Small Farms, Large Transaction Costs:

Incomplete Property Rights and Structural Change in Haiti

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Abstract

Developing countries have too many small farms and could grow more if they reorganized their agricultural structure. But altering the agricultural structure in developing economies is difficult because incomplete property rights and diffuse ownership lead to high transaction costs. This point is seen in Haiti, where transaction costs were high because of historical property rights institutions and prevented Haiti from adapting to changes in the world economy at the beginning of the 20th century. A simple trade model with migration and transaction costs in the land market can explain much of Haiti's history. Using new data on land adoption in Haiti from 1928 to 1950, I test the model's implications of how transaction costs and eliminating migration opportunities affect land adoption. The results are consistent with large transaction costs to acquiring plantation land and imply that good development policy might require violating property rights to achieve the optimal agricultural distribution.

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Agriculture makes up a significant share of developing countries' economies, but the cultivation is usually performed on very small farms. Moving from small farms to larger farms has the potential to significantly improve agricultural and labor productivity (Adamopoulos and Restuccia 2014, Foster and Rosenzweig 2017). Yet moving from small to large farms faces a big problem because reorganizing a country's agricultural structure involves significant changes in property rights, and developing countries already struggle in this area (De Soto 2000). Property rights should adjust to changes in the economy (Demsetz 1967), but most of this land is owned by the poor, and aggregating these properties distributed among many owners may encounter problems. After all, a large farm is just a collection of small farms. Today's developing countries may not adjust their agricultural structure to changes in global demand because incomplete property rights create large transaction costs.

A mismatch between the country's agricultural structure and the world economy's demands is not without historical precedent. At the turn of the 20th century, Haiti missed a development opportunity that favored large farms. At a time of export demand growth, many countries similar to Haiti developed large-scale, export-oriented farming. Haiti was a world leader in these exports during colonial times, yet its agricultural exports did not change in response to this demand growth. In fact, it never adjusted; in 1970, less than 2% of Haiti's cultivated land was on farms larger than 20 hectares, while the same statistic for its island neighbor the Dominican Republic was 57%. Today Haiti is the poorest country in the western hemisphere, and its failure to take advantage of this opportunity and switch to large-scale agriculture seems to be the starting point for that divergence (Bulmer-Thomas 2012, p. 190).

In this paper, I test whether transaction costs over property rights impeded the Haitian economy from taking advantage of changes in the world economy. I build on Moral (1961), who argues that Haiti's property rights institutions resulted in high transaction costs and caused Haiti to not develop plantation agriculture, but his case rests mostly on anecdotal evidence. I deepen this argument by showing how Haiti's historical institutions differed from similar countries and led to higher transaction costs. Then I use a model to show how transaction costs can explain many of Haiti's experiences in the 19th and 20th century, and I introduce new data on land adoption patterns that I use to test the model's predictions. The evidence demonstrates that transaction costs significantly impaired Haiti's agricultural development, suggesting that today's developing countries may face

similar challenges to increasing agricultural productivity.

Three historical property rights institutions led to Haiti's high transaction costs. First, right after independence in 1804, the Haitian government redistributed land held by the French. Second, the farmers who obtained property then passed it to heirs through partible inheritance and gave multiple people claim to the same land. This complex property rights system prevented farmers or investors from reallocating land because any claimant could veto alienation of the property. Third, the 1805 constitution banned foreigners from owning land in Haiti. Investors in the 19th century might have acquired the land before it became too costly, but the constitutional ban cut off this key source of capital. Even though Haiti's factor endowments were favorable to sugar cultivation and other high-value crops, getting the land to farm was difficult because of high transaction costs. In contrast, institutions in the Dominican Republic and Jamaica, countries with similar endowments and histories, did not create the same transaction costs and allowed these countries to take advantage of the growth in export demand.

A simple model shows how differences in transaction costs can cause the patterns observed in Haiti during this time period. The model allows for trade between two small countries and the world, where labor is free to move between the two countries, but acquiring land faces transaction costs. In equilibrium, workers migrate to the country with higher productivity or lower transaction costs. When an exogenous force halts migration, the net-exporter of labor will adopt more plantation land, similar to how protectionist tariffs spur industrial development, unless transaction costs prevent them.

Testing the relationship between transaction costs and land adoption in Haiti has been difficult because of the paucity of data; however, I have collected new data to examine this question. The data come from a reform implemented by American officials during the 1915-1934 U.S. occupation of Haiti and consist of over 5,700 plots adopted from 1928 to 1950. The data reveal four empirical patterns. First, under favorable rental conditions, farmers did not adopt much land. In a 22-year period, farmers adopted less than 30,000 hectares of the nearly one million hectares available. Second, farmers adopted small plots. Third, farmers chose small plots even when they had the chance to adopt more land. Finally, farmers adopted land in a pattern that indicates large contiguous government land did not exist.

I combine the model and the data to test the relationship between transaction costs and land

adoption. First, the model predicts that in the absence of transaction costs, a labor supply shock should increase the amount of land adopted under large-scale farms relative to small-scale farms. However, transaction costs in the land market will distort adoption towards smaller farms. I test this prediction using the Trujillo Massacre of 1937. The massacre shut off the Dominican Republic as a source of labor demand and pushed refugees into Haiti's border districts. I show that the massacre increased land adoption in the whole country, but disproportionately so in border regions, as we would expect with a labor supply increase. Yet practically no new plantations started in response to the shock, and three-quarters of the land was in subsistence farm sizes. This result is consistent with transaction costs impeding the land market.

Second, I examine how settlement patterns affect land adoption. In a Coasean world, settlement patterns have no effect on transaction costs. But in a world with transaction costs, whether someone is located on the land or not makes a big difference. I show that how households are distributed across the land has specific implications for land adoption. I test these predicitons using settlement patterns dervied from a geodetic map. The regressions confirm the predictions, providing further evidence that transaction costs play a significant role in the land market.

This paper demonstrates that property rights security is not a sufficient condition for development. Property rights must also be elastic enough to respond to economic changes. Property rights security benefits a range of economic outcomes, both in developed and developing countries.[1] But economic development sometimes requires reallocating property rights, at times involuntarily, in response to changing economic conditions (Lamoreaux 2011). Three examples show how this principle worked around the world. First, Southern France's pre-revolution agriculture failed to develop much needed irrigation because various parties held the property rights between the agriculture and the water source, but then irrigation developed after the French Revolution reallocated the rights (Rosenthal 1990). Second, British property rights became so specific that holders would not have taken advantage of industrialization opportunities had Parliament not provided a mechanism to alter the rights (Bogart and Richardson 2011). Finally, early-American borrowers faced lower costs than their British counterparts because property laws made American property easier to seize if the debtor defaulted (Priest 2006). In all of these examples, violating property rights or making

[1]For delveloped countries, see Hornbeck (2010), Libecap and Lueck (2011), North and Weingast (1989). For the evidence in developing countries, see Alston et al. (1996), Banerjee et al. (2002), Besley (1995), Chernina et al. (2014), De Janvry et al. (2015), Field (2007), Goldstein and Udry (2008), Jacoby et al. (2002)

them less secure led to economic development. These economies did not face problems because of low property right security, rather they had to overcome the problem that property rights were too strong. If property rights in developing countries cannot respond to changes, then these countries might miss opportunities to grow.

1 Haiti's missed opportunity

From 1870 to 1930, Latin America and the Caribbean experienced an export boom. The boom came from shippers adopting steam-powered vessels, which lowered trade costs and increased exports from Latin America and the Caribbean (Pascali 2017). These countries exported new crops as well as crops already in production in great volumes (Chasteen 2011).

Although nearly all countries in the region benefited from the boom, Haiti missed it. Bulmer-Thomas (2012) estimates that Haiti's divergence began right at this time, somewhere between 1890 and 1910. From 1820 to 1900, Haiti's economy was always in the bottom quartile of countries in the region, but it was never the poorest, and in many decades it outperformed Puerto Rico, Jamaica, and the Dominican Republic (p. 157). Haiti's economy relied on coffee during this period, but during the boom Brazil became a large coffee producer, and the price dropped. Haiti continued producing coffee, even though it was suitable for other high-value crops. Bulmer-Thomas concludes, "The Haitian economy, it would seem, was not able to respond to these price signals from the market with the flexibility required" (p. 190).

It is not exactly true that the Haitian economy did not flexibly respond to the price signals; the labor market responded in great force. In the early 20th century, large numbers of Haitian workers migrated to earn high wages abroad. Most went to the Dominican Republic, but a considerable number also went to Cuba. The porous border between the DR and Haiti allowed uninhibited and undocumented migration, and several estimates put the flows at about 100,000 seasonal migrants (State Department 1924). Plantations in the Dominican Republic paid twice the Haitian rural wage and workers incurred low migration costs (State Department 1924). The flows to Cuba are better documented and between 10,000 and 25,000 migrants a year traveled there (Haiti Bureau du representant fiscal (1926) p. 96), even with the high migration costs.[2] Haitians working in Cuba

[2]Sugar companies paid the costs of travel, passport, and a bond for each laborer to insure the migrant's return upfront. These costs were not trivial–the United Fruit Company spent more than $100,000 annually on 5,000 men

could get wages six times as large as the rural Haitian wage.[3] Although many of these workers migrated on a seasonal basis, some stayed in the destination country.

While the labor market responded to the export boom, the land market did not. At the same time as these high migration flows, Haiti had lots of idle land available. At the beginning of the American occupation, the government owned approximately half of the country's area, but no one occupied or cultivated it (Millspaugh 1929). By Brisson's (1968) estimates, the government and other large holders owned about 960,000 hectares of agricultural land, of which only 7% was under cultivation.[4] Even small holders left land idle; one of the government's principal problems was inducing land owners to cultivate idle land (Haiti Bureau du representant fiscal 1938 p 99. See also Millspaugh (1929)).

Much of this state-owned land was quality agricultural property. Certainly some of the land was unfit for production (Lundahl 1996, Millspaugh 1929), but much of it was fertile. The State originally acquired the land when it sequestered the French plantations during the Haitian Revolution from 1792 to 1804 (Trouillot 1990, Millspaugh 1929). During the colonial period, farmers proved the land's productive value by using it to supply half of the world's coffee and sugar. After the government confiscated it, the land sat fallow for 100 years, allowing it to regain its fertility (Haiti Bureau du representant fiscal 1927 p 137; Haiti Bureau du representant fiscal 1932 p 28; see also Millspaugh 1929). Indeed, peasants found the land attractive compared to the land already under cultivation because generations of use had exhausted the privately held land. At one point under a government program, farmers could exchange their privately-owned land for state-owned land (Renaud 1934 p. 228), but the program was so popular that the government had to shut it down because of the adverse selection problems it created (Haiti Bureau du representant fiscal 1940 p 121).

Hence, at the beginning of the 20th century, many workers left Haiti and lots of land was idle. Together these two facts present a puzzle in Haitian economic history: with so much idle land available, why did so many workers move abroad? Evidently Haitian labor was more productive

(State Department 1924). The record is conflicted on how much the incidence of migration costs fell on the worker. Some laborers could circumvent migration fees by taking unofficial boats, so the true flows were higher.

[3]The average unskilled wage in Haiti was 1.00 to 1.50 Gdes per day but in Cuba it was 5.00 to 7.50 Gdes (Haiti Bureau du representant fiscal 1926 p 97).Furthermore, the workers could purchase clothing from the company store at one third to one half the price of clothing in Haiti, which means the real wage was even higher (State Department 1924).

[4]Lundahl (1996) argues that large, private land owners would have held very little of this land. The government held most of it.

abroad than at home. Yet, Haitian farmers could have increased their productivity by expanding production into the idle land. In fact, expanding domestic production would save migration costs and possibly reduce the harsh working conditions found abroad.

