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Roads or Rivers: Ecuador's Infrastructure Stock before the Banana Boom (1948-1952)

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Abstract

This paper questions whether road stock in 1947 or distance to rivers correlates with four outcome variables regarding banana production from the 1954 census: sowed area, harvested area, number of plantations and output at the cantonal level. I use geo-referenced data on the existing road network in 1947 and the mean distance to a river or lake as measures. I found no correlation between the road network and the outcome variables. Meanwhile, an increase of one kilometer in the distance to a river or lake at the cantonal level is correlated with a decrease of 21 plantations. The results suggest that public investment in road infrastructure came after the banana boom

Keywords:

Ecuador, Economic History, Road Networks, State Capacity, Banana

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Link to code repository: https://github.com/nicochuquimarca/banana codes.git

1 Introduction

Bananas are the most exported tropical fruit in the world. In 2019, the world market traded 24,760,113 banana tonnes. The same year, coffee traded 7,879,848 tonnes, approximately one-third as much, as reported by Food and Agriculture Organization of the United Nations (2021). In the banana export market, Ecuadorian bananas represent 25% of the world export supply, see Wunder et al. (2001). This export industry is relevant to the country; it represents approximately 14.46% of exports and 3.05% of GDP in 2021, as reported by Banco Central del Ecuador (2021).

The industry historically has influenced Ecuador's local and foreign policies. Due to the banana, an elected Ecuadorian administration accomplished its four-year term (1948-1952) for the first time in seventeen years (Donoso, de Jesús, et al., 2020). Bananas brought agricultural industrialization to Ecuador, and trained a specialized labor force. The first agrarian labor association was rooted in 1944 in Tenguel banana plantation (Southgate & Roberts, 2016). The biggest company in Ecuador between the 1970s to the 1990s, Bananera Exportadora Noboa, was a banana export firm; for further details check Revista Líderes (2017); Noboa (2000). The banana industry also accelerated Guayas, Los Ríos, and El Oro provinces' urbanization, (Hamerly, 2006). The banana in Ecuador is a broader topic in academics, businesses, and society.

Interestingly, Ecuador began to export the fruit to the global market 54 years after Central American countries. The standard agreement in the history literature is that banana production and export have always been supported by a development policy implemented by investment and provision of key infrastructure goods such as roads and ports, see Larrea, Espinosa, and Charvet (1987). Others, such as Southgate and Roberts (2016), state that the Ecuadorian rise in the banana export market results from entrepreneurial leadership rather than public infrastructure. They suggest that investment in the industry came after it proved to be a successful endeavor.

This paper questions whether two measures of public goods (roads or rivers) correlate with banana cropping outcomes during the boom period (1948-1952). To answer this question, I use historical geo-referenced data on the length of roads in 1947, the mean distance to a river or lake and banana production outcome variables from 1954. The outcomes include output, number of plantations, and sowed and harvested area; I explore the relationship between existing infrastructure and these outcomes. I found no correlation between the permanent road stock in the years before the boom and production outcomes in the post-boom period. However, I found a negative relation between the mean distance to a river or lake and the number of banana plantations at the canton level. This suggests that in the absence of extensive road networks, more plantations were located near rivers. Due to the small sample dataset from the 1954 census, this work cannot provide causal estimates.

The economic literature provides the general idea that providing infrastructure has the potential to increase economic activity. Economists have documented the causal impact of the increase in the infrastructure stock in exports and employment (Martincus, Carballo, & Cusolito, 2017). Most recent literature has taken a nuanced approach to this classic consensus by analyzing potential parallel objectives in infrastructure provision such as state control and repression (Saiz, 2006; Burgess, Jedwab, Miguel, Morjaria, & Padró i Miquel, 2015; González, Miquel-Florensa, Prem, & Straub, 2025).

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González et al. (2025) provide evidence that the increase in the road network can be linked with increased state-led repression and illegal land allocations, opening the political economy behind road building as a public good provision. A major challenge in any public good provision is whether the national or local governments have the funds and ability to provide them. All the countries in Latin America are thought to have low-state capacity driven by multiple factors such as elite behavior, geography and institutional dynamics, see Peña, Baquero-Mendez, et al. (2025) for an extensive discussion of the topic. Thus, the financing and implementation of road network was and remains a complex task in the region. In a low-state capacity context, it remains rational that governments desire to invest their scarce resources in industries that maximize potential outcomes.

My analysis is not subject to changes in property rights on land tenure as documented by Gachet (2024). The period of analysis remains before the announcement and implementation of the Ecuadorian agrarian reform, which took place in 1964. Thus, the land property rights remain constant throughout the paper's analysis.

This paper makes two contributions. First, it provides a comprehensive historical background on the banana boom in Ecuador, examining infrastructure, foreign investment, and market structure. Second, it empirically investigates the relationship between existing infrastructure stock and banana production outcomes during the boom. In the broader context, this paper seeks to quantify potential explanations for Ecuador's rise and persistence in the global banana market. The lack of correlation between road infrastructure and production outcomes is a puzzling observation. This suggests that, despite the banana industry's boom, the canton-level road network had little relation to banana outcomes. However, the road network does correlate with the number of cacao trees in production, indicating that the infrastructure may have been more aligned with the country's prior export markets. I find no evidence to reject the hypothesis that the development policies historically linked to the banana industry emerged after it consolidated as a national leader.

