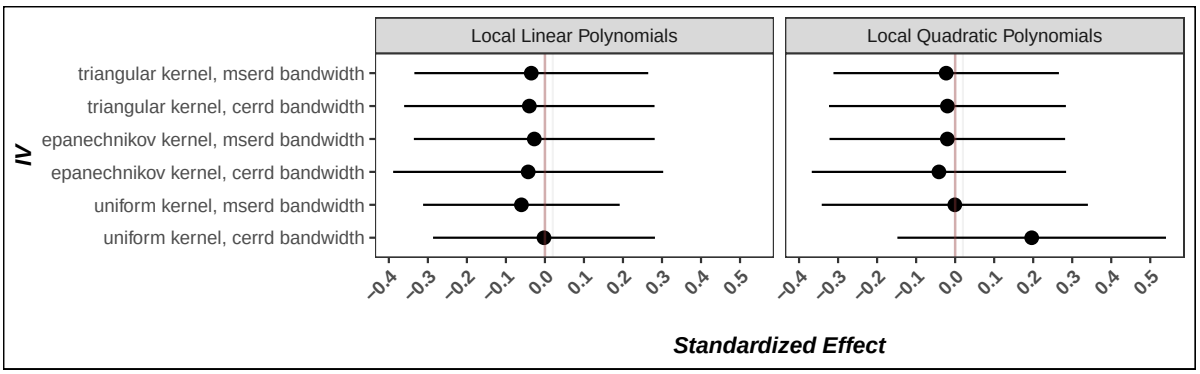
Notes: Standard errors clustered at the former owner level reported in parenthesis. *Profits per Hectare* is measured as total value in 2007 dollars of all crops produced minus the costs of production of each crop from MAG production reports divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Panels vary the local RD polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details. Bandwidths are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A27: Robustness to Alternative RD Specifications - Farm Productivity

	Profits per Hectare *ln($/ha)*											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Local Polynomial Order 0											
Above 500	-0.0892	-0.0766	-0.156	-0.131	-0.165	-0.112	-0.0892	-0.0766	-0.156	-0.131	-0.165	-0.112
	(0.448)	(0.558)	(0.476)	(0.398)	(0.380)	(0.388)	(0.448)	(0.558)	(0.476)	(0.398)	(0.380)	(0.388)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	114	55	86	133	107	131	114	55	86	133	107	131
Clusters	72	32	56	106	146	103	72	32	56	106	146	103
Mean Dep. Var.	5.803	5.893	5.725	5.888	5.849	5.876	5.803	5.893	5.725	5.888	5.849	5.876
Bandwidth	87.05	50.98	74	94.34	65.50	91.59	87.05	50.98	74	94.34	65.50	91.59
	Panel B: Local Polynomial Order 1											
Above 500	-0.0864	0.0364	0.00721	-0.102	-0.238	-0.0894	-0.394	-0.00991	-0.262	-0.247	0.0754	-0.152
	(0.731)	(0.683)	(0.690)	(0.622)	(0.532)	(0.573)	(0.812)	(0.780)	(0.804)	(0.706)	(0.644)	(0.682)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	177	195	215	226	253	250	118	125	133	153	169	165
Clusters	114	121	136	379	399	397	76	81	86	236	247	298
Mean Dep. Var.	5.845	5.796	5.809	5.758	5.755	5.755	5.786	5.810	5.834	5.808	5.797	5.757
Bandwidth	121.7	127.9	136.3	132.7	148.7	143.5	89.65	94.19	100.4	97.77	109.6	105.7
	Panel C: Local Polynomial Order 2											
Above 500	-0.497	-0.167	-0.469	-0.237	-0.147	-0.193	0.250	0.266	-0.00551	-0.395	-0.358	-0.488
	(0.884)	(0.960)	(0.940)	(0.760)	(0.794)	(0.759)	(0.760)	(0.905)	(0.824)	(0.825)	(0.887)	(0.848)
Bandwidth Type	mserd	mserd	mserd	msetwo	msetwo	msetwo	cerrd	cerrd	cerrd	certwo	certwo	certwo
Kernel	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov	Triangular	Unifrom	Epanechnikov
Observations	170	178	184	294	254	277	101	113	118	194	161	181
Clusters	111	115	119	402	399	400	68	71	76	393	333	392
Mean Dep. Var.	5.862	5.841	5.823	5.754	5.751	5.754	5.841	5.825	5.786	5.760	5.770	5.757
Bandwidth	117.8	122.4	126.4	166.3	146.4	157.6	83.10	86.35	89.16	117.3	103.3	111.1