Contemporary observers struggled with this puzzle too. Legislators noted that migration removed agriculturalists from Haiti even though there was sufficient unused land to provide employment to all, and they tried to reduce migration through small changes in migration costs (State Department 1927). Some officials observed that areas with high emigration rates also had lots of fertile, idle land (Casey 2012 p. 86). Other officials believed that the revenue from employing the migrant labor on the idle domestic land would exceed migration incomes, but they had no recommendations for how to put the land into production (Haiti Bureau du representant fiscal 1930 p 141).

High migration caused labor shortage problems in Haiti. If 100,000 workers migrated each year (a rough estimate of the combined flows to DR and Cuba) then foreign countries employed about 20% of Haiti's prime-age (25-55) male workforce. The workers' absence did not go unnoticed, and many villages lost a substantial amount of productivity to these plantations.[5] For instance, in Aux Cayes, the fourth most populous district in the country, scarce male labor caused women and children to fill the vacant positions (State Department 1927). Not only did migration diminish the stock of labor, but it decreased the quality too as recruiters selected the healthiest and most able workers (State Department 1927).

1.1 Small Farms in Haiti

Haiti failed to switch to plantation farming on its abundant idle land because it had few tracts of *contiguous* idle land. Even though half of the agricultural land sat idle, this land did not exist on a frontier characterized by large spaces of unoccupied land. Farmers occupied the land like a checkerboard.

Haiti's absence of large landholdings made it unique in the region. This contrast is most clearly demonstrated looking at the border of Haiti and the DR. Figure 1 shows this border using an excerpt from a map created by the U.S. Army Inter-American Geodetic Survey. Each dot on the map represents a building, and the difference in the distribution of dots between the two countries

[5] See the editorial in Le Temps, Oct 1927

is clear. In Haiti, the dots are spread all over the land, but in the DR they are clustered together. This difference is why Moral (1961) argues that American capital went to other Caribbean countries: Haiti did not have large tracts of land owned by a single tenant (see p. 64). By 1970, farms five hectares or smaller accounted for 86% of Haiti's cultivated land, while in the DR 57% of cultivated land occurred on farms that were 50 hectares or larger.

Not only did private individuals not hold large plots of land, the government did not either. The government published a full-page ad in 1934 that demonstrates the difficulty of finding large tracts of government-owned land. In this ad, the government listed 26 properties available for rent, but it presented few large properties–only five were larger than 100 hectares.[6] Moreover, it listed 11 properties smaller than 10 hectares and even one that was only 0.36 hectares. One can conclude that if the state held large, contiguous tracts of land, it would not have bothered to announce such small parcels.

Thus, there were few opportunities to immediately swith to plantation agriculture in Haiti. Starting a plantation would require buying land from enough smallholders to reach the efficient scale. But the historical institutions that destroyed large farms in Haiti also caused Haiti to have high transaction costs.

2 The Historical Origins of Haiti's High Transaction Costs

Although the government owned a lot of idle land, investors could not acquire large tracts without negotiating with or evicting tenants because private holders dotted the land in a checkerboard pattern. Other countries, like the DR, did not have this problem and shifted resources to sugar production. Haiti's historical institutions explain how the property rights became so scattered.

2.1 Land Redistribution, Inheritance, and Persistence

The land tenure checkerboard reflects three historical influences. First, the newly independent Haitian government divided the colonial plantations. The Haitian revolution began in 1792, and after independence in 1804 the government, under President Alexandre Petion, began redistributing the land it had confiscated from the plantation owners (Thoby 1888 pp. 11-12). The northern

[6] *Le Moniteur*, 1934 No. 24 (22 March 1934)

portion of Haiti shortly avoided this redistribution and maintained plantation agriculture because Henri Christophe created his own kingdom there. But after Christophe's death in the 1820's, the government reunited the two regions and redistributed land throughout the entire country (Thoby 1888 p 10). More than 450,000 former slaves lived in the country, and almost all gained land through official or unofficial channels.

Redistribution destroyed sugar production and changed Haiti's agricultural structure. Table 1 shows the evolution of Haitian sugar and coffee exports from 1789 to 1824. The difference between 1789 and 1801 shows the revolution's effect on exports. The revolution eliminated slavery, destroyed capital, and removed French landowners, thereby reducing sugar and coffee output to 20% and 56% of their pre-revolution levels. After independence in 1804, the decline continued, and by 1818 total sugar exports were 6% of 1789 levels, and coffee was 34%. It is impossible to tell how much land redistribution contributed to the decline from 1801 to 1818, but it is interesting to note that in the North, where Henri Christophe had established the Kingdom of Haiti and maintained a plantation economy, sugar exports were still 43% of the pre-revolution levels.[7] But when the country was reunited after Christophe's death in 1820, redistribution was immediately in effect in the whole country, and sugar exports completely disappeared. Although sugar exports vanished, coffee stayed strong and became the country's main export through the 19th century. The disappearance of sugar production in the North after redistribution without a contemporaneous decline in coffee production suggests that land redistribution caused sugar cultivation to disappear.

The second historical influence was that the properties obtained through this redistribution fell under the control of entire lineages. Dividing the land among so many small holders would by itself make aggregating land difficult; however, aggregation became even harder because most of the private land had multiple claimants. Property owners divided their land equally among heirs (Bastien 1985). Each heir received usufructuary rights over the inherited land, but the entire family held the alienation rights; thus, a farmer could choose to cultivate his plot as he wished, but if he wanted to sell it he had to receive approval from all of his siblings and even cousins. Some believe the emancipated slaves explicitly designed this practice as a device to commit future generations to remain on small farms and prevent large-scale agriculture from returning and destroying the way

[7] This figure understates the North's decline in sugar production because it only reports unrefined sugar exports. The North was the country's main supplier of refined sugar, but after the revolution the country essentially stopped exporting refined sugar (Chevalier de Proisy 1790, Mackenzie 1830)

of life the early revolutionaries fought to create (Dubois 2012 pp109-110). However, one can also argue that it was a French institution that directed colonial property rights and continued past the revolution (Force 2016, p. 41).

Third, the new Haitian government banned foreigners from owning property. Fearing foreign powers would reassert control over their newly independent nation, the Haitian founding fathers, in the 1805 constitution, put all former French properties into the State's hands and explicitly banned foreigners of any nation from acquiring property in Haiti. The ban was such a policy priority that even when Christophe created his own plantation-oriented kingdom in the North he included it in his constitution (Janvier 1886). The government strictly enforced this ban, and even when outsiders attempted to circumvent the law, the government stopped them.

The ban introduced a crippling hysteresis by cutting-off a key source of capital that could have aggregated land before it became too costly. The US eliminated the ban in 1918, but because the Haitian government enforced it for 100 years after it redistributed the land, removing it did not change the agricultural organization. Without the foreign property ownership ban, a deep-pocketed investor might have purchased large tracts before subsistence farmers captured them. But the government enforced the ban, and the population grew and populated the land, dividing the land amongst more claimants. Once the U.S. removed the ban, investors could not purchase land without dispossessing many farmers.

Because of the checkerboard pattern, anyone wanting to establish a large plantation would have needed to evict or contract with the private farmers. Yet neither farmers, investors, nor even the government had the authority or power to evict farmers. At the beginning of the occupation, the government granted a few thousand acres to American companies, but many of them did not cultivate the land because of the difficulty evicting the small farmers (Casey 2012 pp 84-85). Companies could contract with individual farmers, but achieving the minimum efficient scale required contracting with too many parties. "One sisal company, desiring to acquire about twenty hectares [50 acres] in the east of Cul-de-Sac, *has negotiated for three years with 180 propertyholders*, descendents of an obscure Revolution general" (Moral 1961 p 185, emphasis mine). To this end, no one had access to a low cost solution to the prevalence of smallholders on agricultural land.

Dispossessing farmers was a difficult route because the government had weak eminent domain powers. There are many stories of the government expropriating wealth from peasants, but there are

few confirmed instances prior to the 1915 U.S. occupation of it confiscating peasant land. Indeed, a detailed study of one area could not find a single instance of the government or elite expropriating land (Murray 1977, pp. 341-42). In some cases, the government claimed peasant land, but the owner successfully challenged it in court and won (Haiti Bureau du representant fiscal 1928 p 74). Some U.S. officials complained that the government needed to reform its eminent domain law to make eviction easier (Haiti Bureau du representant fiscal 1938 p 99). But other officials wanted to maintain support from the masses and refused to force peasants to sell their land to large American companies (Schmidt 1971, p 179). Not until the 1940s, after the U.S. occupation, did the government successfully and consistently obtain large tracts of land through evicting smallholders.

The prevalence of small landholders weakened incentives for the Haitian government to engage in agricultural policy. Because everyone owned land, the elites lost their source of cheap labor and with it the profits from owning large agricultural land.[8] The elites moved out of agriculture, and from 1850 to 1915, they constantly fought for control of the government and political rents. This periodic conflict distracted the government from taking an active role in agricultural policy. Meanwhile, peasants had no political power and did not actively seek it, so no one lobbied for government action.[9]

In summary, historical institutions divided the land among the population and created forces that prevented the government or investors from consolidating it. By the beginning of the 20th century, smallholders dotted the country like a checkerboard. Moreover, Haiti's position was unique relative to similar countries.

2.2 Comparison to other countries

While this is not the first paper to highlight the institutions that led to Haiti's high transaction costs, other researchers have not compared Haiti to other countries to show how it differed. Comparing Haiti's history to other countries more firmly establishes the role of these institutions in imparing agricultural development. First, the Dominican Republic's history shows that its colonial economy favored large, unbroken properties and that the historical evolution favored foreign investment. Second, Jamaica's history demonstrates that, like Haiti, it redistributed plantations

[8] The transition from Saint Domingue to Haiti is a perfect example of Domar's (1970) trilemma.

[9] See Chapter 7 of Lundahl (1979) for a more complete treatment of Haiti's passive government.

after emancipation, but unlike Haiti it could not ban foreigners from investing in the land market. The institutional histories of the Dominican Republic and Jamaica did not create large transaction costs, and therefore they both took advantage of the export boom when Haiti could not.

2.2.1 Dominican Republic as counterfactual

The differences between property rights in Haiti and the DR extend back to colonial times. While Haiti generated large profits for French investors, the Dominican Republic (then Santo Domingo) played a peripheral role in Spain's empire because the Spanish could easily extract wealth from its other colonies abundant in minerals and labor. But by the beginning of the 20th century, the countries had switched roles, with sugar becoming the Dominican Republic's top export while Haiti exported virtually none.

Sugar production grew in the DR because it serendipitously promoted foreign investment just as the export boom began. The DR did not promote investment because it knew demand would soon increase; the invesment policy was a defensive move against Haiti. In February 1822, Haiti conquered the entire island of Hispaniola, just three months after the DR declared independence from Spain in November 1821. After Haiti left the eastern half of the island in 1844, the DR sought protection from Haiti through international powers. In 1861, the Dominican Republic voluntarily returned to being a Spanish colony–the only Latin American country to do so after gaining independence–but then declared independence in 1865 (Sagas 1994). After the Civil War, President Buenaventura Baez of the DR worked with members of the U.S. government towards annexing the DR to the United States, even making large land concessions to Americans, but the effort ultimately failed (Pinkett 1941). The DR actively promoted foreign involvement just as export demand increased.

When the export boom began, the DR was an attractive investment opportunity not only because it actively sought foreign capital, but also because history had left many open, uncultivated tracts of land. During the colonial times, because Spain's other Latin American colonies were abundant in labor, the DR's economy did not rely on labor-intensive activities. Some farmers cultivated cash crops using slave labor, but cattle raising generated the most economic activity. Ranchers needed large, open pastures for grazing, so the population did not spread over the land. Its colonial economy produced more concentrated land holdings and a lower population density. Thus, by the end of the 19th century, investors bought large tracts of land on the Dominican

frontier, demanded clear property rights, and received preferential treatment from the government (Martinez 1999, Moya Pons 1985).