The paper is structured as follows: Section 2 presents the historical context, Section 3 presents the data and sources to be used, Section 4 exposes and performs the empirical analysis, and Section 5 concludes.

2 Historical Background

2.1 The early stages, 1900-1948

Before significant banana production in Ecuador, the country experienced a cacao boom, which, according to Acosta (2006), led Ecuador to grow at a rate of 2.5% in the early 1900s. The best period for cacao exports was from 1908 to 1914. In 1908, President Eloy Alfaro inaugurated the first highlands-shores railroad, which connected the port city of Guayaquil — linked by river to the Pacific Ocean — with Quito, the capital, landlocked in the Andes. This railroad was crucial to Ecuador's economic development, as, previously, only footpaths connected the cities. Unlike Central American countries, Ecuador already had infrastructure such as international ports and emerging road networks before the banana boom. For an example of the Central American newcomer strategy, see Méndez-Chacón and Van Patten (2022). Between 1920 and 1930, cacao prices decreased worldwide as more competition entered the market and diseases affected Ecuador's plantations.

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The economic system under which the cacao boom emerged was a sociopolitical alliance between large landowners, bureaucrats, and Catholic authorities. According to Acosta (2006), the 20th century in Ecuador was marked by a significant migration flow from the Sierra region (highlands) to the Costa region (coastal areas). The land and labor policies in the Costa region allowed more room for small to medium private property configurations, in contrast to the Hacienda system that dominated the highlands. A more detailed analysis of the rigid labor mobility in the Sierra region can be found in Rivadeneira (2020). In the early 1920s, Ecuador began an uncoordinated road-building campaign. Cuenca, Guayaquil, and Quito were the primary cities with suitable roads. These roads were built and maintained by local rather than national governments; see Caspa Pacheco (2020) for further details. By 1924, Ecuador had an estimated 437 kilometers of road available year-round; see Curran (1925).

Figure 1: Ecuador roads in 1924
This figure shows the Ecuador road network in 1924. It contains available roads at the time and blueprints for future links. The map was prepared as part of planning for the Panamerican highway. Source : Curran (1925)

Cuetos (1987) documents that during the prosperous years of the cacao boom, the cantons home to the largest operations were Babahoyo, Baba, Machala, Palenque, Vinces, and Yaguachi. Since the labor structure in the Costa region was non-coercive, employee status was standardized, even though 16 families controlled the majority of the land in the region. However, the attack of fungi[1] and competition from African economies caused a cacao bust. Ecuador's income declined amid export contraction, and many businesses responded by cutting wages or extending shifts. Henderson (1997) mentions how former cacao exporters had the ability to change working conditions without government interference.

Social conditions deteriorated in the aftermath of the cacao bust. Guayaquil witnessed a workers' massacre in 1922 due to protests against wage cuts. Government officials at the time had little connection with most of the population. In 1925, the July Revolution took place, consolidating a coup d'état against President Gonzalo Córdova and establishing two temporary government boards before Isidro Ayora was elected president, serving from 1926 until 1931. Ayora's actions included the establishment of

1 The two fungi, Witches' Broom and Frosty Pod Rot, were responsible for many plantation closures.

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Ecuador's Central Bank (BCE), the social security office, the banking regulatory authority[2], and the introduction of income taxes; see Paz y Miño Cepeda (2002) for details. The wealthiest families lost their concentration of power, though they retained economic influence. When Isidro Ayora left office, the country's instability resulted in eight different presidents in ten years. Public infrastructure suffered due to political instability. By 1940, all rail lines were running at a financial loss. As a consequence, public policy shifted toward highway construction; no more railroads were constructed or planned.

The first company to export bananas from Ecuador was the Chilean South American Fruit Company (SAFCo), which established an office in Guayaquil in 1908 for exports to Chile (Southgate & Roberts, 2016). The United Fruit Company's (UFCo) entry into the Tenguel hacienda in 1934 marks the beginning of a significant banana market in the country, as reported by Striffler (2001); Larrea et al. (1987); Wunder et al. (2001). UFCo's entry was driven by the vision of its CEO, Sam Zemurray ("the banana man"), who took over the company in 1932; see Koeppel (2008) for further details.

UFCo's Ecuadorian operation was different from that in Central America. Instead of building all the infrastructure needed for production and shipping from scratch, the company used the port of Guayaquil. The absence of *Panamá* disease was Ecuador's main attraction for UFCo (Mallesard, 1968). Additionally, labor unions did not exist, and therefore, there was no local pressure to provide hospitals or schools for the workforce, as documented by Chapman (2014).

The banana boom began in 1948 when global prices skyrocketed. From 1946 to 1947, the price increased by 30.15%, as measured by U.S. Bureau of Labor Statistics (2020). This price growth resulted from steady demand and a limited supply. Central America was in the midst of a severe *Panamá* disease outbreak (Koeppel, 2008). UFCo and Standard Fruit tried to meet demand by purchasing production in both Ecuador and Colombia. In 1945, Standard Fruit bought the first 100 bunches from a then-unknown businessman, Luis Adolfo Noboa Naranjo, who would later become the wealthiest entrepreneur in Ecuador (see Noboa (2000); Revista Líderes (2017); Southgate and Roberts (2016)). Prior to exporting bananas, Noboa had successfully exported rice[3].

