

The long-run effects of public land settlement policies: Evidence from Ecuador's agrarian reform

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Abstract

I study the long-run impacts of a policy that affected the quality of property rights in a developing country. I focus on a region in Ecuador that was affected by land redistribution but where one side was granted full property rights over crop choice, while the other was restricted to growing rice, following food security concerns and kept traditional *latifundia* practices. I use the 2000 agricultural census to examine the effects of these property rights regimes on crop productivity and credit markets. I use alternative data sets to study the same effects on efficient land use and structural transformation. Thirty years after the reform, I find that areas that received full property rights are more productive in permanent (perennial) crops. Moreover, this effect comes from outside traditional crops such as bananas or cocoa, providing evidence that this type of reform fostered diversification. In addition, these zones show more efficient land use, and there is suggestive evidence of rapid structural transformation. Areas that faced the crop restriction policy are still devoted to rice production and are not more productive for transitory (annual) crops in general. These zones are more likely to have access to informal credit markets, which I argue is a novel mechanism that influenced farmers' long-run decisions and set them on a path dependency cycle. A counterfactual analysis, using a region where agrarian reform was not fully implemented as a comparison group, helps me contrast how each type of reform performs against a non-reform scenario.

JEL classification:

Keywords:

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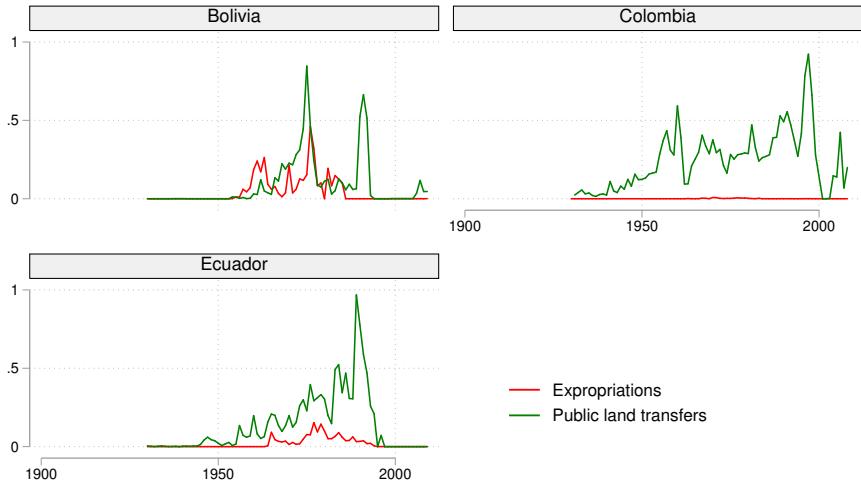
1. Introduction

The quality of property rights has long been recognized as a crucial determinant of economic outcomes, especially for long-term decisions (Demsetz, 1967; Acemoglu et al., 2005; Galiani and Schargrodsy, 2010; Hornbeck, 2010; Libecap and Lueck, 2011). In developing countries, particularly in the rural sector, different property rights regimes coexist due to institutional legacies or sub-optimal implementation of agrarian reforms. Agrarian reforms have been opportunities for policymakers to impose certain practices, such as mandating specific crops to enhance food security, while also aiming to expand the agricultural frontier and provide farmers with flexibility in crop choice. The coexistence of these different property rights regimes raises important questions about their economic consequences. Alchian (1965) reflected on the issue of restricting property rights and questioned whether such restrictions might cause more harm compared to less restrictive environments.

Agrarian reforms in Latin America have typically involved two types of projects: expropriations and public land settlement policies/transfers (hereafter PLT)¹ (Albertus, 2015). While the former has been extensively studied, the latter has received little attention, especially with regard to property rights. Expropriations resulted in irregular forms of land tenure among both owners and beneficiary farmers, while PLT was more uniform in this regard. Cumulatively, PLT affected a larger area of land than expropriation in some countries (see Faguet et al. (2020) and Galán (2020) for extensive studies on Colombia). Figure 1 shows the importance of PLT relative to expropriations for a selection of three Latin American countries. Given the ubiquity of both types of land allocation programs in several Latin American countries during the 20th century, studying agrarian reforms exclusively through the lens of expropriations provides an incomplete assessment of their impacts. In other words, it is crucial to assess the ultimate consequences of each program in relative terms.

¹In Latin America, it is common to refer to public land distributions as "colonization" processes because one of the goals was to encourage internal migration and expand the agricultural frontier (hence "colonizing" new national/internal lands). For the sake of clarity in writing and proper contextualization, I will not use the term colonization, but *public land transfers*.

Figure 1: Importance of public land transfers in selected Latin American countries



Note: Data is from [Albertus \(2015\)](#). Each series is normalized to be comparable and to be between 0 and 1.

In this paper, I examine the impact of PLT relative to expropriation, the two main land allocation processes during agrarian reform, on agricultural productivity outcomes in the coastal region of Ecuador. PLT programs allocated state-owned or abandoned land and provided their beneficiaries with better defined property rights in terms of flexibility in crop choice. Expropriation, on the other hand, tended to be more restrictive, despite similar legislation. The coastal region of Ecuador was particularly restrictive: Beneficiaries were expected to grow rice, given the country's food security concerns at the time. If the Ecuadorian context created a quasi-random allocation of land rights along the dimension of crop choice, what are the implications for agriculture and development in general?

Addressing endogeneity in this setting is challenging because the land allocated to the PLT program could, in principle, be inherently different. In particular, PLT programs aim to expand the agricultural frontier, that is, to convert unoccupied land into productive farms. Unoccupied land may be different from land that already has an owner, leading to potential problems such as land quality selection or omitted variable bias. Land settlement policies aim to be distributive rather than redistributive, i.e., they focus on allocating state-owned land rather than taking land from current owners and broadly redistributing ownership ([Albertus, 2015](#)). In Ecuador, public land settlement programs were governed by a separate set of laws from those used in cases of expropriation. However, there were cases where land was abandoned but workers remained, leading to a potentially redistributive aspect of PLT. In such cases, the Institute of Colonization

and Agrarian Reform (IERAC, in Spanish) - the government agency in charge of implementing agrarian reform - had to exercise arbitrary discretion in determining the applicable legislation. I argue that this scenario provides an opportunity to defend an identification strategy based on the geographical proximity of sites. Proximity can serve as a proxy for a quasi-random application of different legal frameworks that influenced the property rights regime within the region under study.

Using a geographic regression discontinuity design, I am able to identify an effect of receiving flexible property rights on crop choice via PLT relative to a comparison group. This comparison group is characterized as a region with crop constrained property rights (via expropriation) for two main reasons: first, after the implementation of Presidential Decree 1,001 aimed at eradicating precarious labor, certain areas redirected their resources to rice production to address nationwide food security concerns, following government guidelines. Second, small areas unaffected by Decree 1,001 continued traditional *latifundia* practices. These estates were mostly devoted to banana production, which had been the main cash crop before the land reform.

Using the 2000 agricultural census, I find that being in a zone that benefited from the PLT program is associated with higher productivity and a preference for growing perennial crops (21% relative to comparison group). Within perennial crops, the effects come from outside traditional crops (78% relative to comparison group) such as cocoa and bananas, indicating diversification. In contrast, areas with weaker property rights are persistently committed to rice cultivation (28% relative to PLT), in line with the restrictions imposed in the past. These results suggest that a specific issue to consider is the effect that these land allocations had on time preferences, investment decisions, and willingness to wait². Their main permanent (perennial) crop is bananas, with no signs of diversification. On the expropriated lands, the banana yield is 98% higher than in PLT, even when controlling for agro-climatic conditions. Since bananas was the primary perennial crop previous to the agrarian reform, this might further indicate a low willingness to wait and risk diversification. Finally, I compare the studied regions with one in which the agrarian reform did not fully intervene. To do so, I use a linear regression model that controls for a variety of characteristics. Main conclusions remain.

Following the reasoning from the main results, a more diversified set of perennial crops is likely to result in better land use outcomes. Specifically, in a more flexible environment, the selection of crops should lead to more optimal perennial crop choices relative to the best potential

² See, for example, [Bellemare et al. \(2020\)](#), who finds that in the context of Vietnam, a change in the extension of usufruct rights led to additional investment of a limited dimension.

use of the land. To test this, I use a different and more granular dataset. I find that PLT areas are associated with better land use, as suggested by the main results. Furthermore, I document that PLT areas experience higher economic growth (measured by night light intensity and satellite-measured agricultural GDP) and a rapid decline in agricultural labor. My results suggest that areas that received PLT have better economic outcomes.

When testing for mechanisms, I document a novel dynamic. While access to credit markets is widely acknowledged as an important factor in increasing property rights security ([De Soto, 2000](#)), to the best of my knowledge, there is no comprehensive review of the effect of informal credit markets. Informal credit markets may serve as intermediaries, reinforcing the circumstances of areas that remain predominantly focused on rice production. I find that areas outside of PLT have greater access to informal credit. This might help explain the continued devotion to rice production. Informal credit operates outside the formal market, charges high interest rates, and demands quicker repayment with limited options for debt restructuring. I see this as a novel mechanism that potentially maintains a path-dependent structure, particularly by perpetuating farmers' commitment to short-term crops such as rice. Consequently, this could have implications for efficient land allocation and product diversification.

This paper contributes to the literature by discussing the complexity of contemporary agrarian reform. It considers a property rights dimension within agrarian reform and examines its relative importance for local long-run development. Works such as [Tella et al. \(2007\)](#) and [Galiani and Schargrodsky \(2010\)](#) analyze cases of formal land titling and find that it is not access to credit that enhances the effect of formal titling on better economic outcomes, but rather investment-related explanations. More closely related to the property rights intervention analyzed in this paper, [Libecap and Lueck \(2011\)](#) and [Bellemare et al. \(2020\)](#) examine "subtle" changes in the property rights dimension of land received by people in the US and Vietnam, respectively. In the former, the type of demarcation and in the latter, a change in usufruct rights lead to significant economic gains. This paper finds that differences in crop choice due to different land allocation laws (PLT vs. expropriation) have significant local economic impacts. In addition, I discuss the possibility of an informal credit market channel that could incentivize farmers to remain in the transitory/annual rice crop.

This research contributes further to a growing body of empirical research on the effects of land allocation and its implications for economic development. I add to the contemporaneous literature on the effects of agrarian (and land) reform on agricultural outcomes (see, for exam-

ple, Montero (2023, 2022); Edwards et al. (2022); Galán (2020); Bühler (2021); Smith (2020)), particularly through the resulting variation in property rights (Goldstein and Udry, 2008). At the same time as Latin American agrarian reforms, the Green Revolution may have played an important role in crop choice through its technological innovations (Gollin et al., 2021). However, it is important to consider that some local economies may not have translated these technological improvements into economic development if this crop promotion was accompanied by explicit restrictions on crop choice.

Many studies have primarily examined the role of expropriation in agrarian reform, overlooking PLT, which often outperformed expropriated land in terms of land distribution in several Latin American countries (Faguet et al., 2020; Albertus, 2015). Due to minimal political friction (since PLT mostly distributes abandoned or underutilized lands), PLT tended to grant better property rights to its beneficiaries. This paper contributes to the limited empirical research analyzing the effects of PLT, particularly its property rights allocation, and its long-term impact on agricultural and development outcomes. Latin American agrarian reforms are often perceived as failures because they do not significantly increase agricultural productivity at the aggregate level. However, this study reevaluates this claim by taking into account the complexity of contemporary agrarian reform policies. While it's clear that Latin American agrarian reforms have not in general produced positive aggregate effects, certain phases within these reforms have produced positive results at the local level. This research shows that, in the case of Ecuador, a specific aspect of agrarian reform improved agricultural and development outcomes compared to the widespread policy of expropriation.

The paper is structured as follows: Section 2 presents the institutional and historical context of the setting, Section 3 presents the data and sources to be used, Section 4 explains the empirical strategy to be used, Section 5 presents the results from the main empirical model, Section 6 discusses plausible mechanisms and alternative data sets to test the reasoning and implications of the results, Section 7 concludes.

2. Institutional context

2.1. Pre-agrarian reform

Before the agrarian reform, Ecuador experienced the rise and fall of two crops that significantly influenced the country's agricultural and political development: cocoa and bananas. Traces

of cocoa plantations in the Americas come from the pre-colonial period. Ecuador, and specifically its coastal zone, hosted some of the largest cocoa plantations. According to historians (Chiriboga, 1980; Arosemena, 1991). Ecuador experienced two Cocoa booms; the first one in the 19th century and the second in the beginning of the 20th century. International trade expanded considerably and Ecuador became one of the most important cocoa exporters in the world. These gains shaped a landed elite that built *haciendas* and established different levels of precarious work. The property rights regime adhered to a *latifundia* system, where land was concentrated in the hands of a few land-owners and the relationships with workers were primarily characterized by serfdom or low-paid labor. Landed elites became rentist, since most of them lived overseas, specifically in Europe (Guerrero, 1994).

Around the decade of the 1920s, two phenomena negatively affected cocoa producers: A worldwide decline in cocoa prices and the appearance of a plant pest called "witches' broom". Some (but not all) owners opted to leave their estates altogether, as they were already living abroad. As a result, the workers remained uncertain about the ownership of the land, which led to disputes, rebellions, and alternative land uses(Uggen, 1975). These plots were not officially recognized by the state, but they were the result of a de facto agreement between the workers and the former landowners (Espinosa, 2014).

The expansion of rice cultivation had significant effects on the rural landscape in the coastal region of Ecuador. Large areas of land that had been devoted to cocoa ended up covered in small rice plantations, changing the rural landscape of the coastal region. This shift in land use also had important implications for the local economy. While cocoa had been an export crop that brought foreign currency into the country, rice was mainly grown for local consumption. During the agrarian reform, rice would be declared an strategic sector by former President José María Velasco Ibarra.

Ecuador's second commodity boom came from bananas. After the collapse of the cacao haciendas, some landowners decided to take additional risks and switch to banana production. This was especially the case in the center-south of Los Ríos and Guayas, including the province of El Oro. The fruit became relevant after Costa Rica, the first banana exporter in Latin America before the 1950s, experienced a collapse in production. To fill the gap, Ecuadorian banana production increased. In addition, the wave of export-oriented ideas in Latin America was influential during these years. Initially, banana plantations were not concentrated, but rather a general activity among large and small landowners (Larrea, 1987). However, there was no organization

among small producers or workers. (Larrea, 1987) concludes that despite the inequalities generated, areas with banana cultivation had a potentially higher standard of living, particularly due to the influence of the Standard Fruit Company in the Tenguel *hacienda* in the southern part of the region³.

These events set the stage for the implementation of Agrarian reforms in Ecuador in the 1960s and 1970s. The reforms aimed to tackle the issue of land inequality and provide a path for landless peasants to acquire land ownership. The beginning of the reform was the Agrarian reform Law of 1964, which provided the legal basis for the creation of the National Agrarian Reform Institute (IERAC, in spanish). The IERAC was responsible for the implementation of the Agrarian reform program, which included PLT and expropriation.

2.2. Agrarian reform and public land transfers

Similar to other Latin American countries that performed Agrarian reforms during the second half of the 20th Century, Ecuador experimented with two projects within its Agrarian reform project: Expropriation and PLT⁴. The former refers to the action of the government to buy land from large landowners and reallocate it to farmers, normally to the same people that was working within the land. The latter had the aim of allocating abandoned or non-explored land in order to "expand the agricultural frontier" (Canelos, 1980). PLT played an important role in the Coastal and Amazon region. Expropriation was more common the midland region of Ecuador, but it also played a role in the southern part of the coastal region in the mid 1970s.

In the Ecuadorian context, PLT and expropriation were governed by two different pieces of legislation. In principle, both laws were very similar, requiring beneficiaries to repay for the land transfers over a period of 20 to 25 years, with an additional grace period of 3 to 5 years. Financial conditions were relaxed since the objective was to carry out agrarian reform while also preventing any patronage. In this context, it is challenging to engage with studies that argue that agrarian reform schemes benefit authoritarian regimes (Albertus, 2015; Albertus et al., 2016). Although this possibility cannot be entirely dismissed (and is not the focus of this paper), in the case of Ecuador, the military regime that implemented the reform voluntarily transitioned to a democratic government. The newly elected governments served only four-year terms, and the country experienced constant political instability. Due to these factors, it is difficult to attribute

³ It has been documented that the Standard Fruit Company had positive local impacts in Costa Rica (Méndez and Van Patten, 2022).

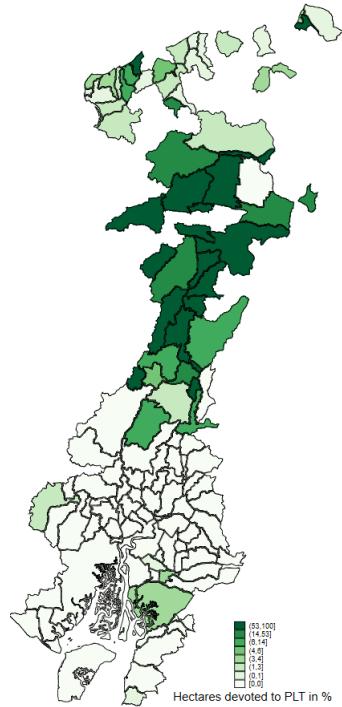
⁴ The official name of the public land transfers program was "Colonization".

the negative side effects of the agrarian reform solely to the political sector. Instead, I contend that the institutional framework of the reform played a critical role by providing incentives to farmers and private sector actors (such as informal lenders), which in turn influenced agricultural and development outcomes.

The initial rollout of the PLT program, which began in the 1950, was initially slow, but accelerated (along with expropriation) after the promulgation of the First Law of Agrarian Reform and Colonization of 1964. The PLT program was supported by international organizations such as the World Bank and the Inter-American Development Bank, both of which undertook surveillance of the project. The specialised literature on the agrarian reform in Ecuador, normally concludes that the conditions received by beneficiaries of the PLT were more flexible and generous in terms of land awarded ([Barsky, 1984](#)). An important consideration that has not being fully addressed in this literature is that PLT also acted on abandoned land that had complex and organized production beforehand, such as old cocoa haciendas. In fact, [Carrasco \(1994\)](#) acknowledges that the old cocoa haciendas were important in this process. The PLT, in particular, faced several challenges, including the resistance of farmers to change old agricultural practices.

Why this particular region in coastal Ecuador? The provinces of Guayas and Los Ríos witnessed a unique feature of the Agrarian reform process. Some areas experimented PLT, while nearby areas in the same province were untouched or affected by expropriations. While expropriation was concentrated in the southernmost part of the provinces, the PLT did not necessarily affect only vacant land, but rather land that was occupied by previous cocoa hacienda workers as well. Figure 2 shows a map of Guayas, Los Ríos, and the northern provinces Santo Domingo, Pichincha, and Esmeraldas. Greener areas represent a stronger intervention by PLT, measured as the ratio of the amount of land devoted to PLT (from IERAC archives) over the overall area of the affected parish.