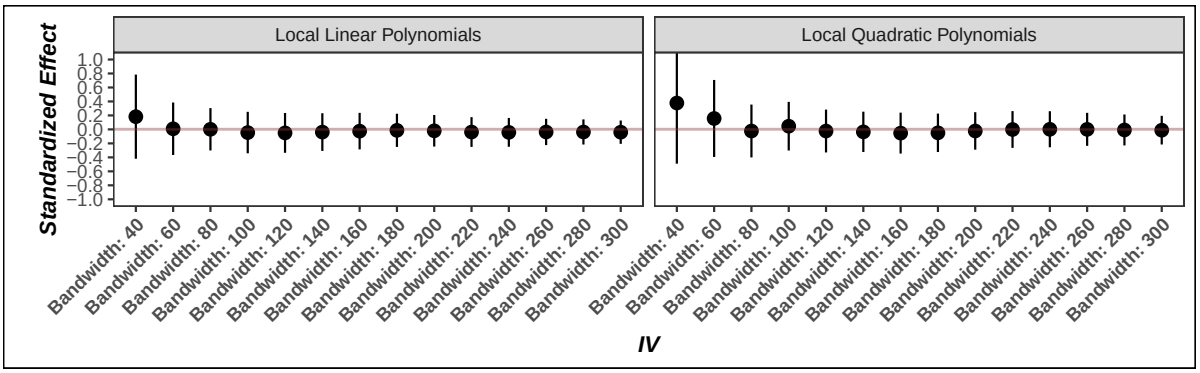
Notes: Standard errors clustered at the former owner level reported in parenthesis. *Profits per Hectare* is measured as total value in 2007 dollars of all crops produced minus the costs of production of each crop from MAG production reports divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Panels vary the local RD polynomial in the total landholdings of the former owner estimated separately on each side of the reform threshold. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details. Bandwidths are reported in ha. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure A34: Robustness to Alternative RD Specifications - Revenue per Hectare



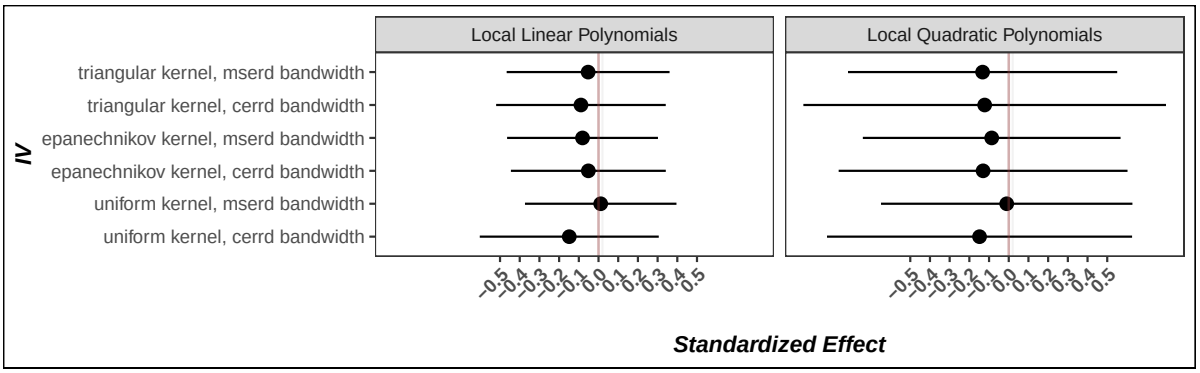
Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD specifications. The dependent variable is *Revenue per Hectare*, measured as the total value in 2007 dollars of all crops produced divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details.