Two international factors prompted Ecuador to begin banana production: (1) a major outbreak of *Panama* disease in other producing countries, and (2) the absence of cyclones and hurricanes (Striffler, 2001; Wunder et al., 2001). The specialized literature documents that the regular patterns of Ecuador's banana export market include (1) a high number of small and medium plantations, (2) active government policies, (3) the non-consolidation of multinational companies, and (4) the rise of a large national company, Exportadora Bananera Noboa (Larrea et al., 1987; Cueva, 1964).

2 Known as the "Superintendencia de Bancos" in Spanish

3 Luis Noboa Naranjo was born and raised in poverty, working actively in merchandise resale before getting in touch with Juan F. Marcos, founder of Sociedad General Bank. Sociedad General was an agricultural bank that specialized in loans to cacao plantations. Under Marcos's guidance, Luis Noboa learned and developed export business skills (Larrea et al., 1987; Southgate & Roberts, 2016).

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2.2 Gross Michel boom

2.2.1 Gross Michel boom

After 1948, prices rose and steady production concentrated in Guayas province gave birth to the banana boom in Ecuador. Figure (2) shows the price inflation rate of bananas for consumers in the US from 1939 to 1959. As the government assumed the infrastructure expenses (especially for ports), the settlement for foreign companies was less expensive than their original investments in Central America. Nevertheless, from 1955 onwards, *Panamá* disease spread uncontrollably throughout Ecuador. In 1955, Standard Fruit introduced the *Panamá* disease-resistant *Cavendish* banana, primarily in Central America (Koeppel, 2008). Consequently, UFCo abandoned Tenguel in the 1960s and re-established plantations in Central America.

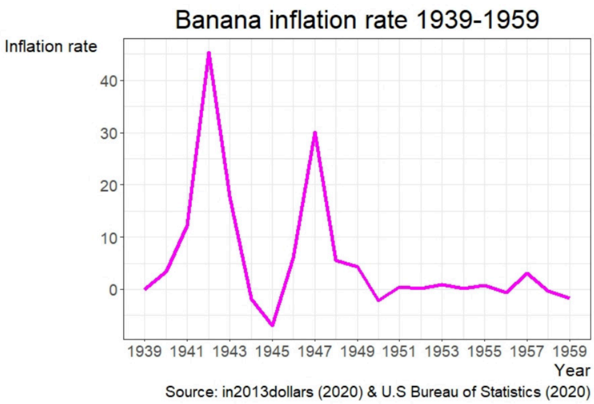

Figure 2: Banana price evolution
This figure plots the percentage change in prices for the period 1939-1959. The data sources used to build the plot are U.S. Bureau of Labor Statistics (2020); In2013Dollars.com (2020). Both sources provide information at constant prices. I use 1982 and 1983 as the base year.

Galo Plaza Lasso was president during the banana boom period (1948-1952). Among experts, such as Donoso et al. (2020), he is praised for approaching problems within the economic public policy framework development, which prioritized technique over political favor. His administration took the US economic and social systems as gold standards; see Gómez and de la Torre (2008) for further details. The Galo Plaza administration brought international experts to collect data and create policy suggestions. During his presidency, he was unable to extensively address the land concentration problem, especially in the highlands (Donoso et al., 2020). He could not dismantle the Huasipungo institution; haciendas in the Sierra region remained untouched.

In the short run, Galo Plaza Lasso's economic policies aimed to initiate more banana plantations by offering low-interest loans through the Banco Nacional del Fomento (Gómez & de la Torre, 2008). Clemente Yerovi, the economy minister, created the first small- and medium-sized farmer cooperatives with access to loans and machinery (Donoso et al., 2020). As farmers improved both quality and quantity, Luis Noboa finally founded a fruit-exporting company in 1956, following the termination of his contract with Standard Fruit. See Larrea et al. (1987); Southgate and Roberts (2016); Noboa (2000) for further details.

2.2.2 Labor Unions, Panama Disease and Market Structure after the Boom

In the 1955-1965 period, *Panamá* disease severely damaged Ecuadorian plantations. Simultaneously, Central America began transitioning to the *Cavendish* variety. The United Fruit Company abandoned the country in a disorganized manner in 1961 and 1962. A peaceful transition of ownership to the buyers and employees turned violent in 1962, when labor union leaders incited members to invade the property (Mendoza, 2018)[4]. When the invasion took place, President Otto Arosemena Monroy initiated an expropriation process for the entire plot in May 1962 (Ibarra, 1979).

Rudimentary workers' associations began in the final days of the cacao bust; indebted landowners sold their properties in small plots and rented out the remaining land. In the transition to banana cropping, the remaining landowners became production managers. In search of efficiency, they paid wages to workers (instead of using a tenant system) (Ibarra, 1979). Once wages were established, labor unions emerged as a mechanism to demand welfare practices. Tenguel workers created the first agricultural labor union in 1944. Labor unions gained only ephemeral benefits, as foreign companies abandoned production and transitioned solely to port transportation (Ibarra, 1979; Larrea et al., 1987). As a result, after the banana boom, an export monopsony was created.

Panamá disease threatened bananas to disappear. The monoculture nature of fruit production meant that once one plant was contaminated, the entire plantation's demise was a matter of weeks (Ploetz, 2000). Under threat, Standard Fruit first introduced the *Cavendish* variety for mass consumption in the late 1950s. The change was initiated in Ecuador in 1967 (Larrea et al., 1987). Since Standard Fruit had already invested in introduction costs (technology and marketing), Ecuadorian producers benefited (Southgate & Roberts, 2016).