Figure 2: Variation in PLT



Note: This map represents the region of focus in this paper. Darker green areas represent parishes where PLT was more intense. The source of information is IERAC's statistical reports and parishes match with current administrative borders.

Why Property Rights? The southern region, shown on the map in Figure 2, experienced expropriations governed by legislation similar to the PLT. However, a unique feature was introduced here. These expropriations were carried out under *Decree 1,001*, an executive order issued by President Jose María Velasco Ibarra. This decree was aimed at addressing food security concerns in the country due to increasing rice imports and declining local production. Specifically, the decree required the beneficiaries of the expropriations in Guayas and Los Ríos to engage in rice production, implicitly imposing a 10-year commitment to this crop.

The expropriation laws, like those of the PLT, tied the beneficiaries to a debt with more flexible terms than market rates. Decree 1,001 leveraged this aspect to ensure that its beneficiaries focused on rice cultivation. It was very specific in directing land use to rice for those who acquired land through expropriation. I interpret this rice cultivation requirement as a restriction on property rights, consistent with Alchian (1965) argument. Alchian suggested that in most societies, property rights are a bundle of rights, and restrictions on them can lead to worse outcomes for society than more flexible scenarios would.

3. Data

The data used come from several sources: National statistics institute of Ecuador for the agricultural censuses and surveys, historical archives for maps and historic data on Agrarian reform in Ecuador. FAO-GAEZ, WorldClim, University of Wisconsin-Madison, the United States National Centers for Environmental Information, and map repositories of the Ministry of Agriculture of Ecuador are the sources for the geographic data.

3.1. Historical data

I use historical data in two different formats: Old maps, archival reports from IERAC⁵, and physical censuses. The first two were obtained from archives preserved by the Jesuit library "Aurelio Espinosa Polit", the latter are stored in the Ecuadorean National Statistical Agency's (INEC in spanish) library. An example of the original aspect of the sources are found in Figures A1 and A2.

3.2. Geographic data

I use geographic and satellite data to account for different exogenous characteristics such as: Temperature, precipitation, elevation, agricultural suitability, and potential yields of relevant crops. I obtain this information from several sources: Temperature and precipitation come from WorldClim; elevation and agricultural suitability come from the Center of Climatic Research from the University of Wisconsin-Madison; data of potential yields of relevant crops come from the United Nations Food and Agricultural Organization Global Agro-Ecological Zones (FAO-GAEZ) data base⁶. Furthermore, I also use night-light satellite data from the United States National Centers for Environmental Information as a proxy of economic development.

In addition to using international datasets on geographic characteristics, I also use national datasets. The Ministry of Agriculture of Ecuador (MAGAP, in Spanish) publishes large datasets on the agricultural characteristics of the country over several years. Specifically, MAGAP publishes georeferenced data on land use and suitability for specific crops. In the case of land use, the public data measure, at a very granular level, whether the land is being used for its intended purpose, in terms of making the best use of its potential.

⁵ The specific reports that I got access to are for the years 1960-1970 and 1971, 1974, 1978

⁶ These are standard sources of geographical data within the economics literature. For details see Galor and Özak (2016); Droller and Fiszbein (2021); Montero (2022)

3.3. Ecuador's 2000 agricultural census

The analysis that compare areas that received well-defined and flexible property rights from PLT to the ones that do not, uses data from the 2000 agricultural census. This is the last agricultural census performed in the country. The census was conducted between October 1999 and September 2000 by the Ecuadorean government. It has a total of 110 questions over a wide range of topics including: Characteristics of the land, type of crops, plantation-harvest surface, production, among others. There were 158,486 interviews, which after official data processed by INEC resulted in 154,106 observations⁷. Each observation includes location at the parish level and a plot identifier. The analysis in this paper exploit variation at the plot stage since it is the most disaggregated level to consistently merge different questionnaires of the census.

In this study, I focus on the coastal region, with a specific emphasis on the provinces of Guayas and Los Ríos, Santo Domingo, Manabí, Pichincha, and Esmeraldas⁸. Furthermore, I restrict my sample to self-identified crop (either permanent (perennial), transitory (annual) or both) producers⁹. The total number of observations in this sample is 9,992, from a total of 22,264 (including farmers devoted to cattle)¹⁰. For the category of permanent (perennial)/transitory (annual) crops, I utilize the following crops, categorized as the most relevant by INEC: (permanent (perennial))¹¹ Bananas, cocoa, plantain, sugarcane, and oil palm; (transitory (annual))¹² Rice, maize, beans, and potatoes. I define non-traditional permanent (perennial) crops as the same ones, excluding bananas and cocoa, which are the principal commodities in terms of exports.

⁷ According to the official methodology manual of the census, approximately 2.3% of the data was dropped due to missing responses.

⁸ Additionally, there is another zone referred to as "non-delimited areas," within which the Manga del Cura zone is identified after organizing and aligning the data with current cartography.

⁹ The precise criterion here is whether the ID of each plot is listed in the crop questionnaire pertaining to either permanent (perennial) or transitory (annual) crops. It's conceivable that plots listed in either questionnaire claim to produce permanent (perennial) or transitory (annual) crops but may not have had any production at that particular time.

¹⁰ Given the low likelihood of encountering true zeros, I assign zero values to instances where, during the analysis of a specific agricultural outcome variable, a plot appears in both the permanent (perennial) and transitory (annual) crop questionnaires but has a missing value. This assumption ensures consistency in the number of observations across various outcome variables. It's a reasonable presumption, as the absence of production data for one crop, coupled with knowledge that the plot yields another crop, justifies assuming zero production for the former. This make my results to be interpreted on the extensive margin. I provide discussion and alternative and robustness exercises in the appendix.

¹¹ permanent or perennial crops refer to plants that take long periods to reach harvest. Once established, these crops form plantations that typically remain on the land for extended periods.

¹² transitory (annual) or annual crops refer to plants that have short growing periods and can often be cultivated and harvested multiple times within a single year.

3.4. Data set construction

The final dataset is a result of merging various data sources in the following manner: I reconstructed the historical IERAC map (Figure A1) and incorporated it as a layer onto current administrative borders in Ecuador. To achieve this, I aligned the 2000 agricultural census data with consistent parish borders, cleaning and hand-coding based on the INEC administrative zones codes¹³. Within the zone under consideration for this study and the spatial RD analysis, I successfully matched 125 parishes within the regions under study.

Regarding historical records from the IERAC archives, specifically data on the amount of land dedicated to PLT, I manually collected information from historical reports. Using the name of each parish, I located it with its corresponding INEC administrative zone code¹⁴.

3.4.1. Definition of agricultural-related outcome variables

Descriptive statistics for the main outcomes of the used sample can be found in Table 1. The main agricultural outcomes in this paper are defined as follows:

Land usage in permanent (perennial)/transitory (annual) crops: Land devoted to permanent (perennial) crops divided by total land used in permanent (perennial) and transitory (annual) crops.

Aggregate yields (permanent (perennial) and transitory (annual) crops): To compute aggregate yields for the primary permanent (perennial) and transitory (annual) crops, I adopt the empirical methodology outlined in Aragón et al. (2022). Essentially, I assign weights to each permanent (perennial)/transitory (annual) crop based on its 2000 prices according to FAO¹⁵, and then divide this by the corresponding land area dedicated to that specific crop¹⁶. I calculate yields for self-acknowledged producers of permanent (perennial) and transitory (annual) crops and zero otherwise. I subsequently apply a logarithmic transformation.

Yield for specific crops (Rice, cocoa, bananas): When using specific crops I divide the production

¹³ This approach ensures consistency in cases where parishes change provinces or cities, enhancing the usability of the data.

¹⁴ Given that the reports date back to the 1960s and 1970s, some parishes were not yet established. In such cases, historical literature was consulted to determine which provinces were entirely dedicated to PLT, and, whenever possible, it was assumed that a parish was created as a result of the PLT program. Examples of this include Santo Domingo, Esmeraldas, and certain parishes in Quevedo, such as San Carlos. This step allowed for an increase in the number of matched parishes.

¹⁵ I use real prices, specifically producer price index for 2000. This index uses the period 2014-2016 as base.

¹⁶ When using the crop level wave of the data in the census, there are more missing values in land compared to production; certain crops may possess production values but lack corresponding land length values. This observation has been recognized by Adamopoulos and Restuccia (2014), possibly attributed to plots utilizing the same land for different crops. To address this, I utilize the median land length value from complete observations at the crop, plot, and parish levels as a proxy for some missing values. Employing this method, I successfully impute 5% of the missing data for that variable.

value of each crop (in metric tons) by land length¹⁷.

Yield non-traditional permanent (perennial) crops: This variable is computed using a similar approach, with the exception of excluding banana and cocoa, which are deemed traditional crops. I interpret it as a measure of diversification beyond the historically traditional crops.

Table 1: Summary statistics main outcome variables

	(1) PLT					(2) no PLT				
	mean	sd	min	max	count	mean	sd	min	max	count
Land usage perm.crops(%)	0.83	0.27	0.00	1.00	3156	0.48	0.45	0.00	1.00	6836
Yield perm.crops (log)	1.65	1.35	0.00	7.11	3156	0.97	1.51	0.00	8.13	6836
Yield trans.crops (log)	4.02	1.61	0.00	6.81	3156	4.75	1.00	0.00	6.82	6836
Yield Rice	1.09	1.42	0.00	8.57	3156	2.72	1.80	0.00	8.57	6836
Yield cocoa	0.09	0.11	0.00	2.07	3156	0.06	0.12	0.00	4.35	6836
Yield Banana	1.02	4.87	0.00	70.25	3156	1.13	6.55	0.00	80.29	6836
Yield non-traditional perm(log)	1.36	1.70	0.00	6.79	3156	0.60	1.54	0.00	8.20	6836
Land share devoted to PLT	0.39	0.42	0.00	1.00	3156	0.00	0.01	0.00	0.07	6836
Land share devoted to expr	0.02	0.03	0.00	0.10	3156	0.04	0.06	0.00	0.64	6836
Observations	3156					6836				

Note: Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. Land share devoted to PLT/expropriation: Amount of land (from IERAC records)/total land of available parish (current administrative borders). See main text for more details.

4. Empirical strategy

4.1. Identification strategy

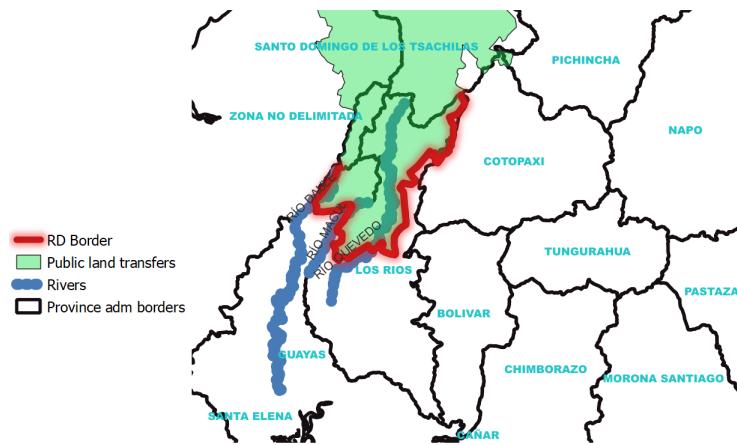
In particular, the provinces of Guayas and Los Ríos were partially affected by PLT in its northern zone, while the rest of their areas were either untouched or irregularly affected by expropriation. Most of the unaffected or less-exposed areas were close to the artificial border highlighted in red in Figure 3. To the best of my knowledge, this border is not associated with past or current administrative borders. The source is a map obtained from the archives of the former Agrarian Reform Institute of Ecuador (IERAC) which I hand digitised using GIS software. As discussed below, there are reasons that follow historical narratives and geographical features to consider this border a good proxy for quasi-random assignment.

Former owners. Along the border -both inside and outside the PLT green area- lay former cocoa haciendas. Some of these haciendas found themselves within the PLT area, a consequence of the cocoa boom fallout in the 1920s. Many owners deserted their plantations, leaving workers

¹⁷ See previous footnote.

with poorly defined lands until the Agrarian reform of the 1960s and 1970s. This abandonment created uncertainty about which legislation applied, whether pertaining to PLT or expropriation. In Los Ríos and Guayas, PLT was somewhat arbitrarily enforced due to unclear land ownership (Carrasco, 1994; Guerrero, 1994). Near the artificial border, both sides accommodated workers, while further north, a land colonization process was underway. Consequently, the region encompassing Quevedo, Mocache, Zapotal, and Balzar -the parishes at the border- experienced the impact of both legislations in areas of similarly characteristic.

Figure 3: IERAC historic map: Artificial border PLT intervention area



Note: This map shows a geo digitized version of Figure A1. Green areas denote the intervened zones by the PLT. The red line is an artificial border created by the historical map. Blue lines represent rivers: Daule, Macul, and Quevedo. Black lines are provincial administrative borders.

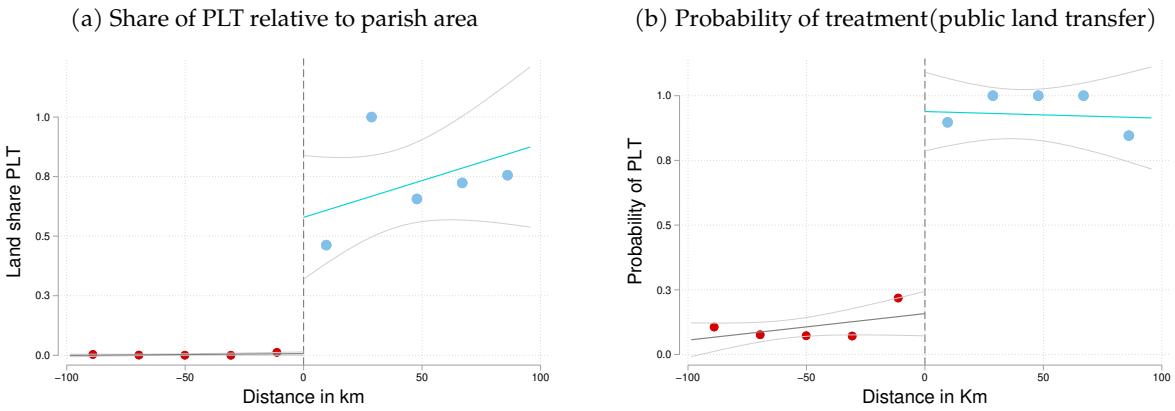
Exogeneous shock experienced by cocoa haciendas that coincides with the artificial border. Historians of the cocoa boom have evidence that suggests that the cocoa boom ended due to exogenous reasons such as changes in international cocoa prices and a cocoa plague known as "witches' broom" (Chiriboga, 1980; Guerrero, 1994). The most important parish in that zone, Quevedo, besides being mostly abandoned after the witches' broom, had its land settlement scheme during the Agrarian reform highly supervised by international organizations and the US (Díaz-Valderrama, 2019; Cuví, 2015). In fact, the U.S. Department of Agriculture in 1947 wrote a report discussing the case of Pichilingue, a former hacienda in Quevedo during the cocoa boom, which was abandoned because of the witches' broom, in the area where IERAC intervened years later. They confirm that the hacienda was abandoned due to unforeseen reasons, basically the plague in the cocoa plantations¹⁸ (Leonard, 1947).

Figure 4 plots the discontinuity in the application of the PLT program using data from archival

¹⁸ Figure A4 shows the original map from (Leonard, 1947).

registries from IERAC. The archival data is at the parish/district level¹⁹. The independent variable is the distance to the artificial border from the centroid of every parish, and negative (positive) values indicate parishes in the constrained (flexible) property rights area. I show in the appendix different sets of manipulations tests at the parish and land plot level (Figure A5 and Table A2)²⁰. Additionally I show that using the number of workers as a proxy for rural population that there is no apparent sorting at the threshold (Figure A6). Finally, Figure A8 compiles data from IPUMS and reveals that nearly 90% of individuals born in the specified regions relevant to this study (utilizing a sample from 1962-2010) in the crop constrained property rights areas continue to reside in those places.

Figure 4: Fuzzy discontinuity in public land transfers and probability of treatment



Note: This Figure plots the share of land of a parish devoted to PLT (a) and the probability of being treated from PLT (b). Data from PLT are from historical archives. The running variable is distance in km from a centroid of a parish to the artificial border. Data on PLT transfers is at the parish level and comes from IERAC archives reports from the Library "Aurelio Espinosa Polit".

I enhance this observation by georeferencing the polygons from map A1. The fact that the threshold does not align precisely with administrative borders allows me to calculate the proportion of land impacted by PLT at the parish level. This approach accounts for variations along the border. Figure A14 in the appendix illustrates the discrete jump and the probability, which is not exactly one at the border²¹.

¹⁹ I merge the data from the IERAC archives with current administrative borders, as some parishes, particularly in the PLT area, were established after the agrarian reform. The most notable cases are the parishes in the Santo Domingo province. Since these parishes were created as a result of 'colonization' (PLT), I assume that the new parishes were fully impacted by PLT interventions. This does not affect the impact experimented by parishes at the border since these already existed at the time of the agrarian reform. I follow the same reasoning and follow historical narrative (Barsky, 1984; Larrea, 1987; Canelos, 1980; Redclift, 1976) for parishes in Esmeraldas, Manabí, and Pichincha; together with map A1, to guide my reasoning.

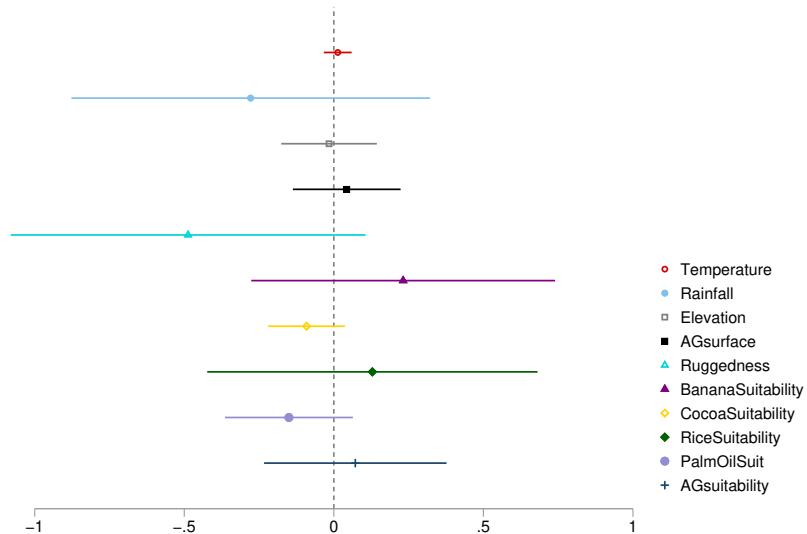
²⁰ Further, and since I can not apply a manipulation test at the plot/individual level, I apply a donut approach (removing the two closest parishes from the threshold) as robustness of my results.