Figure A35: Robustness to Alternative RD Specifications - Revenues per Hectare



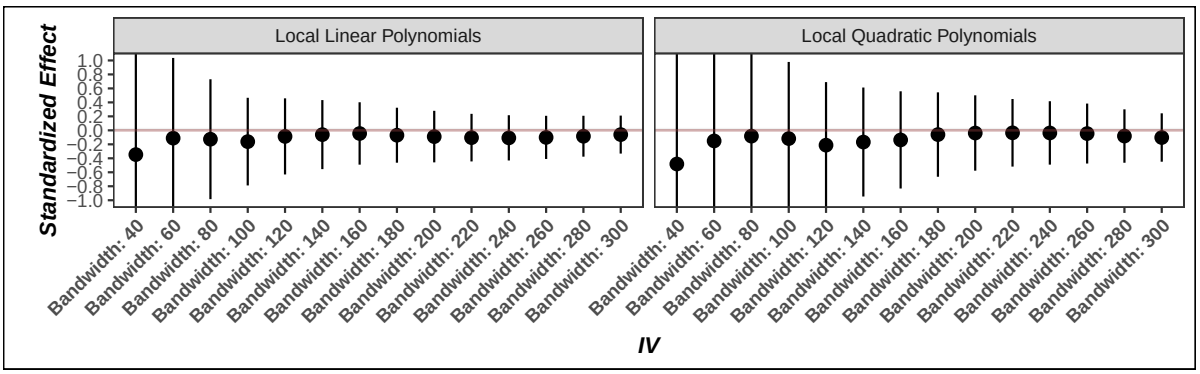
Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD bandwidths. The dependent variable is *Revenue per Hectare*, measured as the total value in 2007 dollars of all crops produced divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidths are presented on the x-axis in hectares (ha) in increments of 20 ha.

Figure A36: Robustness to Alternative RD Specifications - Farm Productivity



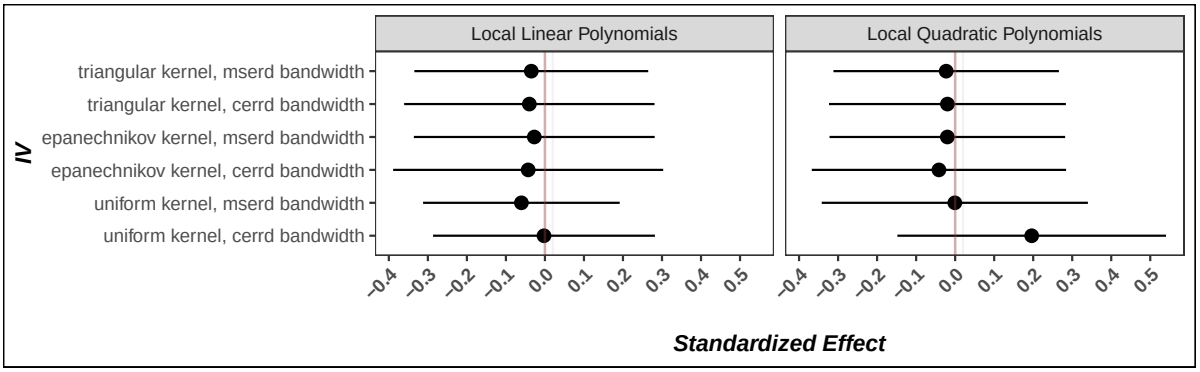
Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD specifications. The dependent variable is *Farm Productivity* is constructed by estimating a producer-level production function and measures the producer-specific component of total factor productivity following the methodology developed by Restuccia and Santaeulalia-Llopis (2017). *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details.