Cavendish adoption made plantations denser, geographically and economically concentrated. Plantations that successfully transitioned to the *Cavendish* variety clustered around El Oro, Guayas, and Los Ríos. Contrary to the Gross Michel variety, the *Cavendish* variety requires careful handling and higher capital investment to meet export quality standards. Chiquita Brands International (2012) documents the process the *Cavendish* must go through to be successfully exported. The procedure involves delicate harvesting, washing, special packaging, and maintaining a stable temperature of 13°C (55.4°F). Once in the destination country, bananas are ripened in temperature-controlled conditions, and they emerge from the box with a yellow color just before they go on sale; see Chiquita Brands International (2012) for details.

4 In the original plan, half of Tenguel was going to be sold to potential buyers, and the other half distributed to employees.

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In 1976, Standard Fruit began a program for associate producers in which farmers grew bananas under contracts using Standard Fruit's technical methods. The associate producers' program allowed farmers to acquire machinery, loans, and technical assistance. Larrea et al. (1987) argues that the associate program discouraged new producers. The transition to the *Cavendish* variety also changed land demand. Larrea et al. (1987) reported a substantial reduction in the labor force dedicated to banana cultivation and export. The number of jobs decreased from 60,000 in 1960 to 32,000 in 1987.

After UFCo left Ecuador (1962-1963), both Noboa and Standard Fruit dominated exports from the country. Standard Fruit bought UBESA (Unión de Bananeros Ecuatorianos S.A.) in 1978, and Del Monte entered Ecuador in 1977. At the time, Bananera Noboa and Standard Fruit held the largest shares of exports, with 46.62% and 18.20%, respectively (Larrea et al., 1987). Figure (3) shows the competition dynamics among Noboa, UFCo, and Standard Fruit. In 1976, five companies accounted for 88.9% of Ecuadorian banana exports. Simultaneously, production was composed of thousands of independent farmers (Larrea et al., 1987). This suggests that the production side was a monopolistic competition, while export companies held a monopsony. Since banana prices fluctuate[5] year-round, the concentration of export firms gave them bargaining power.

2.3 Fall in grace, still a giant, 1990-present

The banana industry was relegated to second-order importance in Ecuador's exports after oil exploitation in the Amazon rainforest began in 1974, see Acosta (2006); Gerlach (2003). On the other hand, Central American countries did not discover oil reserves. Today, their exports still rely on agricultural commodities (e.g., Honduras and Costa Rica). In 2000, banana export companies' standard practice was to buy bunches through agreements with producers. Plantation managers, for their part, hired workers temporarily at a fixed wage without social security benefits (Striffler, 2000). In other words, haciendas hired packaging personnel as outside contractors, not on the payroll. They were not regular plantation workers, but rather worked on a daily or temporary basis.

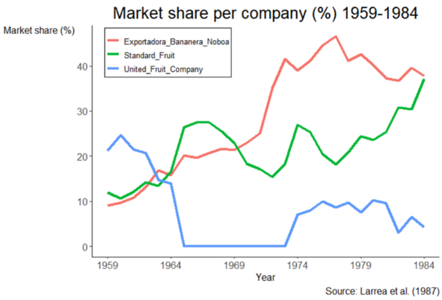

Figure 3: Export Market Share among companies
This table plots the market share of Ecuador's three main banana export companies from 1959 to 1984. The blue line representing the United Fruit Company remains at zero for the periods in which the company ceased operation in the country. Note that the plot shows the export market share, it does not represent output, since the business models of the companies was to buy from a variety of producers within a minimum product quality.

5 Production shrinks globally from December to April due to climate conditions in Africa and Central America (Aggrey-Mensah & Tuckwell, 1969; Southgate & Roberts, 2016).

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Labor unions became unfeasible because employers fired all members after any group formation. Riots against plantation owners were unrealistic, as owners justified their actions based on multinational procedures. Since the export companies operated in cities[6], complaints with exporters were not a solution either. Exportadora Noboa changed its headquarters from Guayaquil to New York in 1993; see Noboa (2000). Rafael Correa's administration tried to end these hiring practices through a ministerial agreement that mandated labor formalization at all stages of production. Workers in all industries had to be included on the payroll, and social security affiliation became mandatory (El Telégrafo, 2013). However, policy enforcement remained problematic, as many producers claimed they were unable to pay for all the labor benefits. Smaller, less capital-intensive plantations consistently hired children (Pier & Zamvil, 2002). These practices persist to this day.

3 Data

Roads data comes from Caspa Pacheco (2020)'s documenting effort of Ecuadorian policy towards road building in the 1925-1962 period. Caspa Pacheco (2020) shows comprehensive maps for all the year-round available roads in four distinct years– 1925, 1947, 1957, and 1968; see Figure (6) for reference. I geo-referenced the 1947 map and built an inventory of kilometers of roads per canton. Using web scraping techniques on the newspapers stored in Biblioteca Nacional Eugenio Espejo (Ecuador national library), I could confirm the permanent connection between major cities in Manabi province.

Table (1) shows summary statistics on two data types. First, it presents the road stock per canton measured in kilometers. Then, it shows two geographical variables: the mean distance to a river or lake and the average precipitation in 1954. These statistics show that the distribution of roads was almost identically split between the two most populated regions of the country: Sierra and Costa. Although this data represents the road stock in place just before the boom, it is worth noting that it does not tell anything about the quality of the links; all it states is their existence as permanent connections between cities. The last row in *Costa region* panel shows a dummy variable indicating whether the canton has either a port or a land border with a canton with a port. In 1947, there were only three international ports in Ecuador: Guayaquil, Esmeraldas, and Machala.