As the DR actively solicited foreign investment, Haiti cracked down on it. An 1860 Haitian law specified that in a marriage between a foreign man and a Haitian woman, only the wife could purchase and hold property (Janvier 1886 p. 275). Merchants exploited this loophole and acquired property through their new Haitian wives, but this strategy soon became popular enough to worry the government. The 1879 constitution stripped women married to foreigners of their Haitian citizenship, required them to sell any property within three months of the marriage, and forbade them from acquiring property in the future. In the event of the husband's death, the woman could only regain her citizenship and property rights if the couple had no children (Janvier 1886 pp. 422-23). Just as export demand took off, the Haitian government closed a loophole available to foreign investors.

The Dominican Republic took advantage of the export boom because investors could get land without negotiating with small farmers. It had similar factor endowments as Haiti, and the fact that it eventually relied on Haitian labor indicates that Haiti had a better labor endowment. But foreign investors could not get the land they needed in Haiti. The difference in the land markets is what caused the Dominican Republic to grow and not Haiti.

2.2.2 The Ban and Bananas - Jamaica as counterfactual

In many ways, Jamaica serves as an even better counterfactual for Haiti. Although they do not share an island, Haiti and Jamaica are geographically close, and their factor endowments are similar. Importantly, like Haiti, Jamaica's colonial economy relied on slave labor to produce sugar. Jamaica also experienced a shift to small-scale farming after emancipation as former slaves divided the plantations. But instead of the Jamaican government redistributing the plantation land, parties of former slaves pooled resources, purchased entire plantations, then divided the land. The freeholders chose similar plot sizes to their Haitian counterparts: the modal plot was between one and two hectares (Holt 1992). Decreasing sugar prices in the 19th century reinforced the decline of sugar plantations and the rise of smallholdings (Dippel et al. 2016). Both Jamaica and Haiti were on track to create economies dominated by small farms.

But unlike Haiti, Jamaica could not ban foreigners from owning property, and soon plantation

agriculture returned to Jamaica. Emancipation did not remove Jamaica from the British Empire, and the freed slaves could not ban the the British from owning land. In the late 19th century, as part of the export boom, banana prices increased significantly. Because bananas spoil quickly once picked, there were significant economies of scale to vertically integrating banana cultivation and shipping. Foreign investors monopolized shipping and then bought land for banana plantations. The demand surge increased land prices, and smallholders sold their plots and worked on banana farms (Holt 1992). Large plantations returned to Jamaica through early foreign investment.

Contrast this to the Haitian banana experience. Emancipation in Haiti came 40 years before Jamaica, and the U.S. did not repeal the ban on foreign property ownership until 1918. Thus, when the export boom came in the 1870s, Jamaica had only been removed from the plantation regime for a few decades, but by the time foreigners could invest in Haiti it had been over a century. At the time foreigners could invest in their land markets, there were significant differences between the two countries in their transaction costs. The Standard Fruit Company's experience investing in bananas in Haiti shows how drastic this difference was. Standard Fruit attempted to establish a 2,000 acre banana plantation in the 1930s, but "in order to secure enough land in fairly contiguous territory for efficient operations, the company [had] to sign lease and share contracts with hundreds of little land owners" (Lundahl 1979, p 286). Standard Fruit tried farming around the households that declined contracts, but these farmers disputed Standard Fruit's property rights and it incurred large costs resolving them. Cultivating the same crop faced much higher costs in Haiti than in Jamaica.

Jamaica and Haiti had similar histories. Both were plantation crop export colonies heavily reliant on slavery; both had widespread land redistribution after emancipation. But Haiti had a large headstart dividing its plantations, and foreigners were unable to enter the market until much later than Jamaica. Transaction costs in Haiti were much higher than they were in Jamaica, and this caused Jamaica to grow over Haiti.

3 Model

Thusfar the evidence has established that historical property rights institutions caused Haiti to have high transaction costs to developing agricultural properties. But I have yet to show that these high transaction costs caused Haiti to miss the export boom. In fact, the discussion has omitted

an obvious culprit: differences in productivity. I present a model that accounts for differences in transaction costs and productivity and show that productivity differences cannot explain all of the facts presented so far. Furthermore, I derive testable hypotheses for how transaction costs affect agricultural structure that I can take to the new land adoption data I collected.

Suppose that there are two small countries, H and D, that produce two goods, X and C, for trade on the international market using two factors, land (T) and labor (L). Country i produces good j using the production function $A_{ij}F(T_{ij}, L_{ij})$, which exhibits decreasing returns to scale and is continuous and twice differentiable, with $f_L > 0$, $f_T > 0$, $f_{LT} > 0$, $f_{LL} < 0$, and $f_{TT} < 0$. Note that the function $F(T, L)$ does not differ across countries or goods, but the productivity A_{ij} can. Because the small countries sell on the international market, the price for each good (p_j) is exogenous to the country's production. For ease of exposition, assume $p_C = 1$.

Each country has an endowment of land and labor, E_i^T and E_i^L. Land of course cannot move between countries, but labor can migrate. There is no cost to migrating, but in the testable hypotheses I look at what happens when the economy goes from free migration to autarky, which is like moving from no migration costs to infinite. The model produces similar predictions as if there were changes in migration costs.

Both countries have incomplete property rights, which introduce transaction costs into the land market. There are two types of transaction costs. First, there is the cost of protecting land, ϕ_{i1}, which applies to land producing either good. Second, there is the cost of assembling land for producing X, ϕ_{i2}. Cultivating X allows the farmer to use technology A_{iX}, but the only way to get that technology is to produce on large, contiguous land. Assembling that land involves transacting with many smallholders, which I assume is constant per unit of land. Below I discuss the microfoundations of these transaction costs and their implications. The transaction costs for land under each good j can be summarized as ϕ_{ij}, where $\phi_{iC} = \phi_1$ and $\phi_{iX} = \phi_1 + \phi_2$. Transaction costs may differ across countries.

The equilibrium is characterized by each country maximizing profits for each good they produce, satisfying the first-order conditions

$$p_i A_{ij} f_T(T_{ij}, L_{ij}) = r_i + \phi_{ij} \tag{1}$$

$$p_i A_{ij} f_L(T_{ij}, L_{ij}) = w_i, \tag{2}$$

the total labor used in both countries is equal to the countries' endowments

$$\sum_{i \in \{H,D\}} \sum_{j \in \{C,X\}} L_{ij} = \sum E_i^L, \tag{3}$$

and the land used in both countries equal to or less than the individual country's endowment

$$\sum_{j \in \{C,X\}} T_{ij} \leq E_i^T. \tag{4}$$

Note that if the land market does not clear, then $r_i = 0$.

The model's purpose is to show how transaction costs affect the economy versus productivity differences. For the sake of focusing on the most important elements of the analysis, assume that endowments are the same across countries ($E_H^T = E_D^T$, and $E_H^L = E_D^L$), that the two countries use the same technology when producing C and for simplicity's sake it equals 1 ($A_{HC} = A_{DC} = 1$), and that the cost of protecting land is the same for both countries ($\phi_{H1} = \phi_{D1} = \phi_1$). Thus, the countries only differ in the technology they use for producing X (A_{iX}) or in the costs of assembling land for producing X (ϕ_{i2}). In some implications the exposition is clearer if we assume a Cobb-Douglas production function, $F(T, L) = T^\alpha L^\beta$ where $\alpha + \beta < 1$.

Implication 1: There exists a $\bar{\phi_1}$ *for which* $T_{iX} + T_{iC} < E_i^T$ *(i.e. there is some idle land) for all* $\phi_1 > \bar{\phi_1}$.

This is a straightforward but important implication that can be seen in Figure 2. This figure plots the marginal product of land in X and C, assuming the country allocates labor efficiently. The x-axis shows the country's land endowment ($O_X O_C = E^T$), measuring from the left shows the marginal product of land in producing X, and measuring from the right shows the marginal product of land in producing C. Without transaction costs, the market clears at rental rate r^* , the amount of land in X would be $O_X D$, the amount of land in C would be DO_C, and there would be no idle land. However, if ϕ_1 is higher than r^*, even assuming $\phi_2 = 0$, then the land market will not clear: $T_X = O_X B$, $T_C = FO_C$, and BF would sit idle. This result explains frontier land in economies in general, and it addresses the puzzle the American occupiers observed when they saw Haiti's idle land.

Implication 2: If the cost of assembling land for X is too high ($\phi_2 > \bar{\phi_2} = (p_X A_{iX} - 1)\phi_1$), then there will be more land devoted to producing C than to producing X.

Figure 2 also shows this implication. With ϕ_2 high enough, $T_X = O_X A$. Since land in C does not have to incur the additional transaction cost, T_C would still be FO_C. At the level of of ϕ_2 drawn, $T_X = O_X A < FO_C = T_C$. Furthermore, the AB section would be idle in this circumstance.

This result holds generally. If $\phi_2 > \bar{\phi_2} = (p_X A_{iX} - 1)\phi_1$, then

$$\begin{aligned} p_X A_X f_T(T_{iX}, L_{iX}) &= \phi_1 + \phi_{i2} \\ &> \phi_1 + (p_X A_{iX} - 1)\phi_1 \\ &= p_X A_{iX} \phi_1 \\ &= p_X A_{iX} f_T(T_{iC}, L_{iC}) \\ \implies f_T(T_{iX}, L_{iX}) &> f_T(T_{iC}, L_{iC}). \end{aligned}$$

From the profit maximizing condition for labor (2) we know that

$$f_L(T_{iX}, L_{iX}) < f_L(T_{iC}, L_{iC}). \tag{5}$$

For both of these conditions to hold, it must be that $T_{iX} < T_{iC}$ and $L_{iX} \leq L_{iC}$.

This implication provides a possible explanation for why Haiti did not develop planation properties while the DR did. If transaction costs to assembling planation land are too high, then most of the land will be in subsistence farming, just as we observe in Haiti.

Implication 3: If $p_X < A_{iX}^{-1}$, then there will be more land devoted to producing C than to producing X. However, as p_X increases, land quickly goes into producing X.

This implication states that if the price of X is too low, the country will devote more land to producing C. This result explains most of 19th century Haiti and the DR. Returns to producing sugar were low (Dippel et al. 2016), so neither country produced much. However, as cash crop prices increased, countries in the region adopted more plantation land. Haiti, on the other hand, did not. Which brings us to the next implication.

Implication 4: All else equal, labor will migrate to the country with (a) the lower ϕ_{i2} or (b) the country with the higher A_{ix}. This migration pattern is exacerbated as p_x increases.

The demand for labor to produce each good in each country, under the Cobb-Douglas production function assumption, is

$$L_{iX} = \left(\frac{p_X A_{iX} \beta^{1-\alpha} \alpha^{\alpha}}{w_i^{1-\alpha} \phi_{i2}^{\alpha}} \right)^{\frac{1}{1-\alpha-\beta}} \tag{6}$$

$$L_{iC} = \left(\frac{\beta^{1-\alpha} \alpha^{\alpha}}{w_i^{1-\alpha} \phi_1^{\alpha}} \right)^{\frac{1}{1-\alpha-\beta}}. \tag{7}$$

Migration causes the wage to equalize across countries, each country demands the same amount of labor for C ($L_{HC} = L_{DC}$), and the country with lower ϕ_{i2} or higher A_{ix} demands more labor for X. Therefore, labor migrates to the country with a comparative advantage in producing X, the one with lower transaction costs or better technology. Migration costs mitigate these flows and may even stop migration, but they cannot change the direction.