²¹ For robustness, I include this variable in the fuzzy RD analysis as a replacement of the share of land devoted to PLT.

4.2. Balance, before-after agrarian reform, and additional considerations

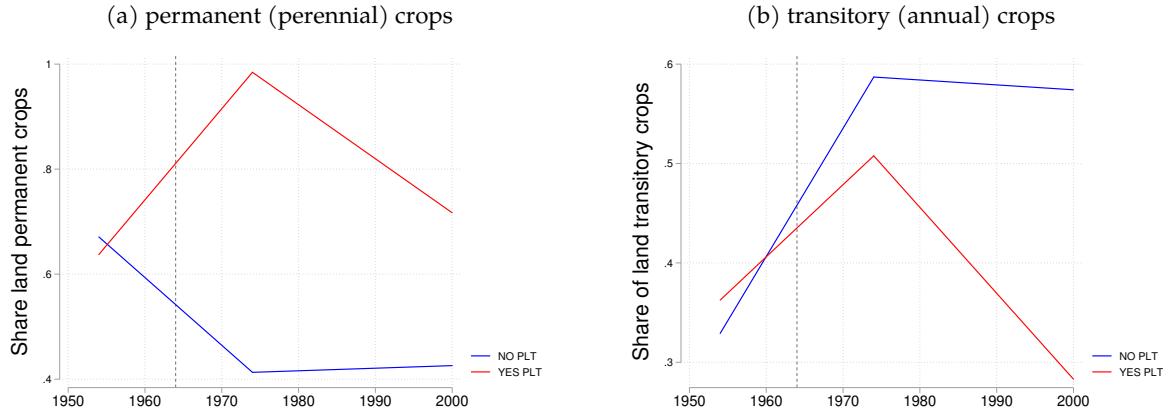
To rule out the possibility of other confounders on the determination of the artificial border, Figure 5 shows different estimates from a regression discontinuity model on different characteristics. From this it is clear that balance holds for the available battery of observable variables. Furthermore, I also collected data from the first two agricultural censuses in the history of Ecuador (These censuses were done in 1954 and 1974). An important shortcoming is that the 1954 census is only available at the municipality level. Because of this, I compare Quevedo (the only available region affected by PLT available in the 1954 census) with Ventanas, Publoviejo, Vincos, and Balzar; which are the closest available municipalities in the 1954 census. Figure 6 shows descriptive evidence that the divergence between the share of permanent (perennial)/transitory (annual) crops started after the Agrarian reform implementation.

Figure 5: Balance on exogenous characteristics



Note: Each dot in this Figure indicates a RD estimate using a linear polynomial and the optimal bandwidths of Calonico et al. (2017) for each of the outcomes presented in the legend. All variables are standardised between 0 to 1.

Figure 6: Before-After comparison: permanent (perennial) and transitory (annual) crops 1954-2000



Note: This Figure plots the trajectory in time of the share of permanent (perennial) and transitory (annual) crops. The graph is done at the municipal for the number of municipalities available in the agricultural census of 1954. The red line refers to zones beneficiaries of the PLT, while the blue line refers to the areas in the comparison group (affected by expropriations). Available municipalities: Quevedo (only observation available affected by PLT in the 1954 census), Ventanas, Publoviejo, Vinces, and Balzar

It has been stated that the PLT ultimately resulted in larger land parcels for its beneficiaries (Barsky, 1984; CIDA, 1975; Carrasco, 1994). In the specific context I am focusing on, there is no statistical significance in terms of larger plots within the artificial border by 2000. A hypothesis that arises here is that the land market was more active in the zones that benefited from PLT, thus leading to a partition of plots that resulted in similar land sizes by 2000. In fact, the "multi-partition" of plots is a phenomenon described in the sociological literature that studies the Ecuadorean Agrarian reform (Jacome et al., 2008). Hence, the ultimate difference and meaningful comparison in this context is the property rights regime.

Bananas and segment fixed effects. The banana boom experienced during the time after the cocoa boom and before the agrarian reform was notable in the region since bananas became the primary export commodity for the country (Larrea, 1987). I use data from the 1954 census to compare the number of banana cultivation areas and production levels (Figure A11)²². I do not find significant differences in these dimensions for bananas. I don't find evidence on differences at the border for banana suitability, but the increase in bananas exports might reflect some unobserved underlying characteristic. To take into consideration the role of the banana boom in my research design, I explicitly control for potential yields for bananas as a proxy for plausible banana plantations using the FAO-GAEZ agro-climatic database. Additionally, as is common in spatial RD settings, I also condition my results on border segment fixed effects. Figure 3 shows

²² For this I use the same sample of observations as in Figure 6.

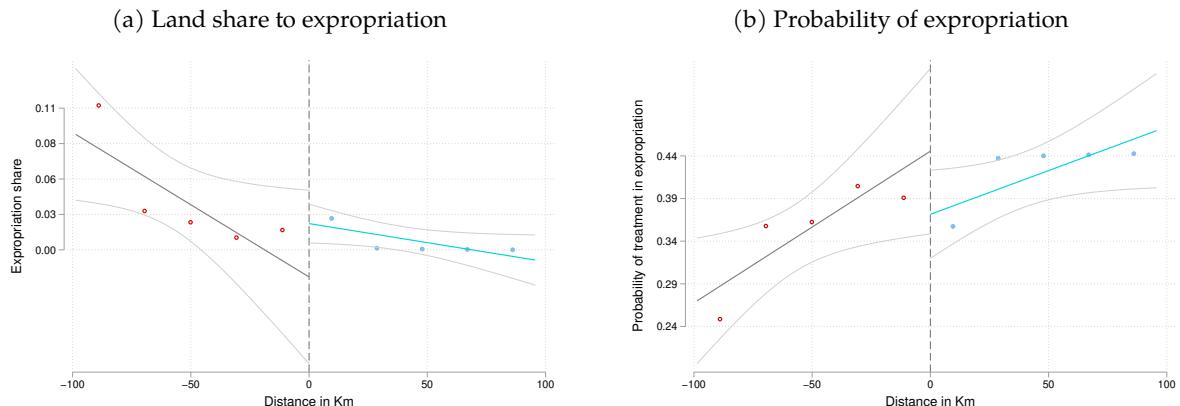
that three of the most important rivers in the coastal region of Ecuador intersect the artificial border: Daule, Macul, and Quevedo. These rivers roughly align with some segments of the artificial border from north to south. To account for characteristics of segments going from west to east, I include a segment-specific fixed effect based on the location of the rivers. Thus, conditional on these fixed effects, the variation in the border should be as good as random.

4.3. Expropriation

After the public land settlement project took place, intense expropriation efforts occurred on ‘the other side’ of the IERAC’s artificial border (my comparison group). [Baquero-mendez \(2023\)](#) collected data on expropriation episodes during the 1960s and for the years 1971, 1974, and 1978 ²³. In Figure 7, it can be seen the relevant information in the context of the RD design, specifically the likelihood of being affected by it. As demonstrated, there is no significant jump in the probability of treatment. Therefore, around the cutoff, this expropriation treatment is independent of the treatment of interest in this paper, which is the PLT.

Figure 7a illustrates the amount of land expropriated relative to the size of the parish. It’s evident that on the PLT side, less than 3% of the land was affected by expropriation. On the other side, the highest share of expropriated area reaches 11% due to expropriation leading to land fragmentation and the creation of ‘minifundias’, which are small parcels of land for peasants²⁴.

Figure 7: Share and probability of expropriation



Note: This Figure plots the probability of being treated from expropriation and share of parish land affected by expropriation.

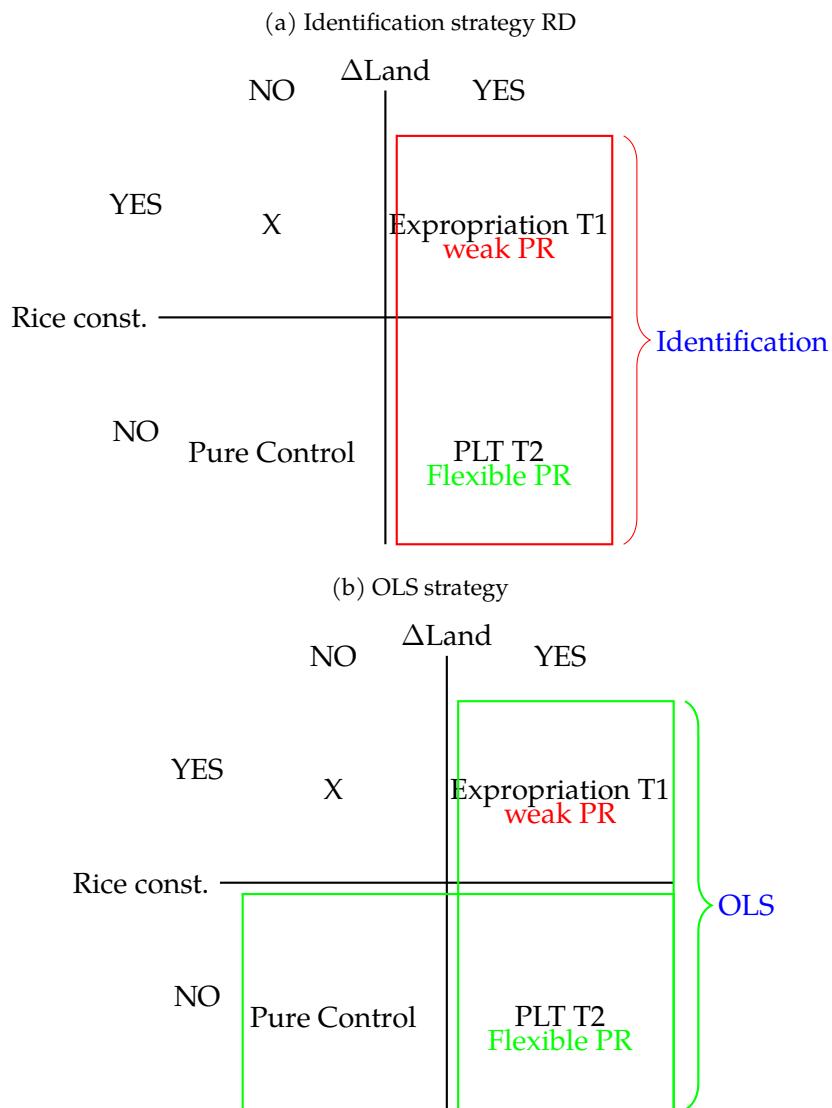
²³The reports used are the “mirrors” of the reports I used to construct the PLT data set, but from the expropriation side of the agrarian reform.

²⁴In the case of PLT-affected areas, the average share of intervened land on the treatment side was 80% (refer to Figure 4).

4.4. Final comparison and method

In experimental terms, what I can compare using my identification strategy and spatial RD design is akin to having two treatment arms. Furthermore, given that the province of Manabí is a region untouched by land reform interventions, I can utilize it as a counterfactual in a controlled OLS analysis, as there is no variation along any border. Despite this limitation, this exercise will aid me in further interpreting my results. A summary of this strategy is depicted in Figure 8.

Figure 8: Comparison explained



Note: This figure depicts the comparisons made in this paper. Panel a) illustrates my identification strategy for the spatial RD design. In this specification, I compare two ‘treatment arms.’ To enhance the characterization of my interpretations, I compare PLT and expropriation (the two treatments) with a region unaffected by land reform (counterfactual), as shown in panel b). I employ controlled OLS regression in this case, using the same controls as those used in the balance test.

4.5. Model specification

The estimation framework follows [Albertus \(2020\)](#), and [Méndez and Van Patten \(2022\)](#),

$$y_{i,p,b} = \alpha + \tau C_p + X_p + f(lat, lon)_p + \delta_p + \phi_b + \gamma + \lambda + \epsilon_{i,p,b} \quad (1)$$

where y is the outcome variable in terrain i in parish p along segment b of the artificial boundary. X represents the running variable which in this case is the distance from the centroid of parish p to the artificial border. $f(lat, lon)$ is a polynomial in latitude and longitude. δ_p Represents any control variables, which for my main specification will only include agro-climatic potential yields for bananas as discussed above²⁵. ϕ_b indicates the inclusion of border segments fixed effects; these segments fixed effects are determined by the rivers Daule, Macul, and Quevedo. In my main specification I add provincial fixed effects γ ²⁶ and self-reported tenure status (from the 2000 agricultural census) fixed effects λ ²⁷. ϵ is the error term. Based on the work by [Gelman and Imbens \(2019\)](#) I use as a prefer specification a linear polynomial and, as a robustness, a second degree polynomial in latitude and longitude. Moreover, my main specification estimates the model at the terrain level and cluster standard errors at the parish level. In my robustness tests I include versions using a donut design, conley standard errors, Huber-white standard errors (as noted by [Kolesár and Rothe \(2018\)](#))²⁸.

My preferred estimation method uses local linear regressions and optimal bandwidth selection. This approach is based on the work of [Calonico et al. \(2017\)](#); [Cattaneo et al. \(2019a\)](#) and has the advantage of using non-parametric techniques to calculate weights around the cutoff.²⁹ Moreover, I use the robust bias-corrected estimator which has been shown to have important coverage error and work well in clustering situations within RD ([Calonico et al., 2014](#); [He and Bartalotti, 2020](#); [Calonico et al., 2021](#)).

²⁵ For robustness tests I also include more controls to test the sensitivity of my results.

²⁶ These type of fixed effects are suggested in [Kelly \(2020\)](#)

²⁷ The 2000 census data indicates that approximately 70% of producers reported having some form of land tenure. This variable encompasses seven categories, namely leasing, cooperative arrangements, mixed ownership (defined as sharing property with a government institution), no title, or other forms of tenancy. It is challenging to interpret these responses, as they are based on self-declarations, and individuals may not necessarily possess any formal documentation (for a related discussion, see [Abad and Maurer \(2022\)](#)). To enhance robustness, I include these controls in my analysis. However, when estimating regressions at the parish level, I do not account for this variable, as the data when collapsed at the parish level already considers its information.

²⁸ Moreover, [Kolesár and Rothe \(2018\)](#) argue that is not prudent in regression discontinuity settings to cluster standard errors when clusters define the running variable. Due to this reason, I also present my results using using conventional heteroskedasticity robust standard errors (HC3) ([Cunningham, 2021](#)) in the appendix.

²⁹ Furthermore, as a robustness and following work by [Barreca et al. \(2011\)](#) I use a "donut" approach in my RD setting by dropping parishes whose centroid is located less than 1km away from the artificial border. This approach is also useful to discard any sorting that may biased the results

Given that the variable I employ in my fuzzy design operates at the parish level, potential inference issues may arise. To address this concern, I provide both my fuzzy RD results and reduced form estimations. While fuzzy RD yields larger estimates, I complement them with the reduced form results to ensure a parsimonious and transparent interpretation of my findings. Furthermore, I place greater reliance on the reduced form model and its results to adopt a conservative stance, interpreting them in relation to a lower bound effect.

4.6. Fuzzy design: First stage

As discussed in the identification section, my strategy relies on a fuzzy regression discontinuity design. [Albertus \(2020\)](#) apply a similar strategy which is described as follows: Define τ as,

$$\tau_{FRD} = \frac{\lim_{\downarrow 0} \mathbb{E}(y_i|X_p = x) - \lim_{\uparrow 0} \mathbb{E}(y_i|X_p = x)}{\lim_{\downarrow 0} \mathbb{E}(C_p|X_p = x) - \lim_{\uparrow 0} \mathbb{E}(C_p|X_p = x)} \quad (2)$$

in simple terms, the parameter τ quantifies the relationship between two distinct factors that impact the outcome of a study. The numerator is the effect of treatment assignment on the outcome (i.e. intention-to-treat). The denominator is the impact of actually receiving that treatment, known as the "take-up effect." In other words, the running variable X becomes an instrument of the actual treatment received C . In this case, C is the share of each parish p affected by the PLT. As discussed in the identification section, Figure 4 shows that there were some affected areas by PLT below the cutoff and some not entirely affected above the cutoff, deviating from IERAC's expectations. This variation creates the opportunity of estimating this model using a fuzzy regression discontinuity design.

5. Results

My results are divided in seven different outcomes: The share of land devoted to permanent (perennial) crops (labeled as "share"); the (log of) revenue per hectare of all permanent (perennial)s (and transitory (annual)) crops (labeled as "permanent (perennial)" and "transitory (annual)"); the yields (production per hectare) of rice, cocoa, and bananas; and the (log of) revenue per hectare of all permanent (perennial) crops, except for cocoa and bananas as a

measure of diversification (labeled as "Non-traditional")³⁰. My sample is restricted to producers of permanent (perennial) and transitory (annual) crops. In this sections I start with the simplest model, ordinary least squares (OLS), and drag certain conclusions from it. Then, I pass to the spatial RD model, using several specifications in order to discuss the plausible causal effect of the PLT on agricultural outcomes relative to the comparisson group that I am using in this paper.