Data for mean monthly precipitation in 1954 and mean distance to rivers and lakes comes from the AidData Lab Research Lab at William and Mary's Global Research Institute. The variable that captures the distances to water in kilometers is derived using the World Vector Shorelines with rivers and lakes from World Data Bank (via Natural Earth). Precipitation data is created using the UDel precipitation dataset v5.01 built by Willmott and Matsuura (2001). Further detail and documentation on the data source can be found in Goodman, BenYishay, Lv, and Runfola (2019).

Data for banana output, number of plantations, and sowed and harvested area came from the 1954 agrarian census. This census was the first official record of Ecuador's agricultural production. Table (2) displays the summary statistics for the four variables at the national and regional levels, respectively. It is worth noting that most of the Sierra region cannot sow banana trees; bordering cantons in these regions account for the data from this region. Figure (7) in the appendix presents the top 25 cantons in each one of the variables.

6 Standard Fruit had a small office in Machala with almost no personnel (Striffler, Moberg, Joseph, & Rosenberg, 2003).

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Table 1: Summary Statistics

Variable	Min.	Median	Mean	Max.	Std. Dev.	Obs.
All Regions						
Year Round Roads in 1947 (km)	0.0000	17.4694	26.3804	148.2417	31.3767	80
Mean distance to river or lake (km)	3.2259	42.1795	44.1183	109.0628	28.6438	80
Mean monthly precipitation in 1954 (mm)	0.7500	79.2972	86.4238	241.8397	44.8203	80
Costa Region						
Year Round Roads in 1947 (km)	0.0000	18.8776	27.0702	144.8207	32.3871	33
Mean distance to river or lake (km)	3.2259	42.9686	41.9328	105.2048	28.7212	33
Mean monthly precipitation in 1954 (mm)	0.7500	76.9239	78.8378	186.7624	45.9362	33
Connection to port [=1]	0.0000	0.0000	0.4242	1.0000	0.5019	33
Sierra Region						
Year Round Roads in 1947 (km)	0.0000	17.4251	25.8961	148.2417	30.9920	47
Mean distance to river or lake (km)	6.7507	42.9686	45.1299	109.0628	28.8562	47
Mean monthly precipitation in 1954 (mm)	31.4948	83.9858	91.7501	241.8397	43.7241	47

Note: This table reports summary statistics for Year-Round Roads in 1947, measured in kilometers. The source for this measure is derived from geo-referencing the road map provided by Caspa Pacheco (2020). Data on the mean distance to a river or lake (measured in kilometers) and the average monthly precipitation (measured in millimeters) come from Goodman et al. (2019). The data are at the cantonal level for all cantons recorded in the 1954 agricultural census. The census covered the Highlands (Sierra Region) and the Coastal Region (Costa), while the Amazon and the Galápagos were omitted. The provinces in the Sierra Region are Azuay, Bolívar, Cañar, Carchi, Chimborazo, Cotopaxi, Imbabura, Loja, Pichincha, and Tungurahua. The provinces in the Costa Region are El Oro, Esmeraldas, Guayas, Los Ríos, and Manabí.

Table 2: Outcome Variables

Variable	Min.	Median	Mean	Max.	Std. Dev.	Obs.
All Regions						
Sowed Area, Thousand of hectares	0.00	0.31	2.00	26.19	4.22	80
Harvested Area, Thousand of hectares	0.00	0.24	1.44	17.89	2.92	80
Number of Banana Plantations	0.00	207.50	506.16	3511.00	738.74	80
Output, Thousand of Bunches	0.00	165.00	776.06	7490.00	1506.95	80
Costa Region						
Sowed Area, Thousand of hectares	0.00	1.90	4.21	26.19	5.75	33
Harvested Area, Thousand of hectares	0.00	1.23	2.95	17.89	3.91	33
Number of Banana Plantations	0.00	428	767.24	3511.00	885.43	33
Output, Thousand of Bunches	0.00	694	1565.82	7490.00	2014.32	33
Sierra Region						
Sowed Area, Thousand of hectares	0.00	0.01	0.45	8.23	1.26	47
Harvested Area, Thousand of hectares	0.00	0.01	0.38	7.18	1.09	47
Number of Banana Plantations	0.00	15	322.85	2063.00	555.5394	47
Output, Thousand of Bunches	0.00	5	221.55	3575.00	561.9563	47

Note: This table presents four outcome variables on banana production at the cantonal level for all cantons recorded in the 1954 agricultural census. The census covered the Highlands (Sierra Region) and the Coastal Region (Costa), while the Amazon and the Galápagos were omitted. Banana production in the Sierra Region is concentrated in cantons bordering the Costa Region, benefiting from favorable climate conditions. The provinces in the Sierra Region are Azuay, Bolívar, Cañar, Carchi, Chimborazo, Cotopaxi, Imbabura, Loja, Pichincha, and Tungurahua. The provinces in the Costa Region are El Oro, Esmeraldas, Guayas, Los Ríos, and Manabí.