When p_x increases, the returns to plantation agriculture increase. Thus, plantation labor demand will increase in both countries. But on net the country with lower transaction costs or higher A_x will receive migrants. These elements give the country a comparative advantage that will increase the return to labor.

This result tells us that migration can come from two sources. If Dominican plantations are more productive than their Haitian counterparts (perhaps due to better soil or technology), then Haitian workers will migrate to the Dominican Republic. But this migration pattern will also be observed if they have the same productivity but it is less costly to assemble plantations in the DR. The increase in prices from the export boom strengthens the migration flows, but migration itself does not reveal whether the country is more productive or has lower transaction costs. To discern the difference, we must stop migration.

Implication 5: If $p_X A_X \geq 1$ *and if* $\phi_2 = 0$*, then if migration between countries stopped, the ratio of* ΔT_X *to* ΔT_C *would be greater than or equal to one. However, if* $\phi_2 > \tilde{\phi_2} = \left((p_X A_{HX})^{\frac{1}{\alpha}} - 1 \right) \phi_1$*, then* $\Delta T_X / \Delta T_C < 1$.

Figure 3 demonstrates this implication. When migration opportunity disappears, the marginal product of land increases for both X and C because each can hire more labor at the same wage. This shift will lead the country to include more land in the C sector, moving from $O_C F$ to $O_C K$, such that $\Delta T_C = KF$. The C sector's change is independent of how high ϕ_2 is, but the change in the X sector depends on ϕ_2's magnitude. If $\phi_2 = 0$, then T_X would expand from $O_X B$ to $O_X H$,

and $\Delta T_X = BH$, a much larger expansion than what the C sector experiences. However, with high ϕ_2, T_X goes from $O_X A$ to $O_X G$, $\Delta T_X = AG < BH$. This is a significant increase over the previous level of T_X, but the change is not as large as what occurs in the C sector.

Another way to think about how transaction costs affect the land market's response to a change in migration costs is to think about how transaction costs affect the marginal rate of technical substitution. When transaction costs are high, the marginal product of land is high relative to the marginal product of labor. An increase in migration costs lowers the cost of labor in H, which will lead farms to hire more labor. However, the marginal product of labor is already relatively low, so hiring more labor does little to improve plantation productivity. With high transaction costs, the marginal productivity of land is high, but the economy cannot afford to adopt more plantation land.

This can also be demonstrated in the Cobb-Douglas demand. Moving to autarky, the wage will go from w_1 to $w_2 < w_1$, and the change in T_{HX} is

$$\begin{aligned}\Delta T_{HX} &= \left(\frac{p_X A_{iX} \beta^\beta \alpha^{1-\beta}}{(\phi_1 + \phi_{H2})^\alpha}\right)^{\frac{1}{1-\alpha-\beta}} \left(\frac{1}{w_2^{1-\alpha}} - \frac{1}{w_1^{1-\alpha}}\right)^{\frac{1}{1-\alpha-\beta}} \\ &= \left(\frac{p_X A_{iX} \phi_1^\alpha}{(\phi_1 + \phi_{H2})^\alpha}\right)^{\frac{1}{1-\alpha-\beta}} \Delta T_{HC}.\end{aligned}$$

If there are no transaction costs to assembling plantations ($\phi_{H2} = 0$), then

$$\frac{\Delta T_{HX}}{\Delta T_{HC}} = (p_X A_{HX})^{\frac{1}{1-\alpha-\beta}}. \tag{8}$$

Thus if $p_X A_{HX} \geq 1$, then $\Delta T_{HX}/\Delta T_{HC} \geq 1$. As ϕ_2 increases, $\Delta T_{HX}/\Delta T_{HC}$ decreases, and if $\phi_2 > \left((p_X A_{HX})^{\frac{1}{\alpha}} - 1\right)\phi_1$, then the ratio will be less than one. Note that $\tilde{\phi_2} > \bar{\phi_2}$ from Implication 3, so if this implication holds then that one does too.

This implication provides a testable hypothesis to discern between technological differences and costs to assembling plantations. It is akin to a protectionist argument for developing plantations: if D produces more X because it has higher productivity, then some protectionist policy that eliminates migration would necessarily create the plantation industry in H. On the other hand, if workers migrate because assembling plantations in H is too costly, then moving to autarky will have almost no effect on plantation land in H. Instead, workers will go to subsistence farms.

3.1 Microfoundations for Transaction Costs

Section 2 detailed the historical origins of Haiti's transaction costs, and now I discuss how the model reflects those.

First, there is significant evidence that contexts with weak property protections produce costs to protecting land, ϕ_1. A common way property owners protect their land is by devoting more labor to the property than to other market activities (Field 2007, Goldstein et al. 2015, Goldstein and Udry 2008). Landowners might need to construct fences to prevent intrusion (Hornbeck 2010). Even in contexts with well functioning legal institutions, the cost of protecting property can depend on how property rights were defined (Libecap and Lueck 2011). Governments might try to coordinate settlements to reduce the costs of protecting property (Allen 1991), but settlers might strike it out on their own if the private costs of protecting property are lower than relying on the government (Dye and La Croix 2013). Thus, there is ample justification for including ϕ_1 in the model.

Second, the justification for ϕ_2 comes from the need for these crops to be farmed on large, contiguous plots of land. Crops like sugar and bananas quickly perish once harvested and need to be immediately process or moved to market. Large, contiguous plots minimize the costs of moving these goods. The examples above have shown how investors in Haiti tried to get contiguous tracts of land, and investors in Jamaica acquired large land for bananas. Another example of this difficulty comes from the Cuban sugar industry at this time. Investors sought to establish new, technologically advanced mills in the developed Western area of the island, but the landholders in this region had the incentive to hold-out for higher prices once the investor had committed site-specific capital. Thus, investors moved to the underdeveloped Eastern region, where there were fewer landholders and the mill owners could minimize transaction costs by buying their own land and contracting it out (Dye 1994). Because farmers need much more land to cultivate these crops, if there are more claims on the land then there will be greater costs convincing all property owners to sell. Moreover, in Haiti you cannot just convince the person on the land, you also have to convince the extended family.

This understanding leads to the final implication.

Implication 6: Settlement patterns affect transaction costs.

The intuition is that if no one has claim to the land, there are no transaction costs, and the

more people who have claim to the land, the higher the transaction costs. Land with households living on it has higher transaction costs than land without households. This is true for both types of transaction costs. More households in the area means more need for protection from neighbors (higher ϕ_1), and more households means more people to persuade or evict (higher ϕ_2).

4 Data on Land Adoption and Transaction Costs in Haiti

To test for whether transaction costs blunted Haiti's reaction to the export boom, we need data on the Haitian land market. Data on Haitian land is notoriously difficult to find (Lundahl 1996), and there are no data available to test the export boom of 1870 to 1930. However, I have collected new data on the land market from a later period, and using the later period we can make inferences about the export boom. The advantage of using the new data is that they come after the ban was removed, and therefore access to foreign capital is not a problem.

The new data come from a 1927 land reform initiated by the U.S. occupation. In 1914, the U.S. Marine Corp extended its Caribbean strategy and began occupying Haiti.[10] The marines initially intended to leave quickly, but because officials feared creating instability if the U.S. withdrew too soon the occupation lasted until 1934.[11] In extending the occupation, American officials gained greater control over policymaking,[12] and one of the top priorities became strengthening the government through increased internal revenues.

Instead of internal taxes, Haiti's government relied almost exclusively on volatile customs receipts for its revenues. From 1911 to 1915, over 97% of government revenue came from customs receipts. The dependency decreased after the U.S. entered, but even in 1926 customs still comprised 86% of revenues.[13] Seeking a more stable source of internal revenue, the Financial Adviser, a position

[10] The Caribbean was a key commercial and military location because of the Panama Canal and the islands' strategic positions. To protect US interests, the military secured nearly every major territory in the region. In the early 20th century, the U.S. was present in Cuba, Puerto Rico, Nicaragua, the Dominican Republic, and Haiti (Schmidt 1971). Haiti was an especially important location because of its strong German presence and its chronic political instability (Heinl 1996).

[11] The grassroots Haitian resistance forces were rising again and causing problems for the American soldiers. Officials believed that withdrawing without establishing stronger institutions would leave the island in chaos (Schmidt 1971)

[12] Schmidt (1971) argues that the U.S. leaders extended the Progressive movement and implemented technocratic reforms to eliminate corruption and improve efficiency. Many reforms were effective and greatly reduced corruption; even U.S. firms had trouble gaining special privileges (Millspaugh 1929, Schmidt 1971). In their reports we can see that officials were constantly looking for inefficiencies to resolve.

[13] A study published at the time, cited by the Financial Adviser's report, claimed Haiti was the country most dependent on customs receipts; its reliance far exceeded the next two highest: Salvador (66%) and the Dominican

created and occupied by the Americans to control Haiti's finances, believed the government could increase land revenues (Haiti Bureau du representant fiscal (1927) p 65). Land was the country's principal source of wealth, but the government faced significant barriers to deriving greater revenue from it. Haiti had no land tax and, more importantly, no cadaster to even indicate who owned land. Instead of instituting radical, divisive new land programs, the American officials decided to reform an old land rental program.

Since 1877, the government had made land available to rent, but it had administered the program poorly. The program was a bureaucratic mess; as one official said, "It would be hard to devise a system more susceptible to fraud or more difficult to administer properly" (Haiti Bureau du representant fiscal (1925) p 119). The American reforms clarified the organization, corrected price distortions, and created incentives to invest. For example, the reformers explicitly chose the rental rate to compete with market rates (Millspaugh 1929). Furthermore, the reform guaranteed the tenant could farm the land for 20 years and receive only one rent increase to keep up with inflation. But the rent increase could not capitalize any investments made on the plot, therefore the tenant became the residual claimant on land investments. The American officials hoped that fixing these issues would quickly supply the government with revenue.

From this land rental program, I have collected new data on land adoption patterns in Haiti from 1928 to 1950. The land rental law required the government to publish a notification every time a farmer adopted idle land. The rental program published notifications in its official gazette, *Le Moniteur,*[14] and kept it in the paper for at least three months. Notifications appeared only when land was adopted for the first time. I have collected the universe of notifications published from 1928 to 1950, during which farmers adopted 5,792 agricultural plots.[15] Each notification contains descriptive information about the requested land, listing the plot's location in one of Haiti's 105 administrative districts (*communes*) and describing the plot's size and the neighbors–i.e. what was located on the north, south, east, and west side of the plot–to facilitate locating it. It also listed the renter's name and the date he or she requested the land.

Republic (50%).

[14] As a civil law country, Haiti regularly publishes notices of government action in its gazette. *Le Moniteur* mainly published laws and presidential decrees, but one can also find notices that affect only one person, such as citizenship declarations or check cancellations.

[15] Every notification lists the first date it was published, which allows me to explore gaps to confirm there are no missing notifications. Because all notifications are published for at least three months, I can use multiple issues to double check notifications and avoid missing data that might result from damaged or missing issues.

4.1 New Patterns from the Rental Data

With this new data, I find four new empirical patterns about land adoption in Haiti at this time. These patterns come with a caveat: they are derived from land observed because it was adopted under this program and do not apply to all state owned land. Nevertheless, they provide evidence consistent with high transaction costs to adopting large tracts of land.

First, under favorable rental conditions, farmers did not adopt much land. The nearly 5,800 plots together constituted about 30,000 hectares, an unremarkable figure compared to the nearly 960,000 hectares available (Brisson 1968). To put this in context, consider that the land adopted did nothing to change the fact that farmers cultivated only two-thirds of the land cultivated by colonists.[16] Despite the government's efforts to induce farmers to cultivate the idle land, farmers adopted little. Farmers establishing plantations could have quickly put large amounts of land into cultivation, yet that few took advantage of the program indicates there must have been something outside of it stopping them.