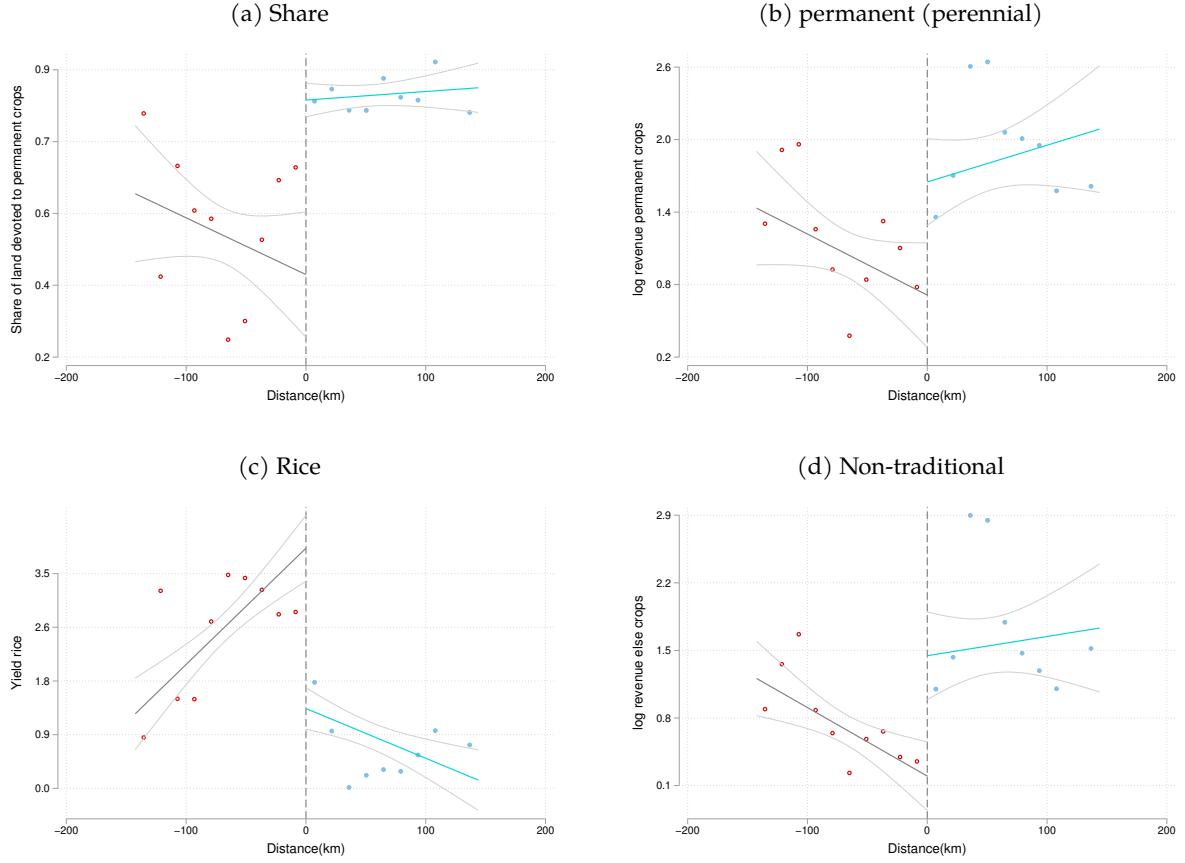
5.1. Raw discontinuities

The main outcomes are shown in Figure 9. Each figure plots a bin scatter and shows the discontinuity relative to the distance of each parish to the artificial border created by IERAC.³¹ The sample is constrained to plots that have permanent (perennial) and transitory (annual) crops. Panel a) shows the share of land devoted to permanent (perennial) crops relative to transitory (annual), Panel b) shows the (log of) yields for permanent (perennial) crops (The most important permanent (perennial) crops are: Bananas, cocoa, plantain, sugar cane, and oil palm. I use international prices (base 2013) from the Food and Agriculture Organization (FAO) as weights), Panel c) shows the yield for rice, and Panel d) shows the (log of) yields for all permanent (perennial) crops except the traditional ones: bananas and cocoa.

³⁰ For permanent (perennial) crops, the agricultural census includes age information, but it has numerous missing values. To address this, I excluded crops older than the initial PLT attempts in the region. Additionally, in some cases, while production is documented for permanent (perennial) crops, the dedicated land amount is unspecified. In these instances, I used the median value of the land devoted to a specific crop in each parish ,for plots with complete information, to estimate land use and calculate yields.

³¹ Figure A7 in the appendix shows that the discontinuity holds for all permanent (perennial) and transitory (annual) crops without weighting and logs (only raw yields).

Figure 9: Discontinuities figures



Note:

5.2. OLS

Table 2 show a simple OLS model in which the independent variable is an indicator on whether an agricultural plot is either on the PLT area or not. This estimates can be interpreted as unconditional means. The seven columns provide the expected signs and magnitudes. Columns 1,2, 5, and 7 present positive coefficients, hence arguing in favor that areas in the PLT zones have on average better performance and more land share devoted for permanent (perennial) crops. In column 6 the permanent (perennial) crop banana present a negative non-significant result showing that this elite-aligned crop was present in the crop constrained property rights area before the agrarian reform was implemented³².

On the other hand, columns 3 and 4 find that, on average, intervened zones have less productivity on transitory (annual) crops, especially, rice. This first set of results present coherence with the historical narrative. Rice is prevalent in the areas with crop constrained property rights

³² Table 2 uses the restricted sample specified above (restricted to permanent (perennial) and transitory (annual) crop producers to have the same number of observations per outcome). In Table A20 (appendix) I show the unrestricted OLS results using the full sample.

following the government incentives and partial control that it executed in the region.

Table 2: Uncontrolled OLS estimates

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Non-traditional
PLT	0.342 (0.041)***	0.680 (0.154)***	-0.727 (0.216)***	-1.630 (0.198)***	0.029 (0.009)***	-0.117 (0.228)	0.764 (0.185)***
Observations	9992	9992	9992	9992	9992	9992	9992
Parishes	125	125	125	125	125	125	125
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	57.71	57.59	-16.10	-73.90	39.89	-10.62	91.33

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. Land share devoted to PLT/expropriation: Amount of land (from IERAC records)/total land of available parish (current administrative borders). See main text for more details.

5.3. Regression discontinuity estimates - The effect of public land distributions on agricultural outcomes-

To obtain a causal estimate, I employ my identification strategy to approach the true effect of property rights regimes on agricultural outcomes, as presented in the OLS model. I report results for fuzzy and the reduced form version. I interpret the coefficients from the fuzzy spatial RD with caution since its variation is at the parish level rather than at the plot level. The reduced form version present more conservative estimates, as is common when using instrumental variables.

In the fuzzy case, the dichotomous variable functions as an instrument for the share of land devoted to PLT relative to the total land of the parish. In presenting results for the fuzzy spatial RD, I include bandwidths calculated using the Calonico et al. (2017) algorithm. For the reduced form case, I use the same bandwidths (35km), which closely align with those suggested by optimal bandwidth calculations. Main results are in Tables 3 and 4 for the fuzzy RD and the reduced form results³³, respectively.

As is common in the empirical literature that employs IV estimation, these estimates tend to be higher. I choose to present both the reduced form and fuzzy versions of the model to anchor my conclusions within a range. Furthermore, the limitations arising from parish-level information (for measuring distance to the border and land shares devoted to PLT) prompt discussion on the statistical uncertainty of the results, specifically, by discussing its implications in terms of ranges.

³³ As a robustness exercise I geo code the historical map in Figure A1 to calculate interventions shares by using the polygons of the map instead of the data from IERAC's reports. Results are available in the appendix in Table A21.

Because of this the bias-robust estimate is relevant since it can provide credible results even in small number of clusters situations(He and Bartalotti, 2020; Cattaneo et al., 2019b). Taking this into consideration, the effects identified are meaningful (both statistically and in magnitude) and relevant.

Table 3: Geographic fuzzy RD estimates

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
PLT	0.319 (0.121)**	0.536 (0.199)**	0.552 (0.192)***	0.774 (0.215)***	0.552 (0.192)***	0.319 (0.120)**	0.552 (0.192)***
Panel B: Fuzzy RD estimates							
Robust	0.291 (0.065)***	0.634 (0.370)*	0.313 (0.246)	-1.770 (0.689)**	0.036 (0.021)*	-1.341 (0.585)**	0.905 (0.515)*
Observations	3151	3478	3290	2954	3290	3186	3290
BandwidthL	28	29	32	24	34	31	32
BandwidthR	23	34	25	27	24	22	25
Parishes	18	23	20	18	20	19	20
Mean	0.703	1.142	4.880	2.020	0.079	1.364	0.706
Variation w.r.t mean	41.4	55.5	6.4	-87.6	45.0	-98.3	128.1

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: PLT is an indicator variable that takes the value 1 when a specific parish is in the public land transfer zone according to IERAC's historical map. Robust refers to the robust bias-corrected RD estimate from Calonico et al. (2017). Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. See main text for more details.

I find a positive relationship between the PLT intervention and the share of land devoted to permanent (perennial) crops (column 1), this effect is 13% relative to the comparison group; this effect is larger, 41.4%, when applying the fuzzy RD estimates. When analyzing yields, I find that the areas affected by PLT are between 21-55% higher than the comparison group (column 2). There is no statistical significance when analyzing temporary crops (column 3). When disentangling the yield of specific crops, rice has a strong negative relationship with PLT (column 4) of 28-88%. There is no significant result when analyzing cocoa (column 5). For bananas, I find a strong negative relationship with PLT (column 6) of 98-117%, so the effect I find for perennial crops does not come from either cocoa or bananas. Furthermore, the strong and robust coefficient for bananas suggests that those areas that were not affected by expropriations are persistently devoted to only one particular permanent (perennial) crop. Column 7 calculates the same model, but using the main permanent (perennial) crops (oil palm, plantain, and sugar), according to

Table 4: Reduced form geographic RD estimates

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non-traditional
Sharp RD case							
Robust	0.095 (0.030)***	0.239 (0.120)**	0.059 (0.151)	-0.598 (0.147)***	-0.002 (0.015)	-1.572 (0.319)***	0.590 (0.166)***
Observations	3513	3513	3513	3513	3513	3513	3513
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	13.2	20.9	1.2	-28.2	-2.9	-117.4	77.8

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Robust refers to the robust bias-corrected RD estimate from Calonico et al. (2017). Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. See main text for more details.

INEC, without the traditional crops of cocoa and bananas. The positive effects of the yields of permanent (perennial) crops come from diversification rather than specialization in traditional crops, this effect is between 79 and 128%.

5.3.1. Extensive and intensive margins

As discussed above, my main results are computed using a homogeneous sample of observations consisting only of self-reported crop farmers. Farmers engaged in other activities, such as livestock, are excluded from this sample. Furthermore, I assume that within this sample of crop farmers, it is reasonable to consider zero production for crops with missing values, but a positive value for other crops. However, interpreting the results, especially for extensive margins, can be problematic. Therefore, I present results using observations outside the sample of crop producers where it is safe to assume zero crop production³⁴. In addition, when considering the intensive margin, I focus on the sample where there are only positive values, i.e. not only crop producers, but also crop producers who actually produce a particular crop in question.

The results presented in Tables 5 and 6 offer additional confidence in the findings outlined in the previous section, even when considering a larger sample that includes observations beyond crop growers. Furthermore, distinguishing between the intensive and extensive margins can provide deeper insights into the results. I present the results using the optimal bandwidths procedure for each outcome variable. The version using the fuzzy design can be found in the appendix (Tables A18 and A19).

³⁴ Summary statistics for this sample are available in Table A3

While a detailed revision of the results is provided in the next subsection, the key takeaway is the impact of non-traditional permanent (perennial) crops on both the intensive and extensive margins. It is noteworthy that the effect on rice yields stems from the intensive rather than the extensive margin. This suggests that the result may not be attributed to farmers switching to rice but rather to increased productivity among existing rice producers. Additionally, the positive effect on permanent (perennial) crops appears to be more pronounced on the extensive margin, implying that farmers opt for these types of crops. As discussed earlier, bananas may influence these effects, but accounting for them reveals that non-traditional permanent (perennial) crops demonstrate greater yield productivity on the side affected by PLT.

Table 5: Extensive margins

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non traditional
Sharp RD case							
Robust	0.215 (0.076)***	0.309 (0.068)***	0.568 (0.408)	0.045 (0.261)	0.001 (0.019)	-1.742 (0.794)**	0.552 (0.048)***
Observations	4578	5319	5952	5569	4620	2766	4707
BandwidthL	25	29	35	38	33	36	28
BandwidthR	29	28	28	29	29	31	40
Parishes	19	22	23	25	23	23	21
Mean	0.897	1.593	5.007	2.942	0.132	22.346	1.598
Variation w.r.t mean	24.0	19.4	11.3	1.5	0.5	-7.8	34.5

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Robust refers to the robust bias-corrected RD estimate from Calonico et al. (2017). Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. See main text for more details.

5.3.2. Interpretation and discussion of each result

Land share devoted to permanent (perennial) crops. Column 1 (of all result Tables) depicts the influence of residing in the PLT area on the proportion of land allocated to permanent (perennial) crops. Regions that experience higher exposure to PLT, while remaining within the optimal bandwidth, allocate around 8-30% increase in their land for the cultivation of permanent (perennial) crops depending on the specification. For the extensive and intensive margins exercise this is 24% and 15% respectively.

Aggregate productivity on permanent (perennial) and transitory (annual) crops. Columns 2 and 3 show the results of PLT exposure on revenue per hectare for permanent (perennial) and temporary crops. In the case of the former, the effect is substantial and noteworthy. Residence in

Table 6: Intensive margins

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non traditional
Sharp RD case							
Robust	0.129 (0.028)***	0.093 (0.137)	0.199 (0.055)***	-0.444 (0.105)***	-0.001 (0.015)	-10.886 (5.828)*	0.512 (0.265)*
Observations	2211	2151	2712	2210	1743	219	1139
BandwidthL	25	30	22	20	32	36	38
BandwidthR	23	26	25	31	23	36	41
Parishes	15	20	16	19	19	25	27
Mean	0.892	1.571	5.034	2.775	0.128	19.749	1.557
Variation w.r.t mean	14.5	5.9	3.9	-16.0	-1.2	-55.1	32.9

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Robust refers to the robust bias-corrected RD estimate from Calonico et al. (2017). Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. See main text for more details.

an area with higher PLT exposure induces producers to increase their productivity in permanent (perennial) crops, which is associated with a greater tolerance for delayed harvests. For temporary crops, the impact is almost negligible. This could be due to the profitability of certain crops, which prevents producers from abandoning them completely. For the extensive and intensive margins exercise, permanent (perennial) crop yields are significant for PLT intervention at the extensive margin (19%). This could mean that farmers in the PLT area choose to engage in these types of crops due to the flexibility that accompanies the intervention. I find a positive result in the intensive margin of transitory (annual) crops, but its overall effect is negligible (4%).

Specific crops: Rice, cocoa, and bananas. Columns 4-6 revise the yield patterns for specific permanent (perennial) and temporary crops. The case of rice is particularly relevant as it is the most important transitory (annual) crop with historical significance in the region analyzed. According to the empirical model, productivity tends to be lower in PLT areas due to the presence of weaker property rights. This scenario pushes these regions into a spiral of rice dependency, resulting in a path-dependent situation centered on rice cultivation. For cocoa, the results lack robustness, while for bananas the results are consistently negative and significant. In this context, bananas play the role of an elite crop, thus interacting with farmers with crop-restricted property rights. For the extensive and intensive margins exercise, bananas seem to be relevant in both cases in the comparison region affected by expropriations. The intensive margin analysis, reveals that the number of effective banana producers is low and concentrated (just 219 observations). The fact that the banana effect is large and robust in every case analyzed leads to the conclusion that

areas unaffected by the rice constraint develop an overspecialization in a particular crop without further risk diversification.

permanent (perennial) crops except cocoa and bananas (Non-traditional). To assess where the permanent (perennial) crop productivity gains come from, since bananas are concentrated in the comparison area, I estimate the model using the same outcome variable as in column 2, but removing cocoa and bananas (traditional permanent (perennial) crops). The results indicate that there is a precise and significant effect of exposure to PLT and revenue per hectare for permanent (perennial) crops, excluding cocoa and bananas. This effect is between 79-128%. *This result suggests that the progress in permanent (perennial) crops is not only the result of intensification within the traditional permanent (perennial) crops category, but rather stems from diversification within this category..* Moreover, in the appendix (figure A13 and table A15), I delve deeper into the investigation by examining whether this effect is influenced by another important crop, namely oil palm. However, I find no evidence that the presence of another important crop forces farmers to specialize too much in that particular crop. The number of different products also confirms the existence of a discontinuity in crop diversification. For the extensive and intensive margins, it is also clear that this effect is large and positive, I find that the effect is 35% and 33% respectively.

5.4. Robustness

The following robustness tests are found in the appendix: Donut RD-removing the closest parishes from each side of the border-(Table A4), Conley standard errors using different windows³⁵ (Tables A5,A6,A7,A8,A9,A10), second degree polynomial in latitude and longitude (Table A11), and placebo exercises moving the border, i.e., the PLT "treatment" by 5 and 20 km³⁶ (Tables A23 and A24).

5.5. Comparing with a region where the agrarian reform did not fully intervene

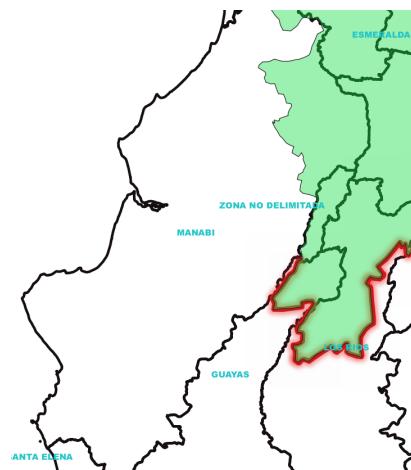
So far, I have investigated the long-term effects of PLT in comparison to a group that received crop constrained property rights in terms of limiting what can be grown as a crop and maintained the pre-existing relationship between landed elites and workers. To further explore the impact of different property rights schemes on long-term agricultural outcomes, a neighboring region,

³⁵For the spatial RD regression using Conley standard errors, I implement the procedure outlined in Colella et al. (2020). This process occurs independently of the algorithm presented by Calonico et al. (2017), resulting in slightly varied estimates while preserving their directional consistency and relative magnitude.

³⁶I perform this exercises for the reduced and fuzzy version of the IV. I use the bandwidth of 35 km for all cases.

Manabí, which remained largely unaffected by the agrarian reform³⁷. Figure 10 shifts the primary map to the west and illustrates the region of Manabí.

Figure 10: Counterfactual region



Note: This map extended the one in Figure 3 to show the Manabí province.

Since parish centroids are not situated near any border, it is not possible to observe variations close to each other or to a border. As an alternative, I conducted multiple regressions, incorporating controls from the balance section, i.e., I run regressions with the controls from the geographic RD plus the variables shown in the balance section. The independent variable is categorical indicating whether an area is situated in a PLT, expropriation, or "pure" control region. The results are presented in Table 7.

From the findings, it is evident that this counterfactual region performs less favourably than the PLT region in terms of yields for both permanent (perennial) and transitory (annual) crops, including the diversification measure (non-traditional). Moreover, rice remains much more prevalent in the area with crop constrained property rights compared to the counterfactual region. The coefficient on land share devoted to permanent (perennial) crops exhibits a negative sign, which is more pronounced when compared to the crop constrained property rights area³⁸.

An intriguing aspect of this analysis lies in the significant importance of cocoa in the Manabí region, as evidenced in column 5. However, the measure of diversification, excluding traditional crops such as cocoa and bananas, is higher in the PLT region. It is also worth noting that the diversification measure is higher in areas with weaker property rights. One plausible interpretation, drawn from both this observation and the main analysis, is that the absence of agrarian

³⁷ I use the term "virtually" as there were minimal interventions, but the majority of the province remained untouched by the agrarian reform (Barsky, 1984).

³⁸ An additional exercise is presented in the appendix AA33, where I geocode the expropriation data and present OLS results comparing areas affected by expropriation and others that were not. In this exercise, I show that the rice and informal credit market effect is due to expropriation.

reform might encourage monocropping, focusing solely on a single permanent (perennial) crop. The formalization of flexible property rights through PLT appears to have stimulated a more complex diversification process. Nevertheless, it is evident that specialization in rice cultivation is a distinctive characteristic of areas with weaker property rights.