4 Empirical Analysis

The empirical analysis is straightforward. I aim to establish whether the available roads, distance to rivers, or both correlate with the outcome variables related to banana production. To do so, I fit a simple OLS regression expressed in equation (1) where y_i stands for one of the outcomes summarized in Table (2), X'_i contains the average monthly rain in the census year and whether the canton has or is connected with a port. The two coefficients of interest are β_1 and β_2, which capture the road network length and mean distance to a river or lake in canton i, respectively.

$$y_i = \beta_0 + \beta_1 \text{Road Length } 1947_i + \beta_2 \text{Mean distance to river or lake} + X_i' \delta + \varepsilon_i. \qquad (1)$$

Table (3) presents the correlation results. I found no correlation between the outcome variables and road stock. However, a kilometer increase in the mean distance to a river or lake decreases the number of banana plantations by 21. A potential explanation is that as mean distance to a river decreases, farmers face lower transportation costs. On the contrary, if the canton is, on average, further away from a river, transportation costs towards the port will behave as an entry barrier.

Table 3: Infrastructure and Production Correlations

Variables	(1) Sowed Area	(2) Harvested Area	(3) Plantations	(4) Output
Year Round Roads in 1947 (km)	0.030	0.016	-1.370	-0.605
	(0.023)	(0.015)	(2.813)	(6.173)
Connection to port [=1]	3.917***	2.748***	242.518	1,363.738**
	(1.336)	(0.896)	(208.340)	(502.743)
Mean distance to river or lake (km)	-0.093*	-0.064*	-21.014***	-29.391
	(0.053)	(0.035)	(6.293)	(19.240)
Mean monthly precipitation in 1954 (mm)	0.108**	0.075**	18.834***	36.020**
	(0.041)	(0.027)	(4.700)	(15.183)
Constant	-2.787**	-1.845**	113.442	-581.765
	(1.331)	(0.870)	(202.426)	(499.100)
Sierra Region	NO	NO	NO	NO
Observations	33	33	33	33

Note: Correlation models relating different outcome variables related to banana production (sowed and harvested area, number of plantations and output) and two infrastructure variables: the length of available roads and mean distance to rivers at the cantonal level. Robust standard errors are reported in parenthesis. Significance levels are *(p < .10), **(p < .05), ***(p < .01).

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The negative relationship between distance and the number of plantations is relevant because it points to the idea that the first banana producers may not have relied on a state-provided road network but benefited from access to rivers as a public good. This argument opposes the classical view that relates the banana exporting industry to state support from its early stages. The infrastructure built after 1954 appears to cover this gap; see Figure (6). This may suggest that government investment resulted from what was already a thriving industry. However, I abstain from making causality claims; I would need a more robust research design to do so. The small sample size of 33 cantons remains a significant constraint. Figures (4) and (5) plot the correlations of interest. The slope of the red line in both plots match the coefficient reported in Table (3).

Since the historical background advocates that a portion of the banana export industry emerged from the ashes of the cacao industry, the stock of public infrastructure available in 1947 may have been designed and implemented to serve that previous industry. To test this hypothesis I run the analogous correlation with respect to four cacao outcome variables: number of cacao trees, number of cacao trees in productive stage, number of cacao plantations and output (measured in thousands of quintals[7]). Table (4) reports the correlations. I found a weak relationship between the kilometers of roads and the number of cacao trees in the productive stage. The sign of this result indicates that apart from surrounding the main cities in the country, the incipient road network may have benefited cacao croppers.

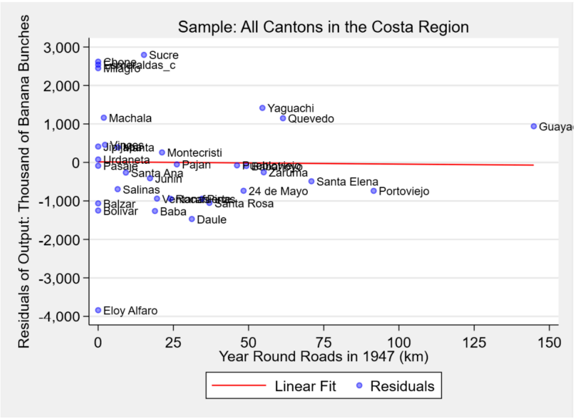

Figure 4: Correlations: Roads in 1947 and Banana Output in 1954
Note: This figure is built by regressing Output against connection to the port, mean distance to the river, and mean monthly precipitation, fitting the residuals and then correlating the residuals to the year-round roads in 1947 variable. The slope of the linear fit coincides with the coefficient reported in Table (3).

7 1 quintal is approximately 46 kg or 100 lbs.

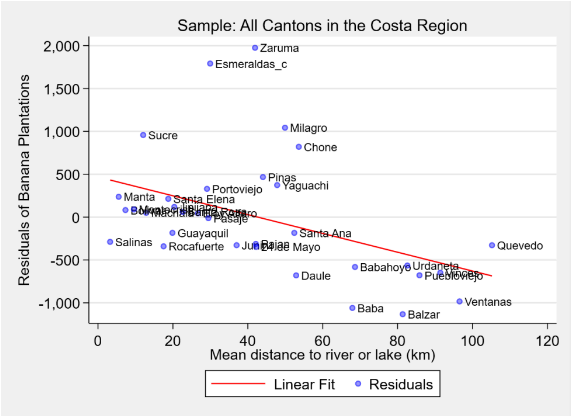

Figure 5: Correlations: Distance to Water vs Banana Plantations in 1954
Note: This figure is built by regressing the number of banana plantations against connection to the port, the length of the road network in 1947, and mean monthly precipitation, fitting the residuals and then correlating the residuals to the mean distance to rivers or roads variable. The slope of the linear fit coincides with the coefficient reported in Table (3).