Second, farmers adopted small plots. Figure 4 shows the plot size distribution, and we can see most of the mass at the low end, with the median plot equal to 1.29 hectares.[17] Nevertheless, we observe a full range of plot sizes, even into the hundreds of hectares. The law did not dictate or limit plot sizes, and the distribution confirms farmers did not face legal size limits. But their preference for small plots indicates that other constraints existed.

Third, farmers did not choose small plots because they had no room to expand; in fact, some farmers could have chosen larger plots but did not. Often the notification described idle land next to the adopted plot. In fact, 15% of plots have at least one neighbor listed as "unoccupied state land," and 31% of plots have at least one neighbor listed as "rest of the land" or simply "the State." Together this means that 46% of renters had the opportunity to choose larger plots but did not. By a revealed preference argument, these subsistence farmers selected the optimal farm size subject to their constraints. This choice is consistent with the inverse productivity result, where at small scales small farms are more productive than larger farms (Foster and Rosenzweig 2017).

[16] Colonists cultivated one million hectares (McClellan 2010, p 64), and Brisson (1968) calculated that four departments cultivated 496,000 hectares, which was 40% of the arable land in these departments. He estimated in the fifth department there was 354,000 hectares of arable land. Applying the same 40% figure to this department yields 141,000 hectares, making the total cultivated land 637,000. Hence, the farmers only cultivated 64% of the total land cultivated by colonists.

[17] The Haitian standard unit of land was the *carreaux*, which is equal to 1.29 hectares.

Finally, farmers adopted many state plots that bordered private land, which suggests that farmers could not find large tracts of land because state and private land coexisted in a checkerboard. The notification's description mentions whether the government owned land bordering the plot or not. If we assume the notification always explicitly said when the government owned the neighboring plot, then 67% of plots had at least one neighbor not owned by the state. But the notification's writer might have assumed that the reader knew the government owned the surrounding land, meaning this figure might overestimate the prevalence of private land. A more conservative estimate looks just at how many plots had at least one state-owned neighbor and at least one privately-owned neighbor. In this case, 48% of plots were bordered by both private and state land. Thus, finding state-owned land without private neighbors must have been difficult.

These findings together illustrate that farmers could not find contiguous agricultural land. But we can get a greater sense of the transaction costs by using the data to explore the model's testable implications.

4.2 Measuring transaction costs

To measure transaction costs, I use the U.S. Army Inter-American Geodetic Survey.[18] The 1956 survey created a detailed map using aerial photographs of the island and marked the location of buildings and huts. The more detailed map (at 1:25,000 scale) covers 70 districts and gives no additional information on landholdings beyond the building locations. The map gives the most detailed record available of the population's spatial distribution. The government never kept a detailed cadaster, and attempts to create them failed.[19]

To measure settlement patterns, I developed an image processing algorithm. First, the maps are divided into simulated plantations of about 100 hectares, 256 x 256 pixel squares. The algorithm mapped the simulated plantations to administrative districts using the original georeferenced maps. For plantations that fell in more than one district (i.e. the border intersected it), the algorithm assigned it the district where the majority of the pixels fell. In the event that the plantation's pixels fell evenly in more than one district, the district was assigned randomly. I discarded all plantations where the majority of the pixels fell in either the ocean or the Dominican Republic. In the end,

[18] The map is available at the Digital Library of the Caribbean www.dloc.com.

[19] The U.S. tried to create a cadaster using aerial photography, but the building containing the photographs burned down under mysterious circumstances (Schmidt 1971 p 179).

I had 32,412 simulated plantations mapped to 70 districts, with the average district containing 506 plantations. I randomly selected 10% of each district's plantations for the image processing algorithm.

The image processing algorithm counts the number of houses on each plantation. This process is relatively easy and mundane for a human because the markers are clear, black dots. However, humans can easily parse out the map's details, such as contour lines or latitude/longitude lines, but the computer must be instructed how to filter the noise. Thus, the algorithm's first step eliminates irrelevant features by converting the image to black and white. Although most of the map is gone, there are still extraneous details, such as roads and place names.

To separate houses from these other features, the algorithm tags all connected groups of black pixels and selects the groups that fit the description of a house. This step in the algorithm is akin to a graph search. The algorithm locates a black pixel, then checks each neighbor to the north, east, south, and west to see if it is also black. Adjacent black pixels are labeled connected, and a group is a set of pixels such that every pixel is connected to at least one other pixel in the set. The algorithm identifies all groups, then it classifies a group as a house if it meets two criteria: (1) the group contains between 8 and 24 pixels inclusive and (2) the farthest distance between any two pixels in the group is less than or equal to 5 pixels. The first criterion comes from the observation that the house markers were typically 3x3 to 5x5 pixels. The second eliminates groups that fit the first criterion but are too diffuse to be a house marker; i.e. a road that is 20 pixels long.

The algorithm compares incredibly well to hand-counting. Prior to developing the algorithm, I had hired a freelancer to count the number of dots on 1,629 images. I ran these same images through the algorithm to check its validity. Figure 5 shows the relationship between the hand-counted and machine-counted tallies, and the correlation coefficient between the two counts is 0.96. Although the relationship is strong, there is clearly some measurement error, which I address below.

After running the image processing algorithm, the data are ready to construct the transaction cost variables. For plantation i in district d, the algorithm outputs x_{id}, the number of dots on the image. The number of counted plantations in district d is N_d. For each district, I calculate μ_d and σ_d, which are the mean and standard deviation of x for all plantations in district d. Section 5.2 describes how to use these statistics to test Implication 6.

5 Testing for transaction costs

Combining the model with these new datasets allows me to test for transaction costs. First, I observe how the land market responds to changes in migration opportunities. I test the model's predictions of the land market response to labor market changes using the 1937 Trujillo massacre. The massacre was a political event exogenous to economic conditions in Haiti that created a large labor supply shock with differing effects throughout Haiti. Thus, it serves as a sudden market signal to which we can test the land market's response using the new data. The analysis focuses on whether the land market responded as we would expect.

Second, I try a more direct test of transaction costs looking at the relationship between land adoption and settlement patterns. In a Coasean world, where people live has no effect on the land market. However, when transaction costs enter, where people live affects land adoption. The second test involves measuring how transaction costs differ across districts and observing their relationship with land adoption patterns.

5.1 Removing migration opportunity - The 1937 Trujillo Massacre

First I test Implication 5 from the model. This implication states that as migration opportunity decreases, land adoption would respond in a certain pattern. Specifically, farmers would adopt more land under plantation agriculture than under subsistence unless transaction costs distort the optimal distribution. To test this prediction, I use an exogenous change in migration opportunity looking at the 1937 Trujillo massacre.

In October 1937, without warning, the Dominican Republic's President Rafael Trujillo sanctioned the slaughter of Haitians living in the DR. The exact number of deaths is unknown, and estimates vary widely; however, the most reasonable estimates count 12,000 deaths over a few days (Vega 1988). The massacre came as a complete surprise. Prior to the Trjuillo massacre, the Dominican Republic and Haiti experienced border issues, but they settled it diplomatically (Roorda 1996).[20] Nothing indicated that a year later one of them would commit a tremendous atrocity.

The massacre was unrelated to conditions in Haiti. U.S. officials blamed the massacre on low sugar prices and high Dominican unemployment (Haiti Bureau du representant fiscal 1938 p 78).

[20] They achieved such a peaceful settlement that the two presidents received 14 nominations for a joint Nobel Peace Prize See http://www.nobelprize.org/nomination/archive/show_people.php?id=9662 accessed 22 Aug 2016

But these explanations are inconsistent with the available evidence. First, the large decline in sugar prices occurred from 1929 to 1933, and in fact in 1937 sugar prices increased by 26% (Anuario Estadistico 1938 vol 2, p 205). Second, Dominican unemployment cannot be the cause because Trujillo was not trying to replace Haitian labor with Dominican labor; in fact, he tried to fill demand by recruiting labor from Puerto Rico (Roorda 1996). No one has attributed the massacre to a credible economic cause, and even the racial motivations are hard to find because anti-Haitianism was not substantially a problem in the DR until after the massacre (Turits 2003, Derby 1994). The consensus on the massacre's causes is best expressed by Turits (2003), "What caused Trujillo to order the 1937 massacre will probably remain forever obscure" (p. 179).

While the massacre's cause was orthogonal to Haiti's economic conditions, it had two subsequent effects on the Haitian labor market. First, it increased the cost to Haitians of being in the DR. Any Haitian travelling to the DR now risked death, and surviving Haitians left the country in droves. Conditions were so desperate that workers abandoned land and livestock (Turits 2003, Palmer 1976). In one instance, sugar company recuirters offered high wages to refugees leaving the country by bus, but of the 2,000 passengers they convinced only three to stay (Vega 1988). In the 1935 Dominican Republic Census, the government counted almost 53,000 Haitians in the country, but in the 1950 Census the government found less than 19,000. Within 15 years, the DR lost 64% of its Haitian population. The loss occurred throughout the country, but, as seen in Table 2, the border areas saw some of the largest losses. The count in 1935 for the north-western border provinces where the massacres were concentrated—Libertador, Monte Cristi, and San Rafael—included more than 7,000 Haitians, but in 1950 it was only seven. Even in the southern province of Barahona, where we have no reports of mass killings, almost 6,000 Haitians disappeared in the intercensal years. Yet the census numbers underestimate the massacre's effect on Haitian workers because they do not reflect the change in seasonal migration or the Haitians who would have gone to the DR but chose not to because of the increased cost. The massacre disrupted Haiti's entire labor market.

Second, the massacre created a large labor supply increase in Haitian border districts. The government was unprepared to receive the many refugees who arrived injured and penniless (Haiti Bureau du representant fiscal (1938) p 89). It attempted to solve the problem by sanctioning five refugee camps, called "agricultural colonies," in the border where it could better coordinate aid

and public goods.[21] Although the government's investment in the refugee camps did not last long (Lundahl 1979), the refugees stayed in the border districts and could be found there decades later (Derby and Turits 1993).

Contemporary officials documented the initial refugee influx, but we must use the Dominican census to approximate the total magnitude. As seen in Table 2, between the 1935 and 1950 Dominican censuses 34,000 Haitians disappeared. From this figure we can subtract the Vega (1988) estimate of 12,000 deaths, leaving 22,000 refugees. Using the 1950 Haitian population numbers for the border districts, 22,000 migrants would constitute about 6% of the population, making the shock similar in size to the Mariel boatlift in Miami (Card, 1990).

The model shows that the massacre's effects on the labor market should consequently affect the land market. First, the lost DR market should lower wages everywhere in Haiti, which should increase the demand for land throughout the country. Second, because the border districts received a larger labor supply shock, they should have experienced an even larger decrease in wages, increasing land demand in those districts even more than in the interior districts. If transaction costs do not impede land aggregation, then investors, seeing the refugee influx, should buy land and hire the unemployed on plantations. Indeed, these workers migrated to the DR to work on plantations, so they are exactly the kind of workers the investors would have wanted to hire. However, if transaction costs create barriers, then we would expect to see a disproportionate increase in subsistence farming.

5.1.1 The land market response

I isolate the massacre's causal effect on land adoption by comparing the border and interior districts,[22] shown in Figure 6, in a difference-in-differences analysis. A graphical analysis of the trends displayed in Figure 7 indicate that requests for land were nearly identical before 1938.[23] In the post-massacre period, however, the border districts diverged from the interior districts. The graphical evidence supports a difference-in-differences approach.