Table 7: OLS regressions. Comparing to Manabí region

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Non-traditional
PLT	-0.130 (0.066)**	0.582 (0.212)***	0.457 (0.228)**	-0.069 (0.286)	-0.051 (0.023)**	-0.642 (0.479)	1.301 (0.414)***
Expropriation	-0.400 (0.085)***	0.259 (0.238)	0.739 (0.243)***	1.115 (0.373)***	-0.085 (0.023)***	-0.160 (0.556)	0.849 (0.427)**
Observations	14250	14250	14250	14250	14250	14250	14250
Parishes	194	194	194	194	194	194	194
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	0.63	1.16	4.34	1.72	0.07	0.92	0.81

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the results of an OLS regression with various controls. The independent variable is categorical and classified as follows: 0=no agrarian reform, 1=Area affected by PLT, 2=Area affected by expropriation (crop constrained property rights) legislation. Estimates displayed are relative to the area that did not receive agrarian reform (Manabí). Column (1) refers to land usage. Columns (2)-(7) are measures of productivity (yields) for each aggregate category/crop. Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. See main text for more details.

6. Discussion of mechanism and implications

Property rights can affect crop choice in several ways. A common argument is that they reduce uncertainty and thus improve investment preferences. Flexible property rights may also be associated with better land use, in the sense of optimizing land to its best potential use. In this section, I provide suggestive evidence on some of these dynamics.

6.1. Informal credit markets

The research by [De Soto \(2000\)](#) suggests that secure property rights provide people with access to credit markets, establishing a direct correlation between improved property rights and credit accessibility. However, despite being theoretically appealing, this hypothesis has not necessarily found much empirical support.

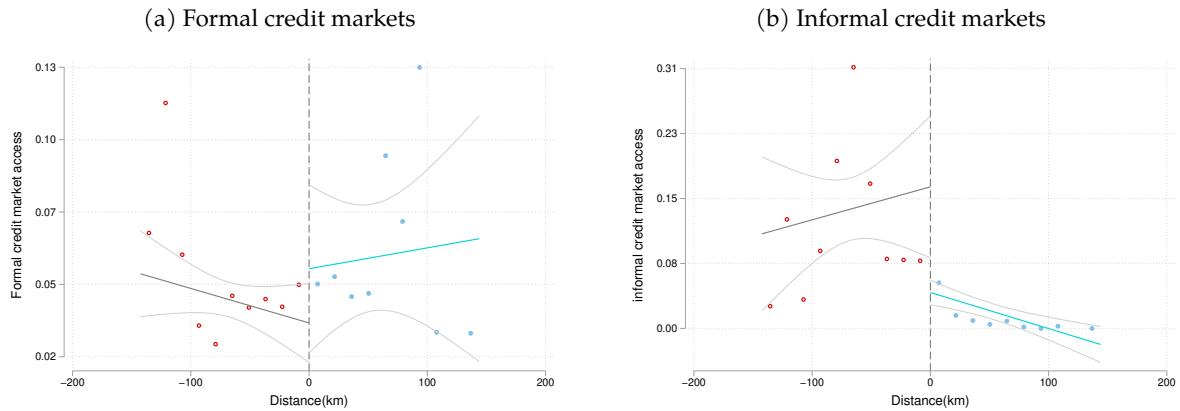
An essential consideration in this paper is the stability of crop constrained property rights as an equilibrium when comparing areas with weak and full property rights. The empirical strategy

section discusses various tests that do not support sorting. However, the question arises: why do individuals in areas with crop constrained property rights do not relocate? Fergusson (2013) proposes a political economy argument wherein elites enforce crop constrained property rights, and peasants, fearing the loss of their plots, choose to stay and accept lower wages. In this section, I present another mechanism that may contribute to the stability of crop constrained property rights as an equilibrium.

While the De Soto hypothesis is debated with a focus on formal credit access, rural areas in developing countries may also have access to informal credit markets. Examples include loans provided by individuals at non-market interest rates. This form of informal credit might also bind workers, who, to alleviate liquidity constraints, may seek loans from individuals, thereby becoming tied to the land through the repayment of relatively high debts.

Figure 11 illustrates the share of plots in the 2000 census with access to formal (a) and informal credit (b)³⁹. Alongside Table 8 uses the estimation sample to calculate in the RD framework if there is any difference in access to credit⁴⁰. It becomes evident that being in the PLT area significantly reduces the likelihood of access to informal credit. Relative to its mean, PLT decreases access to informal credit by approximately 22% compared to the comparison group.⁴¹.

Figure 11: Credit markets



³⁹The specific questionnaire asks: "Where does your credit come from?" I categorize the banking sector as formal credit and "chulquero" as informal credit. "Chulquero" is a term used in Ecuador referring to an individual who lends money informally and charges high-interest rates.

⁴⁰Not all observations respond affirmative on whether they access to credit. From the estimation sample, 962 observations responded that they access some form of credit. 507 in the crop constrained property rights area and 455 in the PLT area.

⁴¹I perform placebo tests for this as well, they are available in Tables A25 and A26

Table 8: Credit market access

	(1) Formal credit market	(2) Informal credit market
	Sharp RD results	
Robust	-0.063 (0.045)	-0.071 (0.023)***
Observations	962	962
Bandwidth	35	35
Parishes	24	24
Mean	0.172	0.319
Variation w.r.t mean	-36.7	-22.2

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Robust refers to the robust bias-corrected RD estimate from Calonico et al. (2017). Among the farmers who responded affirmatively to receiving credit, column (1) is an indicator variable that takes the value 1 if the farmer reported that the credit came from private banks or savings cooperatives. Column (2) is an indicator variable that takes the value 1 if the farmer reported that the credit came from a "chulquero" (slang referring to informal credit).

6.2. Land-use index

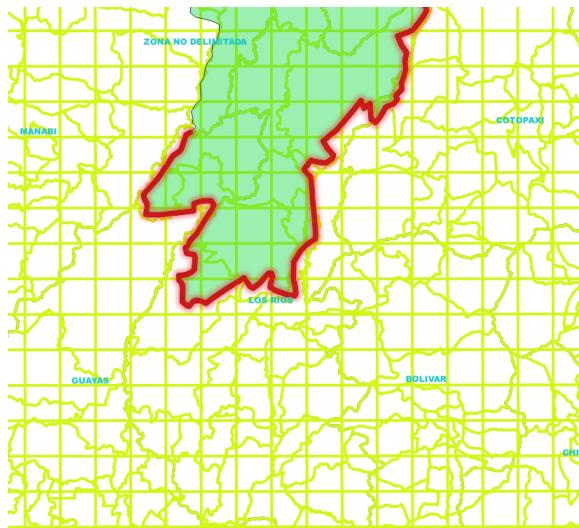
The impact of PLT through property rights should manifest as evidence of improved land utilization. In simpler terms, obtaining enhanced property rights should result in a noticeable improvement in land care within beneficiary areas. To explore this, I leverage data from the Agriculture Ministry of Ecuador, which provides detailed information on land use. The data is comprehensive, derived from a merging process involving multiple administrative sources including satellite data⁴². The ministry furnishes a consolidated dataset for the years 2002 and 2021, with variations in granularity and dimensions across the two years.

In this research, I have shown that productivity (in terms of yields) comes from crops other than the "traditional" ones. However, banana is an important crop that has maintained its influence, in the hands of fewer producers, in areas where Decree 1,001 was intensively applied. This effect could be due to previous plantations that avoided expropriation and were unlikely to have been affected by the artificial border created by IERAC. Moreover, the counterfactual comparison with the province of Manabí also shows that, in the absence of the reform, farmers seem to have specialized in cocoa, the other traditional crop. Thus, it may be that in the absence of reform, there is some degree of specialization in a particular permanent (perennial) and "safe" crop.

⁴² A complete description can be found in Ministerio de Agricultura y Ganadería (2021).

Is there a cost for land use between specialization vs diversification in permanent crops? I expect that diversification provides a better land use, i.e., that the crop being cultivated is the best fit relative to the potentiality in the land. I use the data from the Ministry of Agriculture to test for this. To fully exploit the granularity of the data, I adopt a strategy of dividing the geographical zone into 10×10 km pixels. This not only allows for a detailed examination but also facilitates the incorporation of pixel fixed effects into the analysis. The outlined strategy is visualized in Figure 12.

Figure 12: Pixels



Note: This Figure is an illustration of a pixel strategy using the context in this paper.

The land-use index categorizes land into three groups: Good use, underproduction, and overproduction. To streamline this, I collapse the index into an indicator variable, creating two categories: Good use and bad use, where underproduction and overproduction are grouped together as bad use. My primary focus is on permanent (perennial) cultivations.

The 2021 data provides highly detailed information, disaggregated at the 1:25,000 scale level. Additionally, it includes specifics on whether each observation pertains to permanent (perennial) or transitory (annual) crops. In contrast, the 2002 data is less detailed. To classify observations into permanent (perennial) or transitory (annual) categories, I merge the data with the 2000 agricultural census at the parish level. I make a simple assumption to determine if an observation belongs to permanent (perennial) or transitory (annual) crops: it is the case if the parish has more than its mean amount of land devoted to permanent (perennial) or transitory (annual) crops.

In examining the relationship between being in a PLT area and land use, I employ an inter-

action model and incorporate pixel-level fixed effects. Specifically, I interact two indicator variables: being in a PLT area and having permanent (perennial) crop cultivations. The results are presented in Table 9. Both datasets indicate that having permanent (perennial) crops interacted with being in the PLT zone are associated with better land use, preventing cases of overproduction or underproduction. This suggests that these areas take better care of their land, especially when dedicated to permanent (perennial) crops.

Table 9: Effects of PLT on land use (perennial crops)

	(1)	(2)
Optimal land use index	2002	2021
PLT × Permanent	0.233*** [0.064]	0.183*** [0.045]
Observations	5,468	97,106
Pixel FE	yes	yes
Mean	0.45	0.21
R-squared	0.026	0.103

Cluster standard errors (parish) in brackets

*** p < 0.01, ** p < 0.05, * p < 0.1

Note: This table presents estimates of an interaction model between areas that received PLT and permanent crops. For the 2002 dataset, I utilize parish-level data from the 2000 agricultural census to classify the type of crop. In the 2021 dataset, specific information is provided regarding whether a plot of land is devoted to permanent or transitory crops. Both regressions include each indicator variable (PLT and permanent) as a control.

6.3. Suggestive evidence on the effect on structural transformation and growth

What are the implications of these results? Figure 13 utilizes data from IPUMS ([Center, 2020](#)) to create an event-study type graph depicting the share of agricultural workers relative to the labor population, with 1982⁴³ as the reference year. For this analysis, I manually categorized the treated and control areas within the IPUMS census harmonized sample for each available year⁴⁴.

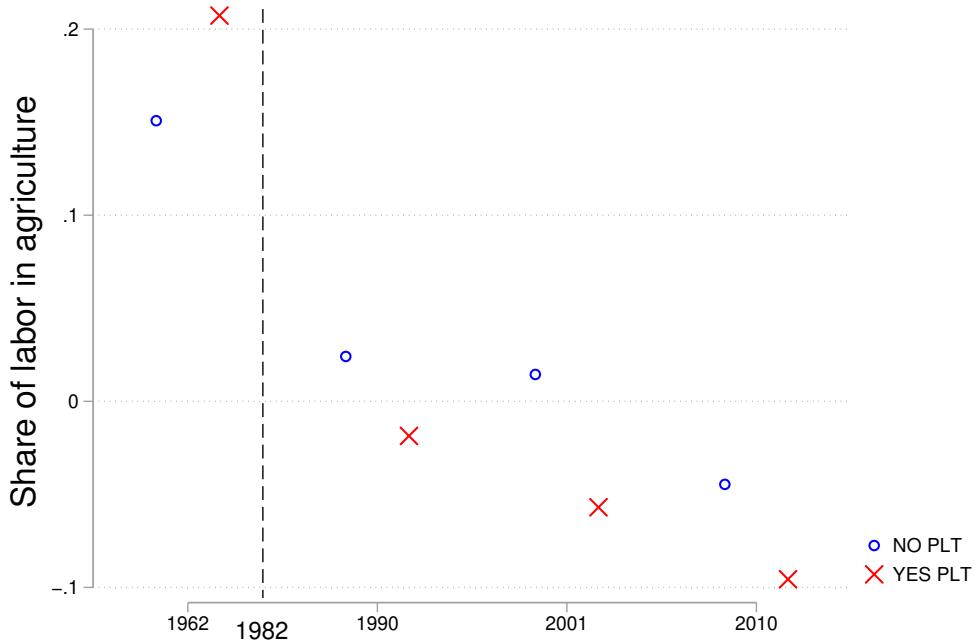
The trajectory reveals a common stylized fact from the structural transformation literature: over time, there is a declining share of workers in agriculture. However, areas benefiting from PLT exhibit a suggestive faster decline. While property rights are recognized as pivotal for structural transformation ([Kitamura, 2022](#)), more research is necessary to explore how property rights shape preferences towards growing specific crops, potentially influencing the decisions of future

⁴³ The first population census available after the agrarian reform is from 1974, but this census did not have availability of industry classification.

⁴⁴ Industry classification was not available for 1974, so it was not possible to use this year.

workers. Productivity increases are crucial, as are the implications of productivity gains on crop choices and how farmers might be influenced by various interventions that impact both land size and property rights under specific contexts. Additionally, Table 10 provides individual estimates for the share of workers in agriculture, manufacturing, households residing in the urban sector, and education (the share of the population that completed primary school).

Figure 13: Share of agricultural workers relative to 1982



Note: This Figure plots an event-study type graph using 1962 as reference year (not shown). Crosses refer to areas that received PLT while circles are areas affected by expropriations.

Table 10: OLS regressions. Structural transformation indicators-IPUMS sample within 50 km of parish distance-

	(1) Ag.Share	(2) Manu.Share	(3) Urban.share	(4) Education (Primary school)
PLT	-0.132 (0.040)***	0.024 (0.005)***	0.181 (0.066)***	0.074 (0.014)***
Observations	50852	50852	43807	60829
Clusters	55	55	46	64
YearXProvinceFE	Yes	Yes	Yes	Yes
Mean	0.44	0.05	0.64	0.57
Variation w.r.t mean	-30.36	47.16	28.23	12.94

Cluster standard errors at the Municipality-IPUMS level in parentheses

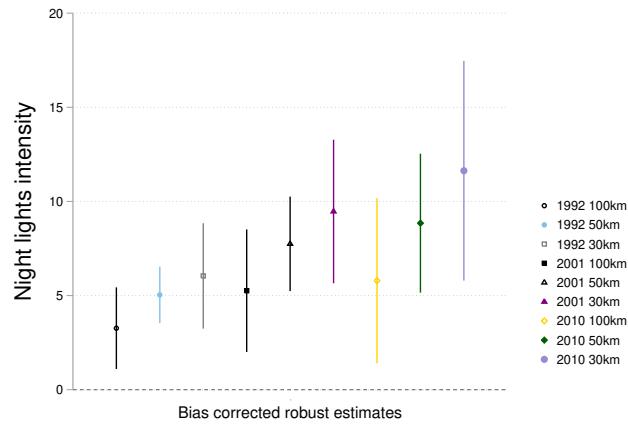
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: PLT is an indicator variable which takes the value 1 when a specific parish is in the public land transfer zone according to IERAC's historical map. Ag.Share: Share of workers in the agricultural sector, Manu.share: Share of workers in the manufacture sector, Urban share: share of the population in urban areas, Education(primary school): Indicator variable on whether or not a person, in the labor force, finished primary school.

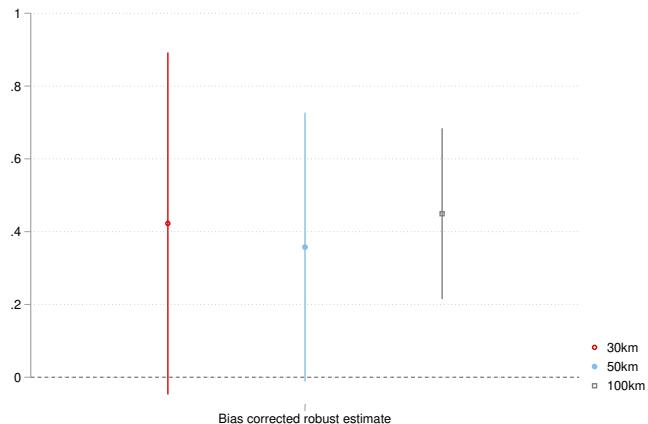
Finally, I explore the impact on economic growth using two measures derived from satellite data: Night light intensity from NOAA and agricultural GDP from [Blankespoor et al. \(2022\)](#). Figure 14, panel a), presents fuzzy RD results employing night light data at the parish level (for 1992, 2001, and 2010), indicating that places treated by the PLT exhibit systematic affluence. In the same figure, panel b), an alternative measure based on satellite imagery, calculating agricultural GDP, reveals positive and substantial point estimates, although not statistically significant in wider bandwidths. It is crucial to note that agricultural GDP encompasses various activities beyond crop production, including forestry, fishery, and livestock.

Figure 14: Effect on growth

(a) Using night lights



(b) Using Agricultural GDP(Satellite)



Note: Panel a) shows the result of the main specification at the parish level using as an outcome night light data from NOAA. Panel b) does the same but it uses as an outcome agricultural GDP (using satellite data from [Blankespoor et al. \(2022\)](#))

7. Conclusions

In this paper, I investigate the impact of public land transfers on agricultural outcomes in the coastal region of Ecuador, focusing on the effects of well-defined property rights granted to beneficiaries through this program. The findings are relative to a comparison group that faced constraints on crop choice and continued with *latifundia* practices. I find a significant positive impact on agricultural productivity, specifically on permanent (perennial) crops. For a country like Ecuador, promoting diversification in crop production is important. The results of this paper indicate that public land transfers were a policy that directed beneficiary areas towards diversification.

Areas affected by expropriations and constrained to produce rice for 10 years are still devoted to rice production by 2000. Additionally, there is no diversification in permanent (perennial) crops, which affects efficient land use. Furthermore, I find that these areas are more susceptible to informal credit markets, which might play a complementary role in motivating overspecialization in a short-term crop such as rice.

In general, I also find that areas that benefited from PLT have more economic growth (measured with satellite information proxies) and suggestive evidence points to more rapid structural transformation. These findings provide valuable insights for policymakers and stakeholders in designing agrarian reform programs that focus on property rights allocation and sustainable agricultural development. Furthermore, I aim to contribute to the literature on the long-term implications of public land transfer programs and highlight the need for further empirical research on the implications of property rights granted during agrarian reforms on long-term outcomes.