Figure A37: Robustness to Alternative RD Specifications - Farm Productivity



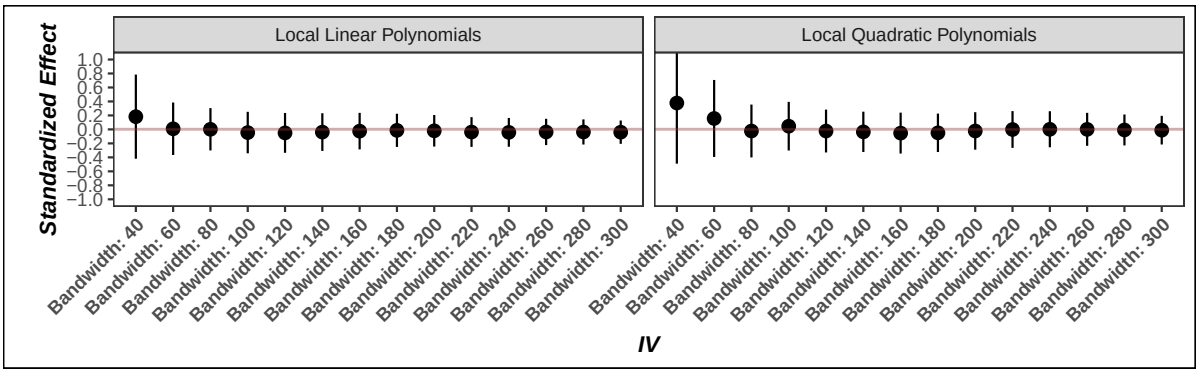
Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD bandwidths. The dependent variable is *Farm Productivity* is constructed by estimating a producer-level production function and measures the producer-specific component of total factor productivity following the methodology developed by Restuccia and Santaeulalia-Llopis (2017). *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidths are presented on the x-axis in hectares (ha) in increments of 20 ha.

Figure A38: Robustness to Alternative RD Specifications - Profits per Hectare



Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD specifications. The dependent variable is *Profits per Hectare*, measured as the total value in 2007 dollars of all crops produced net of production costs for each crop divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidth Type represents the optimal bandwidth selection procedure used for each regression: *mserd* choses one common MSE-optimal bandwidth; *msetwo* choses two different MSE-optimal bandwidths (below and above the cutoff); *cerrd* choses one common CER-optimal bandwidth; and *certwo* twodifferent CER-optimal bandwidths (below and above the cutoff). See Calonico et al. (2017) for more details.

Figure A39: Robustness to Alternative RD Specifications - Profits per Hectare



Notes: The figure plots the standardized effect size (beta coefficients) and 95% confidence intervals on *Above500* for alternative RD bandwidths. The dependent variable is *Profits per Hectare*, measured as the total value in 2007 dollars of all crops produced net of production costs for each crop divided by area in hectares. *Above 500* is an indicator variable equal to 1 if the former owner of the property had over 500 ha in cumulative landholdings in 1980. Standard errors are clustered at the pre-reform land owner level. Bandwidths are presented on the x-axis in hectares (ha) in increments of 20 ha.

Appendix References

Abeler, Johannes, Daniele Nosenzo, and Collin Raymond, "Preferences for Truth-Telling," *Econometrica*, 2019, *87* (4), 1115–1153.

Abramitzky, Ran, "Lessons from the Kibbutz on the Equality-Incentives Trade-Off," *Journal of Economic Perspectives*, 2011, *25* (1), 185–208.

_ , *The Mystery of the Kibbutz: Egalitarian Principles in a Capitalist World*, New York, USA: Princeton University Press, 2018.

Adamopoulos, Tasso and Diego Restuccia, "The Size Distribution of Farms and International Productivity Differences," *American Economic Review*, 2014, *104* (6), 1667–1697.

_ **, Loren Brandt, Jessica Leight, and Diego Restuccia**, "Misallocation, Selection and Productivity: A Quantitative Analysis with Panel Data from China," 2017. NBER Working Paper 25780.

Alston, Lee and Joseph Ferrie, "Paternalism in Agricultural Labor Contracts in the U.S. South: Implications for the Growth of the Welfare State," *American Economic Review*, 1993, *83* (4), 852–876.