The regression analysis confirms that the border districts experienced a large change after the massacre. As shown in Table 3, after the massacre, the entire country experienced a 6.5% increase

[21] The government regularly received updates on the agricultural colonies, but the short reports focused mostly on activities at the schools. For an example, see Republic of Haiti (1939).

[22] I define border districts as any district touching the border or hosting a refugee camp.

[23] The 1934 spike in the border districts is related to a homesteading program featured in another chapter in my dissertation.

in land requests and experienced a 5.7% increase in area adopted. But the effect was four times larger in the border districts where refugees settled. These results remain after including year and district fixed effects.

These results support the idea that the Haitian economy responded to price signals. When foreign markets paid higher wages, labor migrated. When the workers lost access to foreign wages, domestic farms sprouted exactly in the places we expect. But Bulmer-Thomas (2012) was concerned that the farmers did not respond to signals about which crop to farm; that is, they continued farming one crop even though demand increases made another one more profitable. Here we do not have to worry about whether switching costs impeded adjustment because these farms are new operations. But we do have to worry about whether farmers created the plantations the model predicts.

The model shows that the ratio of plantation to subsistence land reflects differences in productivity and transaction costs. There should be at least as much plantation land as subsistence, but transaction costs will bias land adoption towards subsistence farms. Table 3 shows how much land farmers adopted under large-scale plots (50 ha or more) and small-scale plots (5 ha or less) after the massacre until 1942. Farmers adopted significantly more land under subsistence farming. Throughout the country, farmers adopted 3,800 hectares, but only one quarter of that land went to farms larger than 50 hectares. These numbers suggest that transaction costs to creating large plantations were significant.

A simple thought experiment highlights the role of transaction costs. From 1938 to 1942, farmers adopted almost 3,000 hectares on 1,800 farms that were five hectares or less. Imagine that instead of spreading this land over 1,800 farms, investors formed 30 100-hectare farms. The productivity on the handful of large farms would exceed the output of the subsistence farms. Yet this more productive organization did not happen, and therefore farmers must have faced high costs to acquiring large tracts of land.

5.2 Settlement Patterns and Transaction costs

Transaction costs vary both across and within districts, and each district will have a transaction cost distribution. This distribution comes from the fact that some land is occupied but other land is idle. For two pieces of land of equal quality, we expect investors to adopt the lowest cost land first. Thus, the distribution of transaction costs can predict land adoption.

The relationship between a district's average transaction costs and land adoption is straightforward. Acquiring land in a high transaction cost district requires more resources, and therefore, all else equal, investors will adopt less land. Therefore, we should see a negative relationship between land adoption and average transaction costs. On the other hand, the relationship between the standard deviation of transaction costs in a district and land adoption, for two districts with the same average, is positive. For two districts with the same average transaction costs, the one with the greater variance has more land available at low transaction costs, so we should see more land adopted as the standard deviation increases.[24]

The settlement pattern data described above allows me to calculate both the mean and standard deviation of settlements within a district. I assume that transaction costs to aggregating land are proportional to the number of settlements on that land. This is probably an underestimate of transaction costs because holdout problems can significantly increase costs as more people inhabit the land.

Table 4 shows the regression of total land adopted in each district from 1928 to 1950 on the settlement patterns. Consistent with the model, higher average density leads to lower adoption and higher variance leads to more adoption. The regression uses the log transformation of both the dependent variable and independent variables, so the coefficients can be read as elasticities. The magnitude of both elasticities is greater than one, suggesting that each additional household on a plot increases the transaction costs by more than one person, which matches the story of entire ancestral lines holding claim to a property: an additional house is not one extra person to negotiate with, it is an entire ancestral line.

Because settlement patterns are not random, the other columns in Table 5 use additional controls. Because the Trujillo Massacre increased land adoption disproportionately in the border districts, I include a dummy variable for the border districts. I include the average slope of the district, since the terrain may alter settlement patterns, and the district's latitude, to control for climatic suitability to cash crops. There is also a market access variable that measures how many hours it

[24]Suppose you have two districts, D and E, and let X_i be a random variable measuring transaction costs in district i with mean μ and variance σ_i^2. Note that the mean is the same for both districts, and assume without loss of generality that $\sigma_D^2 > \sigma_E^2$. Let $F(Z)$ be the cumulative distribution function for the standard normal distribution. To start a plantation, an investor must find a plot of land where the transaction costs are less than $x < \mu$. Then the probability that the investor finds land in district i with transaction costs less than x is $F(\frac{x-\mu}{\sigma_i})$. Because $x < \mu$ and $\sigma_D > \sigma_E$, $F(\frac{x-\mu}{\sigma_D}) > F(\frac{x-\mu}{\sigma_E})$; thus the probability of finding suitable land in district D is higher than in district E.

takes to get to the closest large Haitian market, taken from a 1932 Marine report. These controls reduce the coefficients' magnitude, but they reamain above one, significant, and most importantly they retain the predicted signs.

To show that these transaction cost variables measure something more than population patterns, I also display a column that controls for the district's land area and population. One might argue that the transaction costs variables are just measures of population density, but including these additional controls holds population density constant and compares differences in settlement patterns. Of course the relationship between transaction costs and population density are real, which is why including the controls reduces the magnitudes further, but the signs remain.

Table 5 also contains some instrumental variable regressions to correct for measurement error. The regressions use an independent sample of simulated plantations to create new measures of μ and σ as an instrument for the original measures. The magnitudes increase, but the coefficients are not statistically different from the OLS regressions. Thus, I stay with the more efficient OLS for the remainder of the paper.

Using the total land adopted in a district does not directly address whether transaction costs prevented farmers from adopting plantations. To further test for the effect on plantations, Table 6 uses a dummy variable for whether at least one plot 50 hectares or more was adopted; only 40% of districts in the sample accomplished this. The results show that the predictions still hold: higher transaction costs decreases the probability of having a large farm, and greater variance increases the probability. Table 6 also looks at the average farm size of new farms in the district and finds similar results.

Although the empirical work is consistent with the model's prediction, the settlement patterns are not exogenous, and we must consider what omitted variables may drive the results. The clearest problem is the relationship between land quality, settlement patterns, and adoption. It is fair to say that households on small plots can easily find and exploit the highest quality land. If these households grab all of the quality land, then only lower quality land remains for new arrivals, which will decrease adoption. There are two responses to this problem. First, as detailed in Section 1, reports claimed the idle land was fertile and at least good enough for plantation farming. Differences in quality should not be large enough to complete suppress plantation development. Second, this land quality story actually reinforces the transaction cost mechanism: for new farmers to get the

higher quality land, they have to remove the farmers already on it.

Another problem is that a negative relationship between settlement patterns and land adoption will arise if denser communes had less idle land. In these communes, new farmers might have adopted a greater proportion of the *available* land but had less *total* land available. Because I do not have a measure of land supply in each district (other than the control for the district's land area), I might misattribute this supply difference to the settlement patterns. However, the adopted land as a fraction of the total idle land is so small that land availability could not have been a binding constraint. For five districts I can construct a lower bound estimate of the total land available using the 1934 advertisement mentioned earlier. Because this is a single advertisement, and assuming the government made more land available in other years, we can take it as a lower bound estimate of available land. Table 7 shows that in most districts farmers did not even adopt in 16 years as much as land as was available in this one year. This suggests that land availability was not a binding constraint and does not drive the results.

5.3 Other barriers to adopting large plots

Farmers adopted much more land into subsistence farming than into large-scale farming, because transaction costs prevented them from obtaining large plots. Other barriers could skew the distribution towards small farms, and here I address some alternative explanations.

5.3.1 Monopoly pricing

Farmers might not adopt large tracts of land because the government can extract additional rents on this land. Suppose the checkerboard did not exist and the State had a monopoly over plantation-sized tracts. The government could exercise its monopoly power and set prices to extract rents from the cultivators. Because it does not have a monopoly in the subsistence land market, the government might set prices on small plots close to the competitive rate, but it could restrict the supply of large land and set prices high.

Data on the prices for some of these plot rentals allow me to test the monopoly pricing hypothesis. For 346 plots adopted from 1928 to 1950, I know the original rental rate and size.[25] I can test for

[25]These prices come from local tax archives in three districts in the *Departement du Nord*: Acul du Nord, Grande Riviere, and Dondon.

whether the government charged above market rates by comparing the per hectare prices on small plots with the prices on large plots.

Figure 9 shows a scatterplot of prices and area with a line showing predicted prices if the government applied the same per hectare rate for all plots as it did for the plots smaller than five hectares. On average, the government charged small plots US$3.12 per hectare.[26] For the six and seven hectare plots, applying this rate tends to overestimate the price. For the three plots above 10 hectares, this rate greatly overestimates the true prices. The government charge much less for these large plots, only about $1 per hectare. The government did not overcharge farmers for these plots relative to the rates on small farms; in fact, it might have subsidized them.[27]

Poor land quality on large plots could explain the low per hectare prices. Small-scale farmers can select the highest quality land with great precision, but on large farms farmers must mix high and low quality land. These prices might indicate that the average quality on large idle land is lower than the quality of a small farm. And low average quality could explain why no one cultivated the land in the first place. But again this argument strengthens the checkerboard hypothesis because it means households occupied the highest quality land, making forming a plantation on quality land even more costly.

5.3.2 Capital constraints

Capital constraints could have prevented farmers from adopting large farms. Without capital, farmers could not establish plantations because they could not have had the equipment for processing crops. Capital constrains could especially cause problems for the post-massacre period because the Depression made capital harder to obtain.

But capital constraints cannot completely explain the patterns I observe. First, although agricultural capital dropped at the beginning of the Depression, it recovered quickly. By 1934, Haiti's agricultural machinery imports had recovered to their pre-Depression levels. The Depression did not stop the Standard Fruit and Steamship Company from obtaining land for a banana plantation in the 1930s; in fact, the companty attributed its failure to the abundance of small-holders (Lundahl

[26] The exchange rate was 1 US$ for 5 Haitain gourdes.

[27] One might ask why someone does not rent the large plots at the low per hectare price, divide the tract into small plots, and then lease them to other farmers at a higher rate. The property rights outlined by the law did not allow for such entrepreneurial activity.

1979 p. 286).

If capital constraints were the only problem, then we would have observed more investors establishing plantations during the 1920s. In the better economic conditions of the 1920s, Americans made big investments in other Caribbean countries. Even when investors had more access to capital, they still could not setup large farms because of all the smallholders. Capital constraints complement the checkerboard story but cannot replace it.

6 Development Policy Implications

This paper has focused on the role of Haiti's historical property rights in creating large transaction costs. Although Haiti is unique in the Western hemisphere, its situation is similar to other countries in the developing worl. Like Haiti, small farms dominate India's economy, and Indian families also divide properties among heirs (Foster and Rosenzweig 2011). In Ghana, similar to Haitian families owning land, whole tribes own land which is distributed by the chief but farmed on small plots (Goldstein and Udry 2008). Moving these countries from small-farm to large-farm economies could involve negotiating with many farmers and incurring large transaction costs.

The lesson from Haiti is that property rights policy in developing countries best assists development when it balances the security of property rights with making them elastic to changes in economic conditions. Haitian farmers could not transition to large-scale agriculture themselves because property rights were too secure: no one abrogated their rights, but they also could not easily sell their property because family members could veto the transfer. A titling program that gives all rightsholders a legal title to the land would not resolve this problem because too many people would still hold legal claim. The government would have to consolidate rights under single holders who possess all usufructuary and alienation rights, but doing so would entail expropriating rights from whole lineages and redistributing wealth to an extent beyond the capacity of most developing countries. A government with greater power to reallocate land to more productive uses could have helped the country capture profits from the sugar industry.