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Appendix

To be organised

Figure A1: IERAC historic map: Original

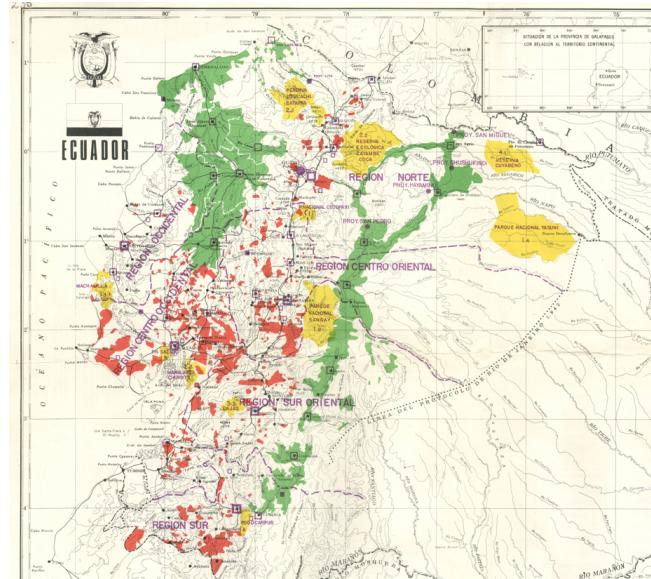


Figure A2: Old agricultural census example

CUADRO NO. 12 (CUEST. CA-01) NUMERO, SUPERFICIE Y APROVECHAMIENTO DE LA TIERRA DE LAS UPA, SEGUN REGIMENES DE TENENCIA, PAG. NO. 12											
REGIMEN DE TENENCIA	TOTAL		TIERRAS DE LABRANZA								
			CULTIVOS TRANSITARIOS			PASTORE CULTIVADOS			DESCANSO		
	NUMERO	SUPERFICIE	NUMERO	SUPERFICIE	NUMERO	SUPERFICIE	NUMERO	SUPERFICIE	NUMERO	SUPERFICIE	
	1	2	3	4	5	6	7	8	9	10	11
PARROQUIA PUERLOVITO											
UPA S T N TIERRA	10	-	-	-	2.015	-	11	-	1.585	-	-
EN PROPIEDAD	190	7.455	106	1.825	94	603	18	1.045	16	177	
PLENA PROPIEDAD	165	7.310	81	1.742	69	520	18	1.045	16	177	
BENEFICIO AGRARIO Y/O COL.	24	30	24	30	24	39	0	0	0	0	
POSEIDA COMO COMUNERO	0	0	0	0	0	0	0	0	0	0	
COMUNALES Y/O COOPERATIVAS	1	115	1	53	1	53	0	0	0	0	
EN ARRENDAMIENTO	93	167	91	160	88	107	0	0	6	53	
CON PAGO DE DINERO Efect	18	80	16	74	14	24	0	0	2	50	
EN ADQUERIA O AL PARTIDO	12	16	12	16	11	13	0	0	4	3	
OTRAS FORMAS DE ARRENDAM.	63	71	63	71	63	71	0	0	0	0	
Ocupadas sin Titulo	15	91	13	49	13	42	2	3	2	4	
Ocupadas del Estado	3	1	3	1	3	1	0	0	0	0	
Ocupadas en Propiedad	12	91	10	48	10	41	2	3	2	4	
OTRAS TENENCIAS SIMPLES	0	294	7	239	6	24	3	210	1	5	
PROP. ARRENDO PAGO EN Efect	3	251	2	3	2	3	0	0	0	0	
PROP. ARRENDO PARTIDO O APARC	1	64	1	21	1	1	0	0	1	20	
OTRAS FORMAS MIXTAS	11	56	11	22	11	22	0	0	0	0	
TOTAL	332	8.378	231	2.319	215	802	23	1.258	26	289	

Table A1: Comparison of decree 1001 and public land transfers

	Decree 1001	Public Land Transfers
Objective/Focus	Expropriate land and end precarious work	Formalize land occupation and promote agricultural frontier expansion
Plot Limits	Unclear (beneficiaries received plots within haciendas)	IERAC defined clear property delimitations
Able to Sell?	No (complex authorization from IERAC after a period)	Yes (fewer restrictions after a certain period)
Type of Crops	Promoted rice cultivation	Not specified (government encouraged agricultural frontier expansion, allowing diversification)

Source: Land Reform and Colonization Laws (1964 and 1973). Decree 1001 (1971).

Figure A3: Raw graphs PLT and Expropriation

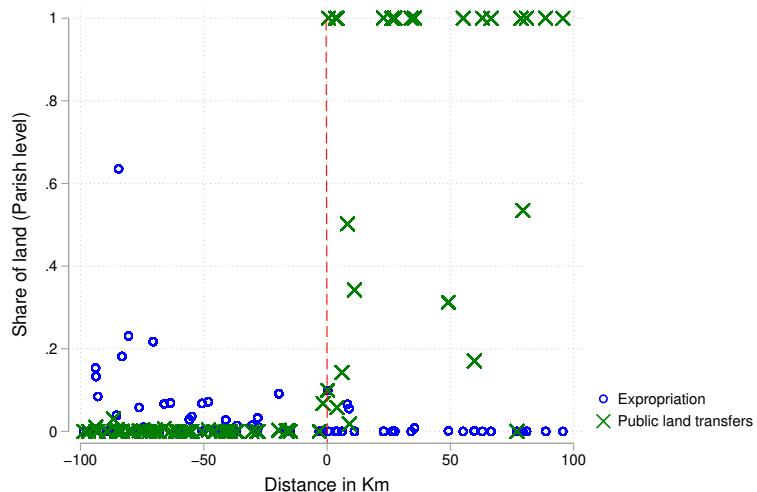
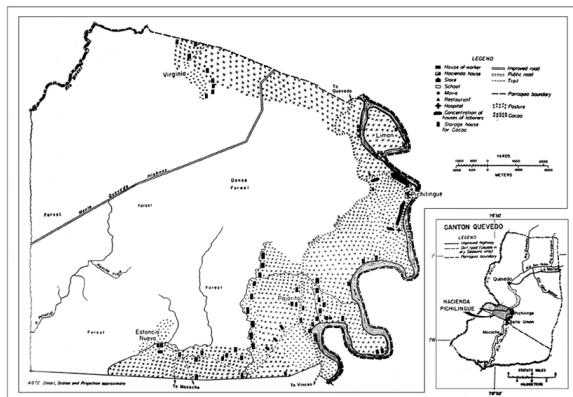


Figure A4: Pichilingue hacienda



Note: This map shows the location of the Pichilingue hacienda that was later transformed into a research center. Its area was affected by the witches' broom plague.

Figure A5: Manipulation test

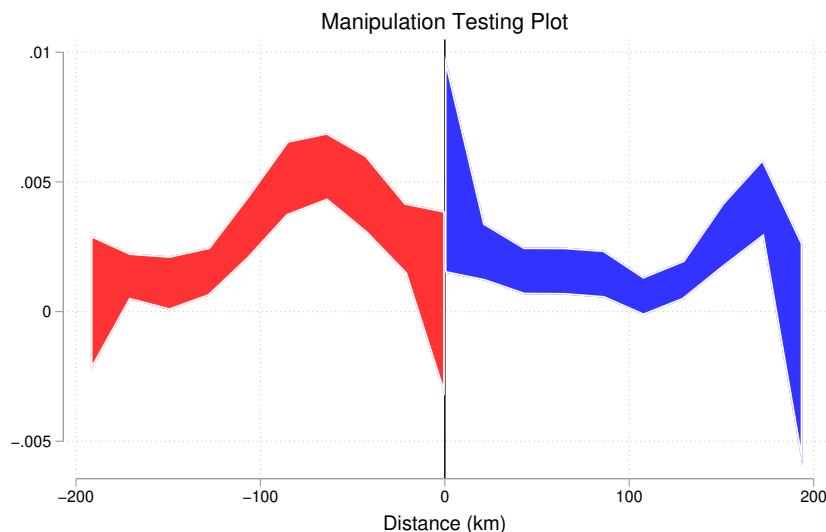


Table A2: Local randomization smallest window - individual data-

Window	p-value	Obs < c	Obs \geq c
-1.576 0.221	0.071	249	292

Figure A6: No sorting in workers

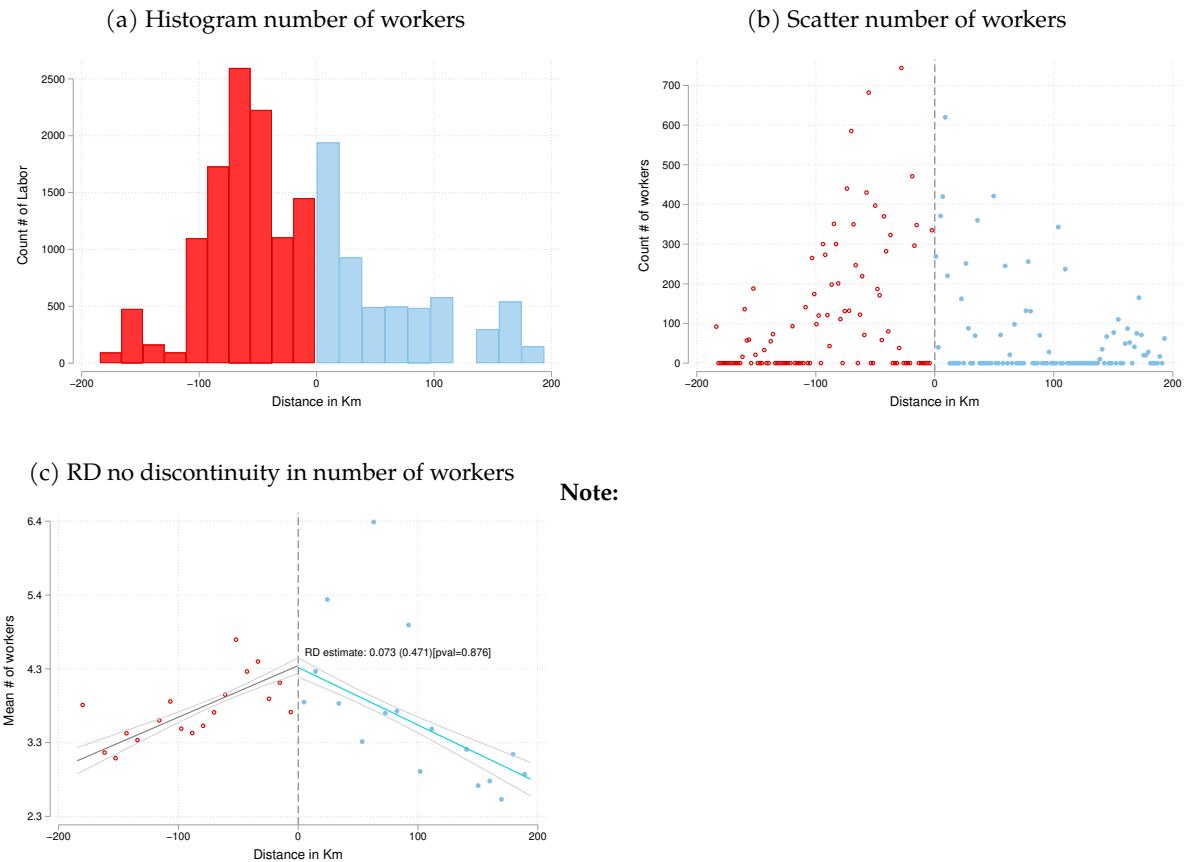


Figure A7: Discontinuities figures-Yields (Raw-no weights-)

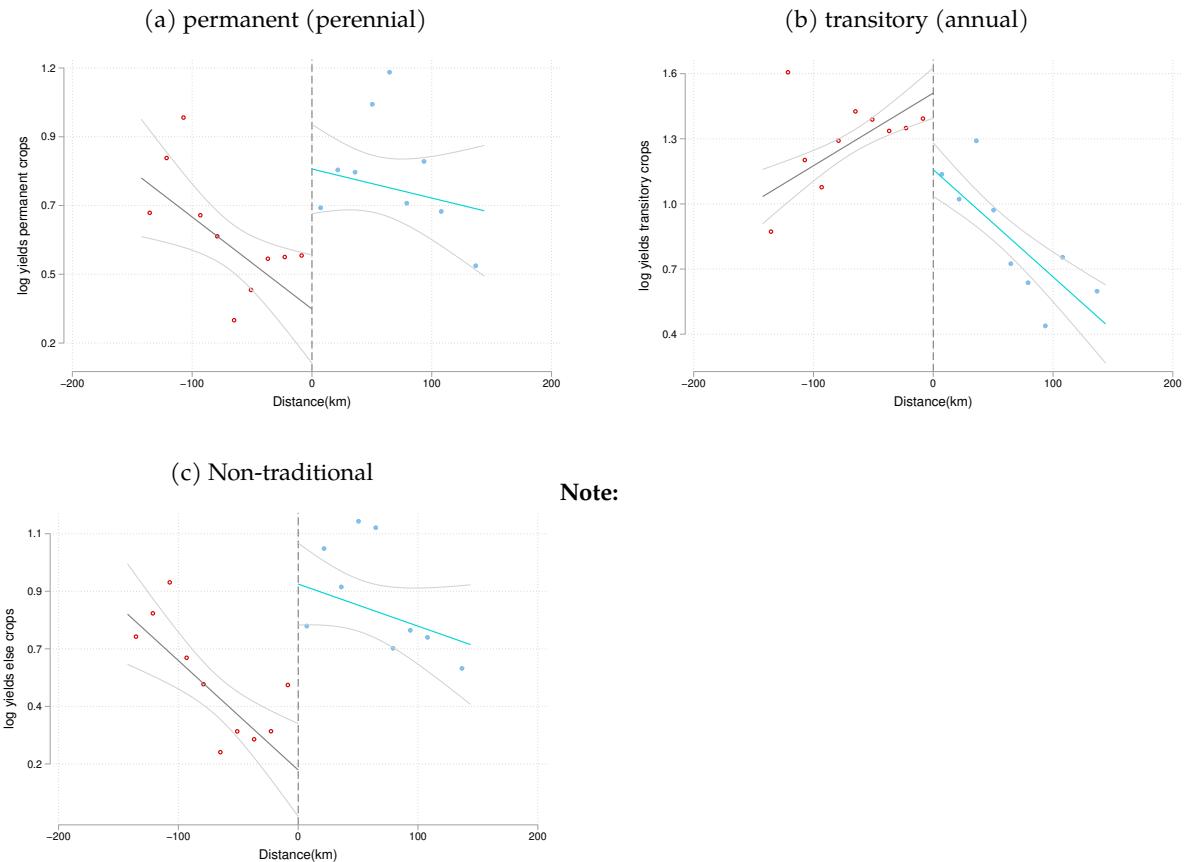
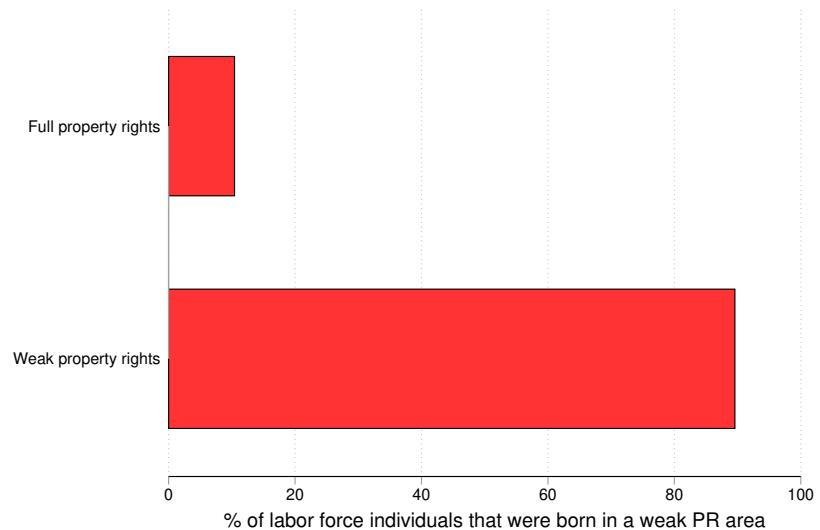
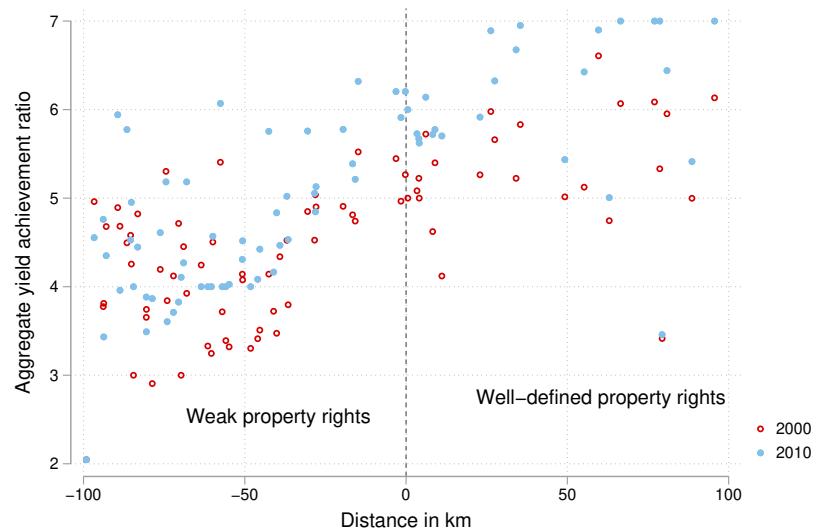


Figure A8: Internal migration-% of workers that were born in weak PR and continue there



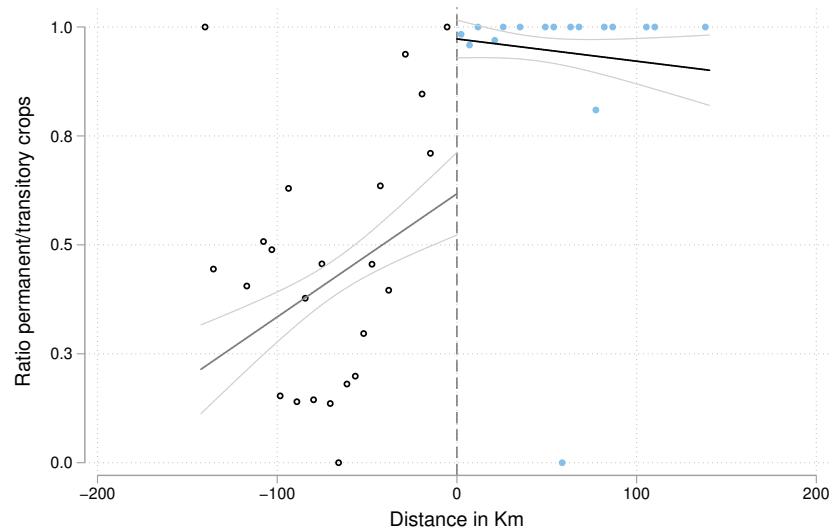
Note: Internal migration with IPUMS and provinces match.