Aragon Sanchez, Fernando M., Diego Restuccia, and Juan Pablo Rud, "Are Small Farms Really More Productive Than Large Farms?," 2019. NBER Working Paper 26331.

Benabou, Roland and Jean Tirole, "Mindful Economics: The Production, Consumption, and Value of Beliefs," *Journal of Economic Perspectives*, 2016, *30* (3), 141–164.

Browning, David, *El Salvador: Landscape and Society*, Oxford, U.K.: Clarendon Press, 1971.

Calonico, Sebastian, Matias D. Cattaneo, Max H. Farell, and Rocío Titiunik, "rdrobust: Software for Regression Discontinuity Designs," 2017. Working Paper, forthcoming *Stata Journal*.

Carter, Michael, "Identification of the Inverse Relationship between Farm Size and Productivity," *Oxford Economic Papers*, 1984, *36*, 131–145.

Cattaneo, Matias D., Rocío Titiunik, and Gonzalo Vasquez-Bare, "Power Calculations for Regression Discontinuity Designs," 2017. Working Paper.

Colindres, Eduardo, *Fundamentos Económicos de la Burguesía Salvadoreña*, San Salvador, El Salvador: UCA Editores, 1977.

Commission on the Truth, *De La Locura a La Esperanza: La Guerra de los Doce Años en El Salvador*, San Salvador, El Salvador: United Nations, 1993.

Cooperativas de las Américas, "Legal Cooperative Framework Analysis: National Report for El Salvador," 2019. Report by *Cooperativas de las Américas*, available at https://coops4dev.coop/sites/default/files/2020-01/Legal%20Framework%20Analysis%20-%20El%20Salvador.pdf.

De Janvry, Alain and Elizabeth Sadoulet, "Land-Labor Interlinkages in a Latin American Context," 1988. University of California, Berkeley. Dept. of Agriculture and Resource Economics Working Paper Series, http://ageconsearch.umn.edu/bitstream/198471/2/agecon-cal-461.pdf.

_ **and** _ , "Optimal Share Contracts under Theft," 2004. University of California, Berkeley. Dept. of Agriculture and Resource Economics Working Paper Series, https://are.berkeley.edu/~esadoulet/papers/Cheating_text6.pdf.

Figueroa Aquino, Ana Gloria and Edgar Marroquín Mena, "La Fase II de la Reforma Agraria y la Estructura Oligepólica en el Agro Salvadoreño," 1991. Tesis, Universidad de El Salvador.

Foster, Andrew D. and Mark R. Rosenzweig, "Are There Too Many Farms in the World? Labor-Market Transaction Costs, Machine Capacities and Optimal Farm Size," 2017. NBER Working Paper #23909.

González, Luis Armando, "El Salvador de 1970 a 1990: Política, Economía y Sociedad," *Realidad: Revista de Ciencias Sociales y Humanidades*, 1999, *67*, 43–61.

_ **and Luis Ernesto Romano Martínez**, "Reforma Agraria y Cooperativismo en El Salvador: Antecedentes y Perspectivas (1970-1996)," *Realidad: Revista de Ciencias Sociales y Humanidades*, 2000, *68*, 175–206.

Heckman, James, "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator of Such Models," *Annals of Economic and Social Measurement*, 1976, *5* (4), 475–492.

Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones, and A. Jarvis, "Very High Resolution Interpolated Climate Surfaces for Global Land Areas," *International Journal of Climatology*, 2005, *25*, 1965–1978.

Junta Revolucionaria de Gobierno, *Ley Basica de la Reforma Agraria*, San Salvador, El Salvador: Publicaciones del Ministerio del Interior, 1980.

Jurado Castillo, Alejandra Elizabeth, María Teresa Naves Medrano, and Loyda Abigail Robles Rosales, "Ley Especial para la Garantía de la Propiedad o Posesión Regular de Inmuebles," 1993. Thesis, Universidad de El Salvador, Facultad de Jurisprudencia y Ciencias Sociales.