There is a serious question as to whether plantations improve development. After all, plantation owners were likely to be foreigners, meaning the largest returns leave the country. Most of the workers would receive low wages, and as plantation ownership grows wages might decrease depending

on market power. Thus plantations likely lead to greater inequality. But plantations do have spillover effects on the economy. In Jamaica and Cuba, large landholders are the ones that stimulated the creation of roads and railways (Holt 1992, Dye 1994). In Peru there is evidence that areas with small farms were less likely to develop roads than the areas with large farms because large farmers could internalize the positive externalities (Dell 2010). Finally, consolidating farms could lead to more labor available for industrial activities. A country with many plantations like the Dominican Republic is not a paragon of economic development, yet GDP per capita there is about ten times as high as it is in Haiti, meaning Haiti would possibly be much better off if it were to adjust its agricultural structure.

7 Conclusion

Haiti's agricultural structure has a large effect on its poverty. This agricultural distribution is the result of institutions implemented after independence in 1804. Farmers could not establish large-scale farms because of the high transaction costs involved with acquiring land. Using new data I collected, I show that the transaction costs prevented investors from establishing large-scale agriculture, even when land and labor were available. Comparing Haiti's history to other Caribbean countries shows that the land institutions indeed played a large role in Haiti's underdevelopment.

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Table 1: Coffee and Sugar Exports from Haiti, 1789-1824

	Pre/Post-Revolution		Partial Redistribution			Full Redistribution			
	1789	1801	1818	1819	1820	1821	1822	1823	1824
Sugar									
Haiti	93,573.3	18,518.6	5,443.6	3,790.1	2,514.5	600.9	200.5	14.9	5.1
Republic of Haiti									
West	60,630.1		1,994.9	871.4	393.7	40.6		14.6	1.0
South	24,959.5		0.0	345.7	1.0	19.3	0.2	0.1	0.0
Kingdom of Haiti									
North	7,983.7		3,547.1	2,914.9	2,101.0	560.1	200.0	0.0	4.1
Coffee									
Haiti	76,835.2	43,420.3	26,065.2	29,240.9	35,137.8	29,926.0	24,235.4	33,802.8	44,269.1
Republic of Haiti									
West	17,829.4		11,509.9	12,380.0	13,729.3	12,530.2	11,141.2	14,156.0	19,478.0
South	4,072.7		3,362.1	4,369.3	3,150.7	4,755.4	2,577.7	3,868.6	5,010.3
Kingdom of Haiti									
North	32,545.5		3,362.1	4,369.3	3,150.7	4,755.4	2,577.7	3,868.6	5,010.3

Source: The 1789 number come from Chevalier de Proisy (1790), Table No. X; the 1801-1824 numbers come from Mackenzie (1830), Appendix Tables. Mackenzie reports 1789 numbers for the whole country that match the Chevalier de Proisy numbers; however, the districts All figures are thousands of lbs. The sugar statistics are for muscavado (unrefined) sugar; in 1789 Haiti exported significant quantities of clayed (refined) sugar, but it disappeared after the revolution. Partial Redistribution refers to the fact that the southern provinces in the Republic of Haiti had already initiated land redistribution, but the Northern provinces in the Kingdom of Haiti still cultivated plantations. In 1820, the country reunited and land redistribution was immediately extended to the Kingdom of Haiti; hence 1821 and onward are the Full Redistribution years.

Table 2: Distribution of Haitians in DR by Province, 1935 and 1950

Relative to Haiti	Province	1935	1950	Change	% Change
Border	Barahona	7,327	1,658	-5,669	-77%
	Independencia	1,491	648	-843	-57%
	Libertador	2,444	1	-2,443	-100%
	Montecristi	1,372	2	-1,370	-100%
	San Rafael	3,442	4	-3,438	-100%
Near Border	Bahoruco	9,647	2,989	-6,658	-69%
	Benefactor	1,785	20	-1,765	-99%
	Puerto Plata	2,313	226	-2,087	-90%
	Santiago	1,255	14	-1241	-99%
East	Azua	29	5	-24	-83%
	Distrito de Santo Domingo	928	1,178	250	27%
	Duarte	278	8	-270	-97%
	El Seibo	7,620	4,667	-2,953	-39%
	Espaillat	112	0	-112	-100%
	La Altagracia	5,514	3,437	-2,077	-38%
	La Vega	264	22	-242	-92%
	Samana	92	18	-74	-80%
	San Pedro de Macoris	6,357	2,702	-3,655	-57%
	Trujillo	223	1,167	944	423%
	Trujillo Valdez	167	6	-161	-96%
Total		**52,660**	**18,772**	**-33,888**	**-64%**

Source: Anuario Estadistico de la Republica Dominicana 1938 V 1; Republica Dominicana Tercer Censo Nacional de Poblacion 1950

Table 3: The Effect of the Refugee Influx on Annual Land Requests and Adoption, 1928-1950

	Requests		Area Adopted	
	OLS	FE	OLS	FE
Post Massacre X Border	0.221*	0.221*	0.313*	0.313*
	[0.131]	[0.131]	[0.159]	[0.160]
Border	0.0288		0.0502	
	[0.0310]		[0.0591]	
Post Massacre	0.0649***		0.0566*	
	[0.0180]		[0.0329]	
N	1,768	1,768	1,768	1,768
R-squared	0.068	0.088	0.068	0.088

Notes: The massacre occurred at the end of 1937. Dependent variable is the inverse hyperbolic sine of the requests and area adopted per capita; the coefficients are interpreted as percent changes. Standard errors clustered at the district level.

Table 4: Total hectares adopted under each farm type after the massacre, 1938-1942

Land Category	Hectares
Land adopted after the massacre from 1938-1942:	3,841
Land adopted under small-scale farms (<5ha) ΔT_C	2,888
Land adopted under large-scale farms (>50ha)ΔT_X	953
Ratio of large-scale to small-scale $\Delta T_X / \Delta T_C$	0.33

Notes: Large-scale is defined as greater than or equal to 50 hectares; smale-scale is less than or equal to 5 hectares.

Table 5: The effect of settlement patterns on the total land adopted in a district, 1928-1950

	OLS	OLS	OLS	IV	IV	IV
$\ln(\mu)$	-1.96***	-1.53**	-1.28**	-3.16*	-3.44	-2.35
	[0.61]	[0.63]	[0.62]	[1.87]	[2.25]	[2.32]
$\ln(\sigma)$	1.88***	1.51**	1.04	3.51	3.88	2.59
	[0.66]	[0.68]	[0.67]	[2.26]	[2.64]	[2.83]
Border		X	X		X	X
Slope		X	X		X	X
Latitude		X	X		X	X
Market Access		X	X		X	X
District Area (km2)			X			X
Population			X			X

Notes: All regressions have 64 observations. Border indicates that the commune was in a border district. Slope is the mean slope in the district. The IV columns take another sample of squares from the district as an instrument to correct for measurement error.

Table 6: The effect of transaction costs on whether a largescale plantation was adopted in the district, 1928-1950

	Any Large Farms			Log(Ave Farmsize)		
$\ln(\mu)$	-0.44**	-0.34*	-0.27	-0.82**	-0.49	-0.37
	[0.18]	[0.19]	[0.20]	[0.36]	[0.36]	[0.37]
$\ln(\sigma)$	0.53**	0.44**	0.33	1.05**	0.70*	0.60
	[0.20]	[0.21]	[0.21]	[0.39]	[0.39]	[0.40]
Border		X	X		X	X
Slope		X	X		X	X
Latitude		X	X		X	X
Market Access		X	X		X	X
District Area (km2)			X			X
Population			X			X

Notes: The dependent variable "Any Large Farms" is a binary variable equal to one if at least one property adopted in the district was 50 hectares or greater. Border indicates that the commune was in a border district. Slope is the mean slope in the district. The IV columns take another sample of squares from the district as an instrument to correct for measurement error.

Table 7: Comparing Land Available in 1934 to All Land Rented from 1934 to 1950

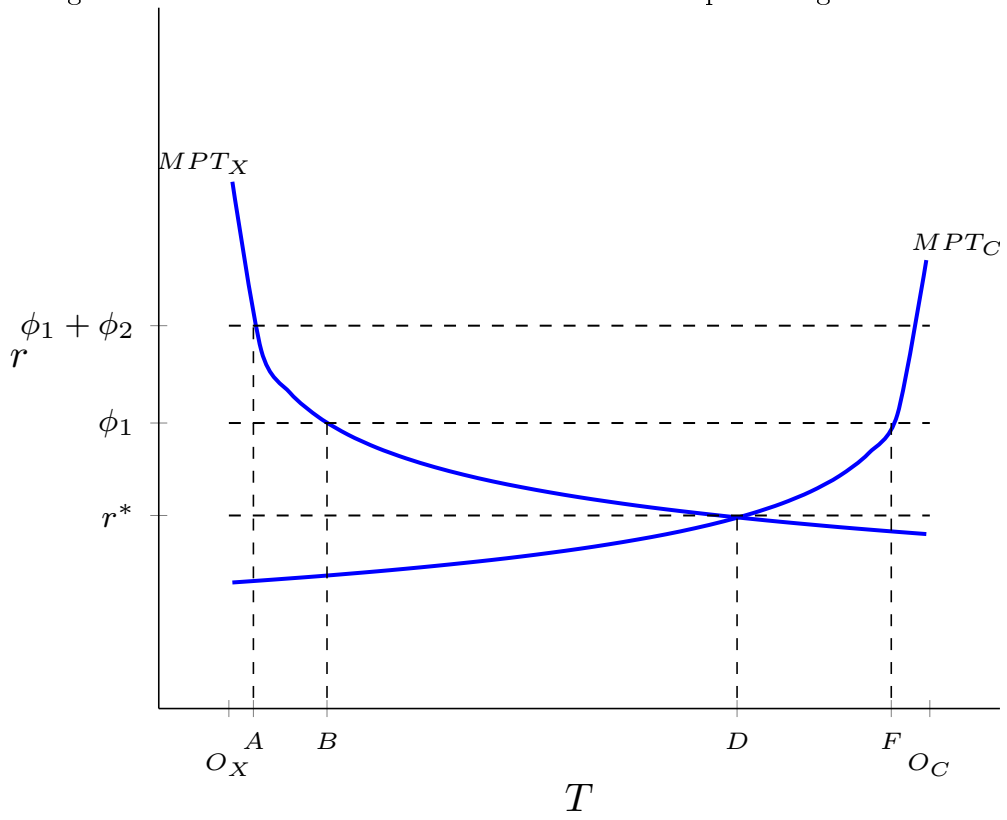
Departement	District	Available (1934)	Adopted (1934-1950)
Ouest	Croix-des-Bouquets	470	94
Nord	Fort Liberte	1,593	1,077
Ouest	Thomazeau	223	610
Ouest	Petionville	301	37
Ouest	Ganthier	168	532

Notes: All figures are in hectares. Available land comes from a 1934 advertisement published in *Le Moniteur*, 1934 No. 24 (22 March 1934).