Table 4: Cacao: Infrastructure and Production Correlations

Variables	(1) Cacao Trees	(2) Cacao Trees in Productive Stage	(3) Cacao Plantations	(4) Output
Year Round Roads in 1947 (km)	47.215*	40.343*	-3.217	0.000
	(24.057)	(20.303)	(3.120)	(0.000)
Connection to port [=1]	3,545.664**	3,091.391**	285.974	0.019**
	(1,622.668)	(1,399.825)	(301.151)	(0.008)
Mean distance to river or lake (km)	120.089***	96.403***	2.106	0.000*
	(40.177)	(33.387)	(8.422)	(0.000)
Mean monthly precipitation in 1954 (mm)	11.313	6.543	8.402	0.000
	(23.692)	(19.050)	(7.029)	(0.000)
Constant	-4,700.495**	-3,695.495**	-128.563	-0.013*
	(1,931.301)	(1,536.819)	(287.261)	(0.008)
Sierra Region	NO	NO	NO	NO
Observations	33	33	33	33

Note: Correlation models relating different outcome variables related to cacao production and two infrastructure variables, the length of available roads and mean distance to rivers at the cantonal level. Robust standard errors are reported in parenthesis. Significance levels are *(p < .10), **(p < .05), ***(p < .01)

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The descriptive evidence that an increase in the distance from a river or lake is related to a decrease in plantations suggests that for less connected cantons, only very productive plantations could be set in place. By achieving economies of scale, they could offset the higher transportation costs of being located further away from a mass of water. Note that proving this potential mechanism is out of the scope of this paper and remains a further effort to contribute to this research agenda.

Another concern is whether the correlations reported in the current analysis are just a consequence of scale and therefore are unit dependent. To check for this, I run the correlation analysis depicted in equation (1) but with the outcome variables, the road length and distance to rivers or lakes in logarithms. Table (5) reports the results from this specification. The negative relation between the number of plantations and distance to river or lake dissipates. However, sowed and harvested area in log scale decrease as the logarithmic distance to a body of water increases. The prior aids the argument that increasing the distance to a river or lake harms banana production outcomes.

Table 5: Banana: Infrastructure and Production Correlations, in Logarithms

Variables	(1) Log Sowed	(2) Log Harvested	(3) Log Plantations	(4) Log Output
Log(Year Round Roads in 1947 (km))	0.066	-0.033	0.064	-0.217
	(0.219)	(0.232)	(0.166)	(0.247)
Connection to port [=1]	2.218***	2.444***	0.722	2.488***
	(0.512)	(0.602)	(0.548)	(0.717)
Log(Mean distance to river or lake (km)	-1.041**	-1.017*	-0.708	-1.246*
	(0.416)	(0.527)	(0.464)	(0.609)
Mean monthly precipitation in 1954 (mm)	0.047***	0.047***	0.022**	0.051***
	(0.008)	(0.010)	(0.008)	(0.012)
Constant	-0.548	-0.884	6.240***	6.468***
	(1.218)	(1.443)	(1.245)	(1.543)
Sierra Region	NO	NO	NO	NO
Observations	33	33	33	33

Note: Correlation models relating different outcome variables related to banana production and two infrastructure variables, the length of available roads and mean distance to rivers at the cantonal level. In this table all correlated variables except for connection to port and mean monthly precipitation are transformed to logarithms. Robust standard errors are reported in parenthesis. Significance levels are *($p < .10$), **($p < .05$), ***($p < .01$)

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5 Conclusion

This paper addresses whether there is a relation between the public good infrastructure in place in Ecuador before the banana boom and several banana outcomes. I found that the length at the cantonal level of the road network in 1947 is not correlated to the banana cropping outcomes measured in the first agrarian census in 1954.

The study, however, finds a relation between the distance to a river and the number of plantations, suggesting that an increase in the mean distance of a canton to a river or lake decreases the number of banana plantations, a proxy variable for the number of producers. The empirical exercise done in this work suggests that the infrastructure investment commonly associated with the banana exporting sector emerged after the industry was proven to be a national champion. Due to data constraints, I cannot provide a causal inference interpretation of the results. This work is a starting point for a research agenda exploring the uniqueness of Ecuador's banana export market.