Kremer, Michael, "Why are Worker Cooperatives So Rare?," 1997. NBER Working Paper No. 6118.

Lehner, Bernhard and Gunther Grill, "Global River Hydrography and Network Routing: Baseline Data and New Approaches to Study the World?s Large River Systems," *Hydrological Processes*, 2013, *27* (15), 2171–2186.

Marroquín Mena, Edgar, *Evaluación Sobre la Reforma Agraria en El Salvador (1980-1987)*, San Salvador, El Salvador: Ciudad Universitaria, 1988.

McReynolds, Samuel Anthony, "Agricultural Labour and Agrarian Reform in El Salvador- Social Benefit or Economic Burden?," *Journal of Rural Studies*, 1988, *14* (4), 459–473.

Michalopoulos, Stelios, "The Origins of Ethnolinguistic Diversity," *American Economic Review*, 2012, *102* (4), 1508–39.

Ministerio de Agricultura y Ganadería, *Tercera Evaluación del Proceso de la Reforma Agraria*, San Salvador, El Salvador: Universidad Centroamericana José Simón Cañas, 1983.

_ , *Retrospectiva Mensual de Precios de Productos Agropecuarios*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2005-2015.

_ , *IV Censo Agropecuario 2007-2008: Metodología y Resultados Generales*, San Salvador, El Salvador: Ministerio de Agricultura y Ganadería, 2009.

Montes, Segundo, *El Agro Salvadoreño (1973-1980)*, San Salvador, El Salvador: Universidad Centroamericana José Simón Cañas, 1980.

Nigrini, Mark, *Benford's Law: Applications for Forensic Accounting, Auditing, and Fraud Detection*, New Jersey, US: John Wiley & Sons, 2012.

Perez Riva, Guillermo and Nain Chavez Castro, "La Reforma Agraria Como Mecanismo de Redistribución En El Salvador, Fases I Y III (1980-1984)," 1986. Thesis, Universidad Centroamericana José Simeon Cañas, Facultad de Ciencias Económicas.

_ and _ , "Ley General de Asociaciones Cooperativas," 1994. Decreto 339, Asamblea Legislativa de la Republica de El Salvador.

Polanco Mazariego, Mario Alfredo, "La Situación Jurídica de los Excedentes de 245 Hectáreas," 1994. Thesis, Universidad de El Salvador, Facultad de Jurisprudencia y Ciencias Sociales.

Prosterman, Roy L. and Jefferey M. Riedinger, *Land Reform and Democratic Development*, Baltimore, USA: John Hopkins University Press, 1987.

Ramankutty, Navin, Jonathan A. Foley, John Norman, and Kevin McSweeney, "The Global Distribution of Cultivable Lands: Current Patterns and Sensitivity to Possible Climate Change," *Global Ecology and Biogeography*, 2002, *11*, 377–392.

Restuccia, Diego and Raul Santaeulalia-Llopis, "Land Misallocation and Productivity," 2017. NBER Working Paper 23128.

Sadoulet, Elizabeth, "Labor-Service Tenancy Contracts in a Latin American Context," *American Economic Review*, 1992, *82*, 1031–1042.

Velis Polío, Rolando Antonio, "La Reforma Agraria de 1980 en El Salvador: Lucha Política, Diseño y Ejecución," *Revista de Humanidades y Ciencias Sociales*, 2012, *3*, 95–120.

Wise, Michael L., "Agrarian Reform in El Salvador: Process and Progress," 1985. USAID/El Salvador Report No. PNABE547.

Wood, Elizabeth, "Insurgent Collective Action and Civil War in El Salvador: Text and Captions for Website," 2002. Cambridge University Press Website.

_ , *Insurgent Collective Action and Civil War in El Salvador*, Cambridge, United Kingdom: Cambridge University Press, 2003.

World Bank, "El Salvador Country Land Assessment," 2012. World Bank Report Number: 82312-SV.