Figure 1: Example of checkerboard holdings on a 100 hectare piece of land

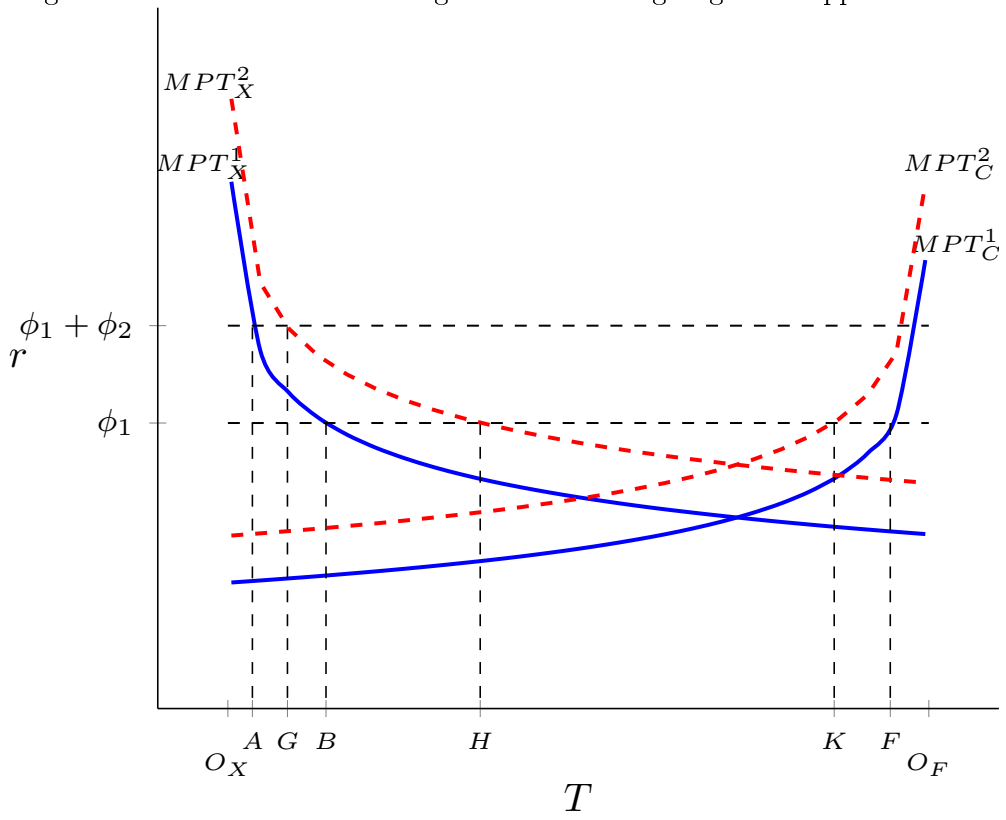
Notes: Every dot represents a building, mostly homes and huts. The map depicts the region around Ouanaminthe, Haiti and Dajabon, Dominican Republic. The thick black line in the middle is the border between the two countries. Red lines are roads and red polygons are urban areas.

Figure 2: Transaction costs and the amount of land producing X and C



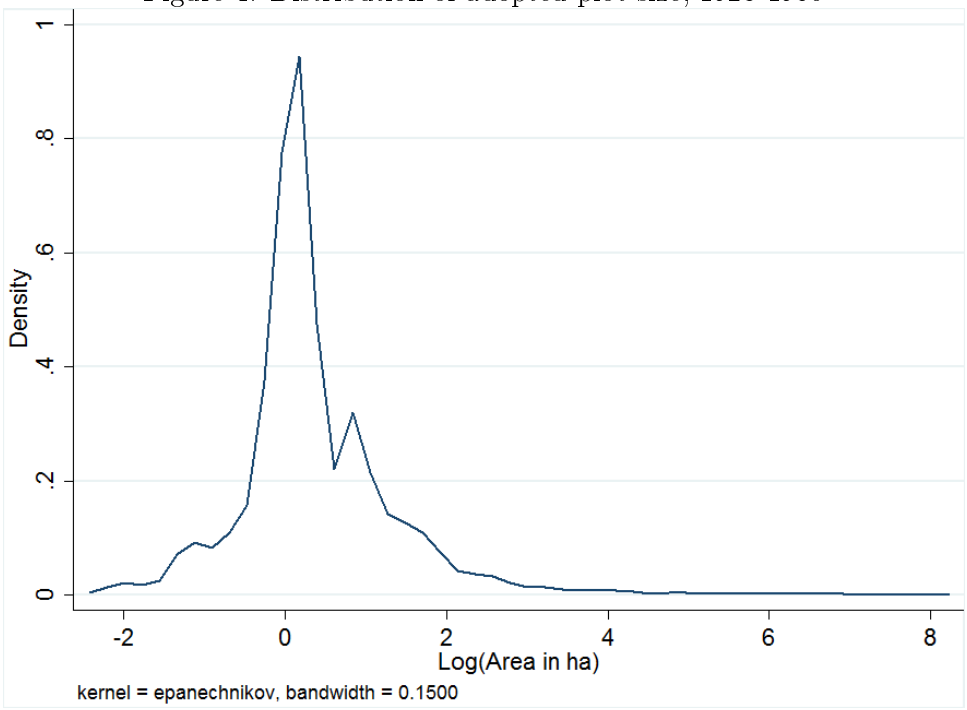
Notes: The x-axis shows the country's land endowment ($O_X O_C = E^T$), measuring from the left shows the marginal product of land in producing X, and measuring from the right shows the marginal product of land in producing C. Without transaction costs, the market clears at r^*. With transaction costs of ϕ_1 and ϕ_2, the amount of land in T_X is $O_X A$, the amount of land in T_C is FO_C, and the amount of idle land is AF.

Figure 3: Land distribution changes after removing migration opportunities



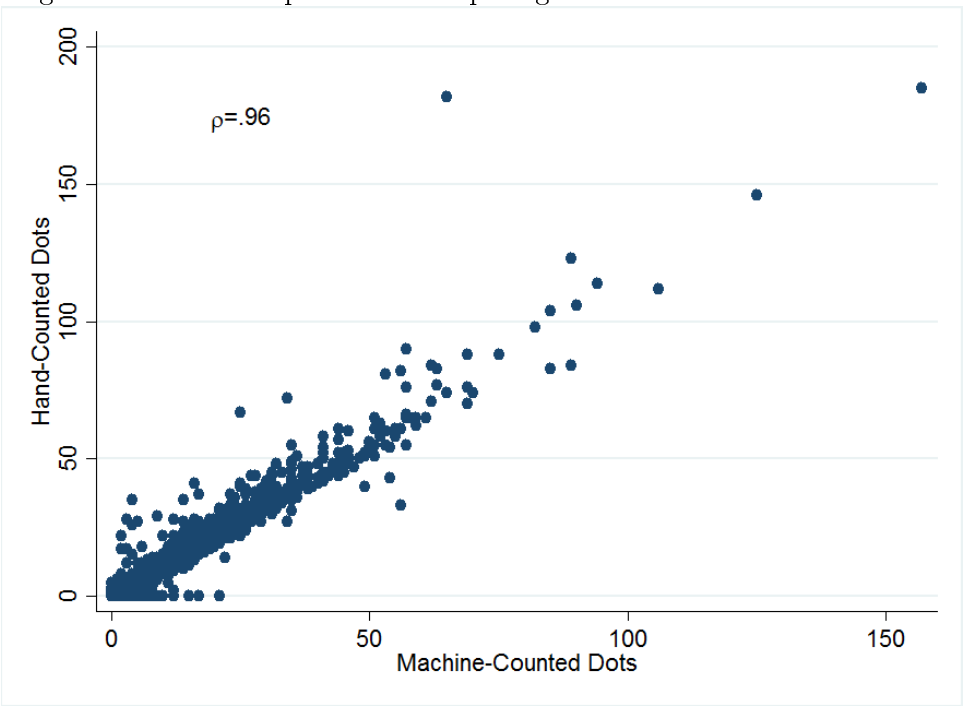
Notes: See Figure 2 Notes. MPT_J^1 represents the marginal product of land in $J \in \{X, C\}$ when labor is free to move between countries. The shift to the dashed curves, MPT_J^2 represents the change in the marginal product of land when migration opportunities vanish and wages drop.

Figure 4: Distribution of adopted plot size, 1928-1950



Notes: Kernal density estimate of the distribution of plots adopted under the Haitian land rental program.

Figure 5: Settlement patterns: Comparing machine counts to hand counts

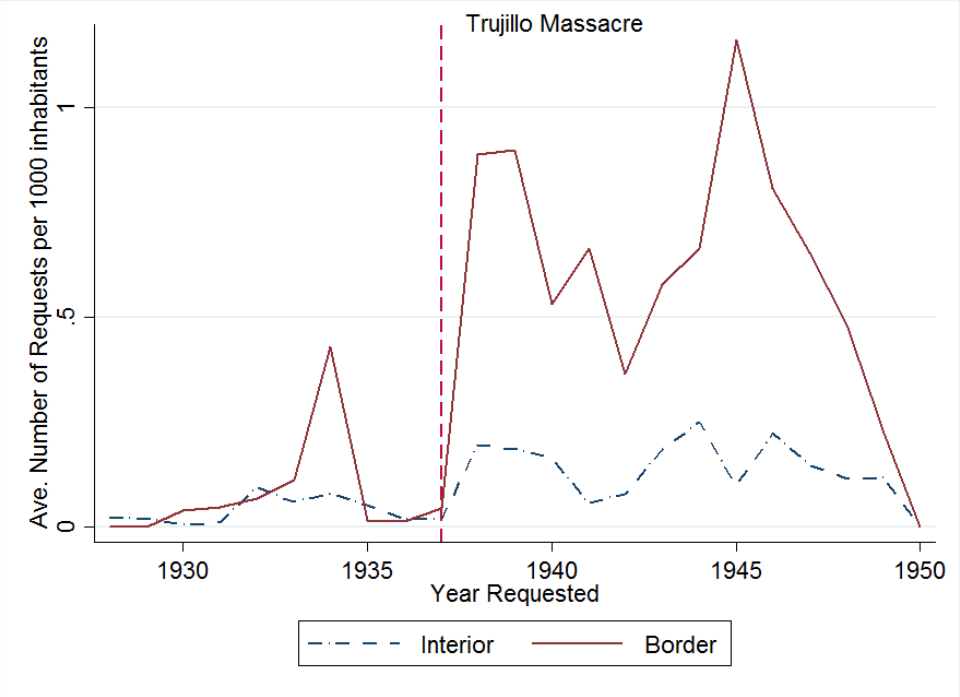


Notes: The x-axis represents the number of dots on the simulated planation image counted by the image processing algorithm described in Section 4.2. The y-axis is the number of dots counted on the same images by a human.

Figure 6: Treatment and control regions for the difference-in-differences analysis

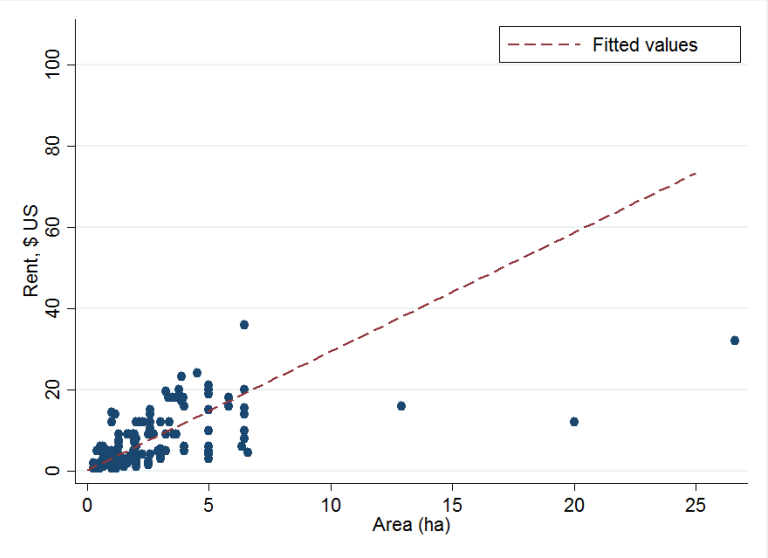
Notes: Border districts (in white) are districts that touch the Dominican border or hosted a refugee camp.

Figure 7: The effect of the Trujillo Massacre on rental plot requests per capita, 1928-1950



Notes: Seem Figure 6 for the border versus interior districts.

Figure 8: Prices and plot sizes from a sample of land appraisals, 1928-1950



Notes: The projection line is based on the prices for plots under 5 hectares.