Figure A9: Aggs ratio



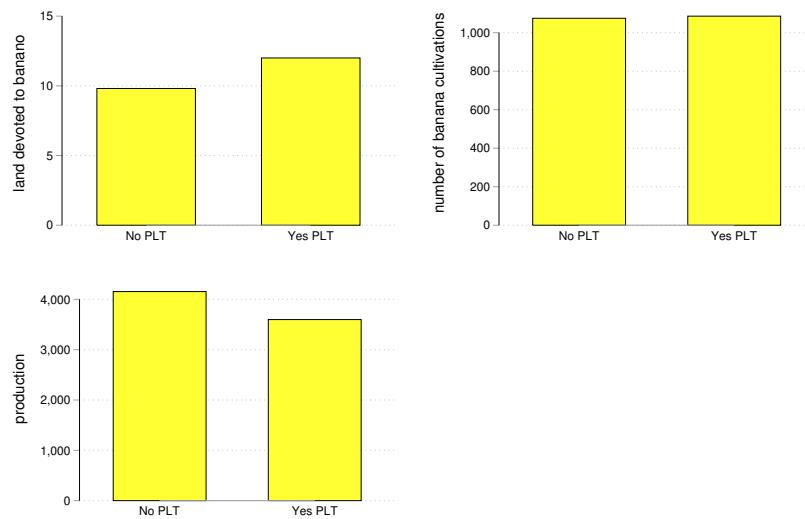
Note: Agg ratio

Figure A10: Ratio permanent (perennial) and transitory (annual) crops (1982)



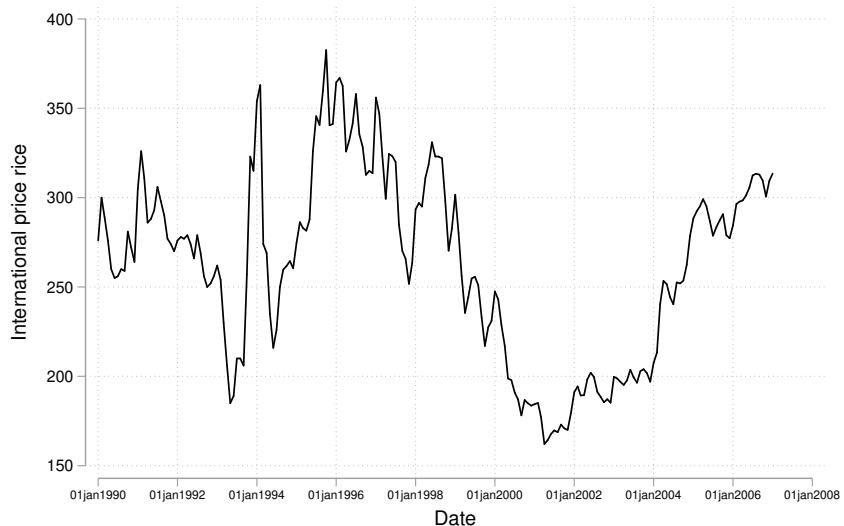
Note: 1982. Source Ministry of Agriculture Ecuador

Figure A11: Banana production 1954



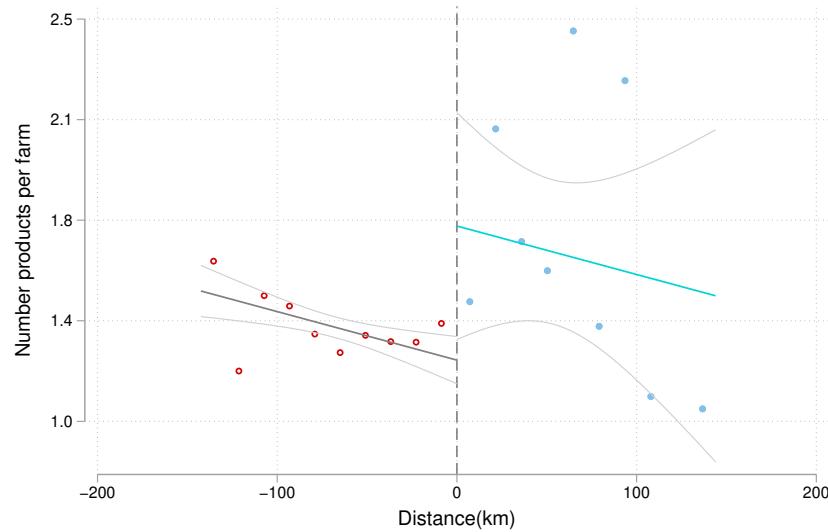
Note: Available municipalities: Quevedo (only observation available affected by PLT in the 1954 census), Ventanas, Publoviejo, Vinces, and Balzar

Figure A12: International price of rice



Note: International price of rice comes from: International Monetary Fund, Global price of Rice, Thailand [PRICENPQUSDM], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/PRICENPQUSDM>, November 21, 2023.

Figure A13: Diversification



Note: Diver

Table A3: Summary statistics main outcome variables

	(1) PLT					(2) no PLT				
	mean	sd	min	max	count	mean	sd	min	max	count
Land usage perm.crops(%)	0.33	0.44	0.00	1.00	7934	0.28	0.42	0.00	1.00	11708
Yield perm.crops (log)	0.66	1.17	0.00	7.11	7901	0.58	1.26	0.00	8.13	11415
Yield trans.crops (log)	1.63	2.22	0.00	6.81	7797	2.31	2.47	0.00	6.82	14063
Yield Rice	0.51	1.11	0.00	8.57	6739	1.43	1.89	0.00	8.57	13020
Yield cocoa	0.04	0.09	0.00	2.07	7064	0.04	0.11	0.00	4.35	10013
Yield Banana	0.58	3.72	0.00	70.25	5522	1.00	6.16	0.00	80.29	7738
Yield non-traditional perm(log)	0.57	1.30	0.00	6.79	7474	0.40	1.29	0.00	8.20	10171
Land share devoted to PLT	0.41	0.41	0.00	1.00	8067	0.00	0.01	0.00	0.07	14197
Land share devoted to expr	0.01	0.02	0.00	0.10	8067	0.04	0.07	0.00	0.64	14197
Observations	8067					14197				

Note: Land usage: Land devoted to permanent (perennial) crops/total land. Yield perm/trans/non-traditional crops: (log of) Revenue (price*quantity)/land devoted to permanent (perennial)/transitory (annual)/non-traditional crops. Yield of a specific crop (rice, banana, cocoa): Quantity produced (in metric tons)/hectares devoted to each crop. Land share devoted to PLT/expropriation: Amount of land (from IERAC records)/total land of available parish (current administrative borders). See main text for more details.

Table A4: Donut geographic RD estimates

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non-traditional
Sharp RD case							
Robust	0.145 (0.059)**	0.550 (0.139)***	-0.103 (0.109)	-0.626 (0.226)***	-0.015 (0.013)	-1.038 (0.468)**	0.810 (0.156)***
Observations	3185	3185	3185	3185	3185	3185	3185
Bandwidth	35	35	35	35	35	35	35
Parishes	22	22	22	22	22	22	22
Mean	0.716	1.178	4.781	2.089	0.085	1.358	0.799
Variation w.r.t mean	20.3	46.7	-2.2	-29.9	-17.2	-76.4	101.4

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Reduced-form with conley SE (10 km window)

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
dd	0.130 (0.048)***	0.363 (0.198)*	-0.085 (0.187)	-0.381 (0.174)**	0.003 (0.013)	-1.895 (0.557)***	0.674 (0.185)***
Observations	3513	3513	3513	3513	3513	3513	3513
Parishes	24	24	24	24	24	24	24
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	21.92	30.72	-1.89	-17.25	4.49	-172.79	80.57

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Reduced-form with conley SE (25 km window)

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
dd	0.130 (0.066)**	0.363 (0.190)*	-0.085 (0.106)	-0.381 (0.106)***	0.003 (0.012)	-1.895 (0.515)***	0.674 (0.196)***
Observations	3513	3513	3513	3513	3513	3513	3513
Parishes	24	24	24	24	24	24	24
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	21.92	30.72	-1.89	-17.25	4.49	-172.79	80.57

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Reduced-form donut with conley SE (10 km window)

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
dd	0.123 (0.049)**	0.584 (0.215)***	-0.229 (0.212)	-0.371 (0.229)+	-0.005 (0.017)	-1.578 (0.574)***	0.881 (0.205)***
Observations	3185	3185	3185	3185	3185	3185	3185
Parishes	22	22	22	22	22	22	22
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	20.80	49.42	-5.06	-16.84	-6.87	-143.91	105.35

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Reduced-form with conley SE (25 km window)

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
dd	0.123 (0.034)***	0.584 (0.147)***	-0.229 (0.096)**	-0.371 (0.181)**	-0.005 (0.015)	-1.578 (0.469)***	0.881 (0.111)***
Observations	3185	3185	3185	3185	3185	3185	3185
Parishes	22	22	22	22	22	22	22
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	20.80	49.42	-5.06	-16.84	-6.87	-143.91	105.35

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A9: Reduced-form credit outcome with conley SE (10 km window)

	(1) Formal credit market	(2) Informal credit market
dd	-0.047 (0.067)	-0.064 (0.033)*
Observations	962	962
Parishes	24	24
Mean	0.13	0.39
Variation w.r.t mean	-37.18	-16.36

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A10: Reduced-form credit outcome with conley SE (25 km window)

	(1) Formal credit market	(2) Informal credit market
dd	-0.030 (0.111)	-0.076 (0.037)**
Observations	1356	1356
Parishes	24	24
Mean	0.13	0.39
Variation w.r.t mean	-23.58	-19.55

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A11: 2nd degree polynomial Reduced-form

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Shard RD case							
Robust	0.042 (0.023)*	0.293 (0.096)***	-0.131 (0.066)**	-0.676 (0.122)***	-0.011 (0.011)	-1.653 (0.317)***	0.738 (0.096)***
Observations	3513	3513	3513	3513	3513	3513	3513
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.698	1.160	3.411	1.567	0.073	2.029	0.821
Variation w.r.t mean	6.0	25.3	-3.8	-43.1	-14.8	-81.5	89.9

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A12: 2nd degree polynomial

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
dd	0.639 (0.185)***						
Panel B: Fuzzy RD estimates							
Robust	0.128 (0.100)	0.894 (0.487)*	-0.401 (0.369)	-2.052 (0.857)**	-0.033 (0.034)	-5.030 (2.937)*	2.245 (1.153)*
Observations	3513	3513	3513	3513	3513	3513	3513
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.698	1.160	3.411	1.567	0.073	2.029	0.821
Variation w.r.t mean	18.4	77.0	-11.7	-130.9	-45.0	-247.9	273.5

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A13: Fuzzy version credit outcome

	(1) Formal credit market	(2) Informal credit market
Panel A: First stage		
dd	0.593 (0.213)**	0.593 (0.213)**
Panel B: Fuzzy RD estimates		
Robust	-0.120 (0.089)	-0.136 (0.062)**
Observations	962	962
Bandwidth	35	35
Parishes	24	24
Mean	0.172	0.319
Variation w.r.t mean	-69.9	-42.5

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A14: Different bandwidth

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
dd	0.544 (0.201)**	0.544 (0.201)**	0.544 (0.201)**	0.544 (0.201)**	0.544 (0.201)**	0.544 (0.201)**	0.544 (0.201)**
Panel B: Fuzzy RD estimates							
Robust	0.209 (0.111)*	0.589 (0.391)+	-0.106 (0.462)	-1.328 (0.430)***	-0.033 (0.044)	-4.150 (1.770)**	1.442 (0.713)**
Observations	3912	3912	3912	3912	3912	3912	3912
Bandwidth	40	40	40	40	40	40	40
Parishes	28	28	28	28	28	28	28
Mean	0.695	1.277	3.246	1.534	0.073	2.232	0.929
Variation w.r.t mean	30.1	46.2	-3.3	-86.6	-44.8	-186.0	155.1

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A15: Effect does come from diversification within permanent (perennial) crops

	(1) Else	(2) Palm	(3) Else no palm	(4) l(N diff.Crops)
Panel A: First stage				
PLT	0.580 (0.205)**	0.638 (0.210)***	0.580 (0.205)**	0.373 (0.157)**
Panel B: Fuzzy RD estimates				
Robust	0.905 (0.515)*	0.024 (0.095)	0.881 (0.529)*	0.066 (0.036)*
Observations	3290	3352	3290	4057
BandwidthL	32	37	31	45
BandwidthR	25	18	25	24
Parishes	20	20	20	26
Mean	0.783	0.384	0.676	0.232
Variation w.r.t mean	115.6	6.2	130.3	28.4

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A16: Intensive margin

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
dd	0.646 (0.187)***	0.648 (0.180)***	0.549 (0.197)**	0.468 (0.180)**	0.657 (0.186)***	0.704 (0.187)***	0.732 (0.138)***
Panel B: Fuzzy RD estimates							
Robust	0.111 (0.058)*	0.050 (0.192)	0.247 (0.132)*	-1.184 (0.410)***	-0.008 (0.020)	-26.084 (12.846)**	1.072 (0.467)**
Observations	2912	2132	3208	2210	1834	237	1213
BandwidthL	30	35	32	23	32	38	30
BandwidthR	33	24	25	29	23	37	54
Parishes	22	20	20	19	20	27	25
Mean	0.718	1.110	4.880	2.004	0.079	1.408	0.915
Variation w.r.t mean	15.5	4.5	5.1	-59.1	-9.6	-1853.2	117.2

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A17: Extensive margin

	(1) Permanent	(2) Transitory	(3) Rice	(4) Cocoa	(5) Banana	(6) Else
Panel A: First stage						
dd	0.436 (0.215)*	0.436 (0.215)*	0.436 (0.215)*	0.436 (0.215)*	0.436 (0.215)*	0.436 (0.215)*
Panel B: Fuzzy RD estimates						
Robust	0.206 (0.129)+	-0.001 (0.042)	-0.229 (0.139)*	0.026 (0.110)	-0.090 (0.085)	0.513 (0.284)*
Observations	3513	3513	3513	3513	3513	3513
Bandwidth	35	35	35	35	35	35
Parishes	24	24	24	24	24	24
Mean	0.668	0.968	0.753	0.574	0.058	0.282
Variation w.r.t mean	30.8	-0.1	-30.4	4.4	-156.6	181.9

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A18: Extensive margins fuzzy all data

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non traditional
Fuzzy RD case							
Robust	0.301 (0.147)**	0.627 (0.232)***	2.230 (1.392)+	0.254 (0.488)	-0.001 (0.039)	-7.644 (3.470)**	1.690 (0.443)***
Observations	5501	5453	4964	4869	4620	3728	5916
BandwidthL	34	32	26	36	33	43	31
BandwidthR	29	34	28	25	29	40	54
Parishes	23	24	19	20	23	31	26
Mean	0.892	1.625	5.007	2.930	0.132	21.507	1.742
Variation w.r.t mean	33.7	38.6	44.5	8.7	-0.6	-35.5	97.0

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A19: Intensive margins fuzzy all data

	Share	Permanent	Transitory	Rice	Cocoa	Banana	Non traditional
Fuzzy RD case							
Robust	0.111 (0.058)*	0.050 (0.192)	0.247 (0.132)*	-1.184 (0.410)***	-0.008 (0.020)	-26.084 (12.846)**	1.072 (0.467)**
Observations	2912	2132	3208	2210	1834	237	1213
BandwidthL	30	35	32	23	32	38	30
BandwidthR	33	24	25	29	23	37	54
Parishes	22	20	20	19	20	27	25
Mean	0.892	1.563	5.030	2.775	0.130	21.126	1.742
Variation w.r.t mean	12.4	3.2	4.9	-42.7	-5.8	-123.5	61.5

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

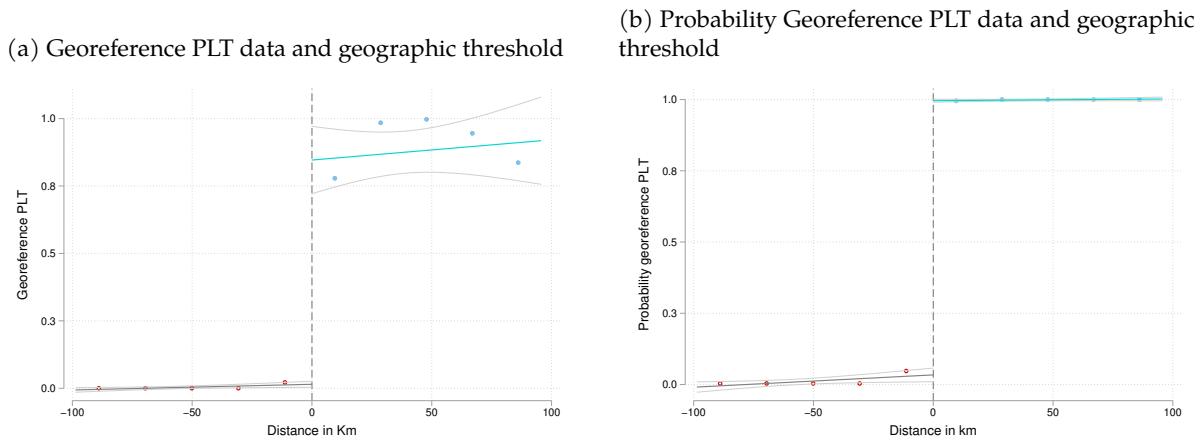
Table A20: OLS all sample

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Non-traditional
PLT (=1)	0.413 (0.047)***	0.832 (0.168)***	-1.795 (0.316)***	-1.729 (0.206)***	0.041 (0.009)***	-0.186 (0.445)	1.035 (0.203)***
Observations	20393	21688	22193	21752	19049	17057	19823
Parishes	125	125	125	125	125	125	125
Mean	0.59	1.18	4.52	2.21	0.07	1.10	0.84
Variation w.r.t mean	69.60	70.46	-39.76	-78.36	56.54	-16.96	123.79

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure A14: Fuzzy discontinuity in public land transfers and probability of treatment



Note: This Figure mimic Figure 4 and exchange the share of PLT taken from IERAC reports by georeferenced information extracted from map A1.