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7 Appendix

A Figures

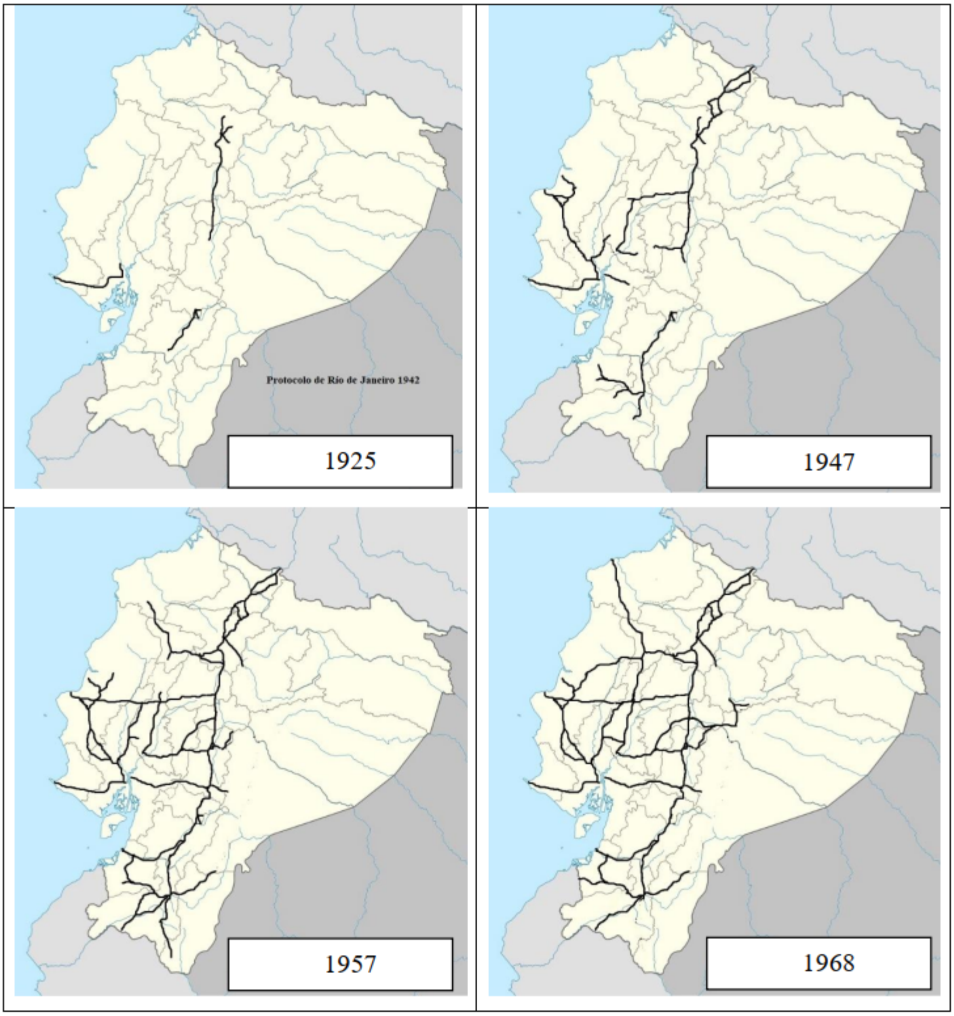

Figure 6: Ecuador Year-round roads stock distinct years
This figure comes from Caspa Pacheco (2020) and shows a historic effort to reconstruct the road-network available in Ecuador during four distinct years: 1925, 1947, 1957 and 1968. Caspa Pacheco (2020) builds connections by using official documents from distinct sources such as the Ministry of Transportation.

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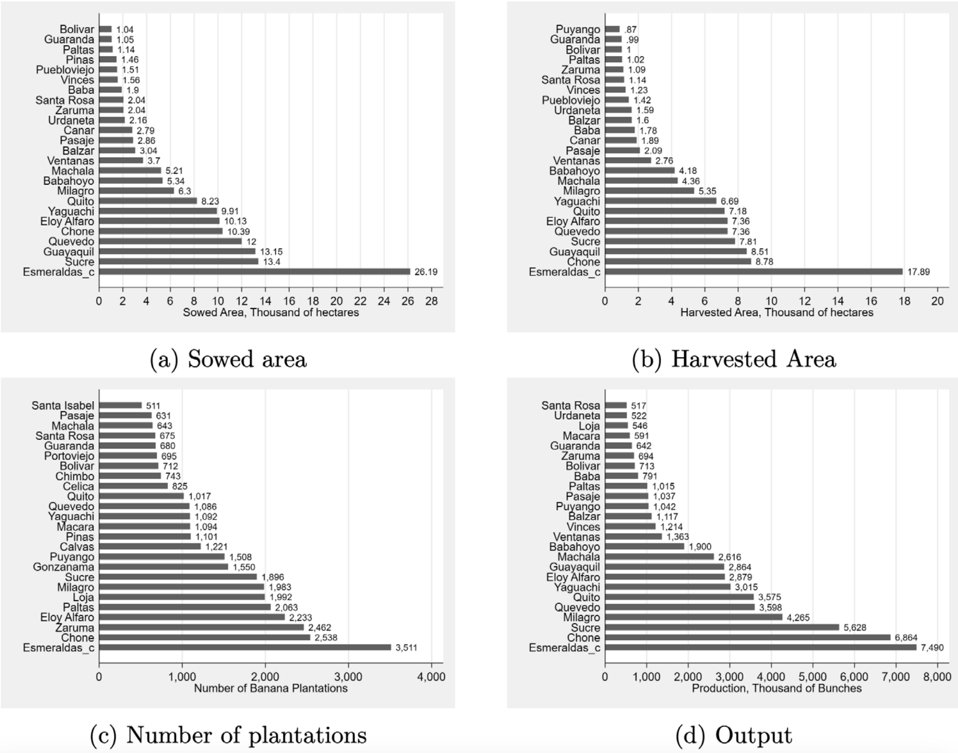

Figure 7: Banana Plantations, Area and Output

Panel (a) shows a ranking of the top 25 cantons with the highest sowed area for bananas. Panel (b) produces the top 25 ranking for the harvested area. Note that the two are positively correlated, but their difference may point out both productivity differences or investments done at the time. Panel (c) shows the number of banana plantations by canton for the 25 with the highest number of banana plantations. This measure cannot control the size of the plantation. Finally, panel (d) shows the final output by canton measured in thousands of banana bunches.

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