Table A21: Using as an IV geo located data from historical map

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Non-traditional
Panel A: First stage							
dd	0.633 (0.143)***	0.633 (0.143)***	0.633 (0.143)***	0.633 (0.143)***	0.633 (0.143)***	0.633 (0.143)***	0.633 (0.143)***
Panel B: Fuzzy RD estimates							
Robust	0.136 (0.071)*	0.344 (0.100)***	0.082 (0.212)	-0.843 (0.143)***	-0.003 (0.021)	-2.233 (0.737)***	0.841 (0.104)***
Observations	3513	3513	3513	3513	3513	3513	3513
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	18.9	30.0	1.7	-39.7	-3.9	-166.7	110.8

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A22: OLS for credit - Including Manabí

	(1) Formal credit market	(2) Informal credit market
1.ddcounter	0.017 (0.128)	-0.034 (0.056)
2.ddcounter	-0.020 (0.123)	0.247 (0.075)***
Observations	7214	7214
Parishes	194	194
Controls	Yes	Yes
Mean	0.16	0.36

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A23: Placebo moving the border 5km

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Shard RD case							
Robust	0.468 (0.394)	0.202 (0.910)	0.405 (0.431)	0.723 (0.951)	0.045 (0.046)	0.302 (2.423)	-0.506 (0.632)
Observations	3757	3757	3757	3757	3757	3757	3757
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	65.2	17.6	8.4	34.1	54.1	22.6	-66.7

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A24: Placebo moving the border 20km

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Shard RD case							
Robust	-0.177 (0.124)	0.031 (0.429)	-0.198 (0.280)	-0.458 (0.594)	-0.004 (0.036)	1.585 (2.047)	0.222 (0.361)
Observations	4894	4894	4894	4894	4894	4894	4894
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	-24.6	2.7	-4.1	-21.6	-5.3	118.4	29.3

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A25: Placebo moving the border 5km-Credit-

	(1) Formal credit market	(2) Informal credit market
Sharp RD results		
Robust	-0.012 (0.146)	0.387 (0.125)***
Observations	1034	1034
Bandwidth	35	35
Parishes	24	24
Mean	0.172	0.319
Variation w.r.t mean	-6.9	121.4

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A26: Placebo moving the border 20km-Credit-

	(1) Formal credit market	(2) Informal credit market
	Sharp RD results	
Robust	0.056 (0.093)	-0.219 (0.156)
Observations	1620	1620
Bandwidth	35	35
Parishes	24	24
Mean	0.172	0.319
Variation w.r.t mean	32.9	-68.7

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A27: Placebo moving the border 5km-Fuzzy version-

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
dd_placebo1	0.170 (0.167)	0.170 (0.167)	0.170 (0.167)	0.170 (0.167)	0.170 (0.167)	0.170 (0.167)	0.170 (0.167)
Panel B: Fuzzy RD estimates							
Robust	1.613 (1.293)	0.803 (2.397)	1.350 (1.524)	2.610 (4.787)	0.158 (0.137)	0.888 (9.297)	-1.621 (1.923)
Observations	3757	3757	3757	3757	3757	3757	3757
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	224.4	70.0	28.0	122.9	189.4	66.3	-213.6

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A28: Placebo moving the border 20km-Fuzzy version-

	(1) Share	(2) Permanent	(3) Transitory	(4) Rice	(5) Cocoa	(6) Banana	(7) Else
Panel A: First stage							
dd_placebo2	-0.294 (0.151)*	-0.294 (0.151)*	-0.294 (0.151)*	-0.294 (0.151)*	-0.294 (0.151)*	-0.294 (0.151)*	-0.294 (0.151)*
Panel B: Fuzzy RD estimates							
Robust	-0.406 (1.130)	-2.077 (4.650)	2.141 (3.156)	-1.575 (6.191)	-0.212 (0.363)	-22.614 (22.389)	1.641 (4.350)
Observations	4894	4894	4894	4894	4894	4894	4894
Bandwidth	35	35	35	35	35	35	35
Parishes	24	24	24	24	24	24	24
Mean	0.719	1.147	4.818	2.123	0.084	1.339	0.759
Variation w.r.t mean	-56.5	-181.0	44.4	-74.2	-252.9	-1688.5	216.1

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A31: Number of observations per parish

Parish name	Distance to IERAC border (sorted)	Number of observations
Tenguel	-184.47	126
Posorja	-162.36	27
Balao	-160.50	247
Puna	-157.16	109
General Villamil (Playas)	-156.91	83
Naranjal	-151.66	315
Morro	-151.31	65
Santa Rosa de Flandes	-142.46	53
Jesus Maria	-138.49	74
Juan Gomez Rendon (Pro-greso)	-135.76	40
San Carlos	-135.47	72
Taura	-119.15	146
El Triunfo	-108.78	212

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Gral. Pedro J. Montero (Boliche)	-102.67	139
Coronel Marcelino Mariduena (San Carlos)	-102.46	183
Virgen de Fatima	-102.19	20
Guayaquil	-100.64	416
Eloy Alfaro (Duran)	-98.66	143
Gral. Antonio Elizalde (Bucay)	-96.69	151
Roberto Astudillo (Cab. en Cruce de Venecia)	-93.87	155
Yaguachi Viejo (Cone)	-93.73	200
Naranjito	-92.96	379
Sabanilla	-89.39	141
Chobo	-88.70	48
Pedro Carbo	-86.53	236
Milagro	-85.40	246
Isidro Ayora	-85.15	213
Mariscal Sucre (Huaques)	-84.51	62
Crnel. Lorenzo de Garaicoa (Pedregal)	-83.20	354
San Jacinto de Yaguachi	-80.50	282
Narcisa de Jesus	-78.67	136
Simon Bolivar	-76.20	154
Febres Cordero (Las Juntas)	-74.43	390
Los Lojas (Enrique Baquerizo Moreno)	-74.06	180
Samborondon	-72.12	157
Tarifa	-70.52	419

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Lomas de Sargentillo	-69.73	292
Alfredo Baquerizo Moreno (Jujan)	-68.98	308
Valle de La Virgen	-68.01	107
Daule	-66.01	303
Juan Bautista Aguirre (Los Tintos)	-63.52	135
Limonal	-61.46	143
La Victoria	-60.36	110
Babahoyo	-59.91	109
Montalvo	-57.56	512
Laurel	-57.00	55
El Salitre (Las Ramas)	-55.88	207
Santa Lucia	-54.85	550
Baba	-50.76	273
Pimocha	-50.68	175
Gral. Vernaza (Dos Esteros)	-48.17	205
Junquillal	-45.99	190
La Union	-45.35	78
Colimes	-42.56	437
Caracol	-41.07	57
Palestina	-40.13	275
Isla de Bejucal	-39.11	95
San Juan	-36.94	90
Antonio Sotomayor (Cab. en Playas de Vinces)	-36.55	271
Catarama	-30.52	51
Ricaurte	-28.36	633

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Guare	-28.12	181
Puebloviejo	-27.91	123
Balzar	-19.53	598
Vinces	-16.57	355
Ventanas	-15.77	316
Puerto Pechiche	-14.83	128
Quinsaloma	-3.12	213
Zapotal	-1.58	249
Palenque	0.22	292
La Esperanza	0.55	40
El Rosario	3.39	43
Velasco Ibarra (Cab. El Empalme)	3.97	272
San Carlos	4.08	164
Valencia	6.11	646
Quevedo	8.26	226
Mocache	8.96	609
Guayas (Pueblo Nuevo)	11.10	238
San Jacinto de Buena Fe	22.92	246
Luz de America	26.28	167
Manga del Cura	27.04	124
Patricia Pilar	27.49	132
Puerto Limon	34.11	91
Santo Domingo de los Colorados	35.42	508
El Carmen	49.22	536
San Jacinto del Bua	55.21	102
San Miguel de los Bancos	59.66	350

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Wilfrido Loor Moreira (Maicito)	62.99	41
La Concordia	66.50	111
Pedro Vicente Maldonado	77.02	185
Puerto Quito	78.65	289
Nanegalito	79.39	35
La Union	80.89	210
Chibunga	88.63	108
Las Golondrinas	95.63	29
Rosa Zarate (Quininde)	103.64	471
Malimpia	109.26	311
Viche	138.17	27
Majua	140.60	48
San Gregorio	143.91	94
Atahualpa (Cab. en Camarones)	150.40	82
Muisne	153.92	137
Chinca	154.06	103
Chontaduro	159.99	57
Tabiazo	161.32	44
La Union	162.63	86
San Mateo	163.53	89
San Francisco	168.34	49
Sua (Cab. en La Bocana)	168.63	31
Atacames	169.09	53
Rocafuerte	169.63	54
Vuelta Larga	171.32	27
Lagarto	171.83	94

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Camarones (Cab. en San Vicente)	171.89	53
Tonchigue	172.13	49
Tachina	172.20	36
Borbon	173.51	50
Tonsupa	173.63	35
Esmeraldas	174.72	5
Quingue (Olmedo Perdomo Franco)	174.79	29
Rioverde	176.87	24
Galera	179.51	41
Carondelet	189.42	24
Tululbi (Cab. en Ricaurte)	193.49	55
Calderon	193.89	15

Table A29: Placebo runs (reduced form)

	(1) Yield permanent(-5km)	(2) Yield permanent(5km)	(3) Yield transitory(-5km)	(4) Yield transitory(5km)	(5) Yield cacao(-5km)	(6) Yield cacao(5km)	(7) Yield rice(-5km)	(8) Yield rice(5km)	(9) else(-5km)	(10) else(5km)	(11) Yield banana(-5km)	(12) Yield banana(5km)	(13) usage(-5km)	(14) usage(5km)
Robust	0.907 (1.396)	0.165 (0.373)	-0.362 (0.477)	-0.370 (0.583)	0.131 (0.104)	-0.004 (0.012)	0.606 (0.692)	-0.423 (0.216)*	0.0702 (0.052)	0.184 (2.488)	0.695 (0.430)	0.454 (0.340)	0.454 (0.051)	-0.089
Observations	3147	3619	3320	3946	3147	3301	3147	3147	3488	3308	3485	3608	3328	
Bandwidth	15	30	23	34	15	39	32	34	25	25	25	25	33	
Parishes	19	29	22	28	17	24	19	19	23	30	21	22	26	
Mean	1,133	1,133	1,133	3,447	0,072	1,579	1,579	1,579	0,072	0,787	2,034	0,696	0,696	
Variation w.r.t. mean	80,0	14,5	10,5	-10,7	181,8	5,2	38,4	26,8	89,2	23,3	34,2	31,2	65,3	-12,8

Notes: bla bla. We denote: * $p < 0.20$, ** $p < 0.05$, *** $p < 0.01$.

Table A30: Placebo runs (Fuzzy RD)

	(1) Yield permanent(-5km)	(2) Yield permanent(5km)	(3) Yield transitory(-5km)	(4) Yield transitory(5km)	(5) Yield cocoa(-5km)	(6) Yield cocoa(5km)	(7) Yield rice(-5km)	(8) Yield rice(5km)	(9) else(-5km)	(10) else(5km)	(11) Yield banana(-5km)	(12) Yield banana(5km)	(13) usage(-5km)	(14) usage(5km)
Robust	40345361 (59111775)	-0.98884 (2.12524)	73915621 (138933350)	100896 (359180)	0.47779 (0.05384)	24.01884 (26.61510)	0.68154 (1.01510)	5114777 (60.87512)	-1.0218 (-3.29558)	-215.6970 (27.16816)	-1.23447 (2.10315)	1270431 (2638922)	0.17386 (0.23044)	
Observations	2992	3854	3147	4725	2992	3854	3453	3608	2992	4437	2992	3608	2992	3633
Bandwidth	16	43	21	55	19	43	25	16	51	21	35	15	40	
BandwidthR	38	31	41	36	33	34	36	35	34	34	35	35	35	
Parties	18	29	21	36	18	31	19	25	34	20	23	17	27	
Mean	1.133	1.133	3.447	3.447	0.072	1.579	0.787	0.787	2.034	2.034	0.696	0.696		
Variation w.r.t mean	34603.3	-84.6	-21463.8	29.2	663.3	9.6	1527.0	43.2	7003.4	-140.0	-10604.4	60.7	1826.3	25.0

Notes: bla bla. We denote: * $p < 0.3$, ** $p < 0.05$, *** $p < 0.01$.

Table A32: Number of observations per parish-restricted sample-

Parish name	Distance to IERAC border (sorted)	Number of observations
Tenguel	-184.4732	13
Posorja	-162.3562	1
Balao	-160.4961	22
Puna	-157.1604	11
General Villamil (Playas)	-156.9122	18
Naranjal	-151.6591	47
Morro	-151.3055	9
Santa Rosa de Flandes	-142.4568	12
Jesus Maria	-138.4864	16
Juan Gomez Rendon (Pro-greso)	-135.7631	15
San Carlos	-135.4682	28
Taura	-119.145	66
El Triunfo	-108.7762	68
Gral. Pedro J. Montero (Boliche)	-102.671	69
Coronel Marcelino Mariduena (San Carlos)	-102.4561	99
Virgen de Fatima	-102.1858	7
Guayaquil	-100.6373	87
Eloy Alfaro (Duran)	-98.65922	45
Gral. Antonio Elizalde (Bu-cay)	-96.69392	73
Roberto Astudillo (Cab. en Cruce de Venecia)	-93.86838	59
Yaguachi Viejo (Cone)	-93.72861	128
Naranjito	-92.96298	192

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Sabanilla	-89.3895	86
Chobo	-88.69868	33
Pedro Carbo	-86.52501	142
Milagro	-85.40132	120
Isidro Ayora	-85.15096	78
Mariscal Sucre (Huaques)	-84.51443	18
Crnel. Lorenzo de Garaicoa (Pedregal)	-83.19691	165
San Jacinto de Yaguachi	-80.50276	105
Narcisa de Jesus	-78.67458	78
Simon Bolivar	-76.20212	82
Febres Cordero (Las Juntas)	-74.42698	216
Los Lojas (Enrique Baquerizo Moreno)	-74.06388	27
Samborondon	-72.1179	59
Tarifa	-70.51548	59
Lomas de Sargentillo	-69.73385	163
Alfredo Baquerizo Moreno (Jujan)	-68.98148	209
Valle de La Virgen	-68.01495	49
Daule	-66.01122	100
Juan Bautista Aguirre (Los Tintos)	-63.51685	62
Limonal	-61.46228	79
La Victoria	-60.36295	32
Babahoyo	-59.90731	55
Montalvo	-57.55959	172
Laurel	-56.9951	33

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
El Salitre (Las Ramas)	-55.88114	124
Santa Lucia	-54.84662	327
Baba	-50.76033	168
Pimocha	-50.67555	131
Gral. Vernaza (Dos Esteros)	-48.17398	158
Junquillal	-45.99139	113
La Union	-45.3502	44
Colimes	-42.5607	298
Caracol	-41.07037	27
Palestina	-40.13063	173
Isla de Bejucal	-39.11358	58
San Juan	-36.93801	45
Antonio Sotomayor (Cab. en Playas de Vinces)	-36.55072	166
Catarama	-30.52181	35
Ricaurte	-28.35747	288
Guare	-28.11565	112
Puebloviejo	-27.90832	61
Balzar	-19.52561	390
Vinces	-16.57451	255
Ventanas	-15.76645	221
Puerto Pechiche	-14.83133	79
Quinsaloma	-3.120633	139
Zapotal	-1.575883	117
Palenque	0.2210712	211
La Esperanza	0.5504975	20
El Rosario	3.392306	35

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Velasco Ibarra (Cab. El Empalme)	3.965198	178
San Carlos	4.081524	114
Valencia	6.113094	301
Quevedo	8.257324	114
Mocache	8.962811	405
Guayas (Pueblo Nuevo)	11.1044	111
San Jacinto de Buena Fe	22.92057	104
Luz de America	26.27738	46
Manga del Cura	27.044	114
Patricia Pilar	27.48923	38
Puerto Limon	34.11245	25
Santo Domingo de los Colorados	35.4233	130
El Carmen	49.21864	148
San Jacinto del Bua	55.2111	33
San Miguel de los Bancos	59.65724	144
Wilfrido Loor Moreira (Maicito)	62.99083	13
La Concordia	66.50226	61
Pedro Vicente Maldonado	77.02114	73
Puerto Quito	78.64874	116
Nanegalito	79.38853	4
La Union	80.88995	30
Chibunga	88.63111	38
Las Golondrinas	95.63153	19
Rosa Zarate (Quininde)	103.6406	70
Malimpia	109.2614	79

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Viche	138.1715	6
Majua	140.5953	19
San Gregorio	143.9084	13
Atahualpa (Cab. en Ca- marones)	150.4025	13
Muisne	153.9245	6
Chinca	154.0636	42
Chontaduro	159.9926	23
Tabiazo	161.3236	13
La Union	162.6324	26
San Mateo	163.5267	26
San Francisco	168.3383	8
Sua (Cab. en La Bocana)	168.6279	7
Atacames	169.0913	6
Rocafuerte	169.6285	20
Vuelta Larga	171.315	2
Lagarto	171.8267	12
Camarones (Cab. en San Vi- cente)	171.8891	23
Tonchigue	172.1263	12
Tachina	172.196	21
Borbon	173.5122	20
Tonsupa	173.6294	10
Esmeraldas	174.7229	1
Quingue (Olmedo Perdomo Franco)	174.7925	9
Rioverde	176.8739	5
Galera	179.5078	4

Continued on the next page

Parish name	Distance to IERAC border (sorted)	Number of observations
Carondelet	189.4169	6
Tululbi (Cab. en Ricaurte)	193.4852	20
Calderon	193.8898	9

A. Disentangling effects within expropriations areas

An important concern to address is to test whether the effects I am accounting for are actually coming from expropriation. Since the expropriations were applied quite dispersed (as shown in Figure A1) I can geo code the actual intervention zones and try to compare them to municipalities within the same region. This process leaves me with 69 municipalities which are the ones in the comparison group, of these 63 were intervened and 6 were not. In table AA33 I show the results of a regression which shows that the areas affected by expropriation are indeed those where rice productivity comes from, as well as the share of land devoted to permanent (perennial) crops. In addition, access to informal credit is higher in these areas. I use the following controls: Latitude and longitude of the municipality, province fixed effects, self-reported tenure status fixed effects, and agro-climatic potential for rice and bananas⁴⁵.

Table AA33: OLS regressions. Comparing within expropriation

	(1) Share	(2) Rice	(3) Bananas	(4) Inf.Credit
Experienced expropriation(=1)	-0.113 (0.040)***	0.611 (0.226)***	-0.102 (0.246)	0.100 (0.053)*
Observations	11708	13020	7738	14197
Parishes	69	69	69	69
Mean	0.28	1.43	1.00	0.15
Variation w.r.t mean	-40.07	42.76	-10.23	64.73

Cluster standard errors at the parish level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the results of OLS regressions with different controls. The independent variable takes the value of 1 if an area experienced expropriation. The sample is the region used as the comparison group in the RD models. Share=share of land devoted to permanent (perennial) crops, Rice-Banana=yield of each crop (quantity/hectare), Inf.Credit=is an indicator variable that takes the value of 1 if the farmer reported that the credit came from a "chulquero" (slang for informal credit).

⁴⁵ since I include all municipalities here, I control for the potential of the main crops