Extractive Institutions in Colonial Africa

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Federico Tadei

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Ai miei genitori, Anna Maria e Roberto, e a mio fratello, Alessandro

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Abstract

A common explanation for African current underdevelopment is the extractive character of institutions established during the colonial period. Yet, since colonial extraction is hard to quantify and its exact mechanisms are not well understood, we still do not know precisely how colonial institutions affect economic growth today. In this project, I study this issue by focusing on the peculiar structure of trade and labor policies employed by the French colonizers.

First, I analyze how trade monopsonies and coercive labor institutions reduced African gains from trade during the colonial period. By using new data on prices to agricultural producers and labor institutions in French Africa, I show that (1) the monopsonistic character of colonial trade implied a reduction in prices to producers far below world market prices; (2) coercive labor institutions allowed the colonizers to reduce prices even further; (3) as a consequence, colonial extraction cut African gains from trade by over 60%.

Given the importance of labor institutions, I then focus on their origin by analyzing the colonial governments' incentives to choose between coerced and free labor. I argue that the choice of institutions was affected more by the properties of exported commodities, such as prices and economies of scale, than by the characteristics of colonies, such indigenous population density and ease of settlement for the colonizers.

Finally, I study the long-term effects of colonial trade monopsonies and coercive

labor institutions. By combining archival data on prices in the French colonies with maps of crop suitability, I show that the extent to which prices to agricultural producers were reduced with respect to world market prices is strongly negatively correlated with current regional development, as proxied by luminosity data from satellite images. The evidence suggests that colonial extraction affected subsequent growth by reducing development in rural areas in favor of a urban elite. The differential impact in rural and urban areas can be the reason why trade monopsonies and extractive institutions persisted long after independence.

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Chapter 1

Introduction

Many hypotheses about current African underdevelopment emphasize the role of colonial extractive institutions (Acemoglu et al., 2001, 2002; Englebert, 2000; Herbst, 2000; Nunn, 2007). They can be defined as those arrangements "designed to extract incomes and wealth from one subset of society [masses, African populations] to benefit a different subset [elite, colonizers]" (Acemoglu and Robinson, 2012). Such institutions, including land alienation, forced labor, and extremely high taxes, were necessary for Europeans to gain profit from Africa's natural resources. Beyond the income they extracted from Africans, they also reduced governments' incentives to provide public goods and African populations' incentives to invest in human and physical capital, hindering economic growth during the colonial period. Moreover, their persistence through independence means they still could explain African underdevelopment today.

The seminal paper originating this literature is Acemoglu et al. (2001). The authors' initial goal is to show that institutions affect economic growth. Since institutions may be endogenous to development, they look at colonial history to find an exogenous source of a variation. They find it in the mortality rate of European settlers at the beginning of colonial period. In low mortality colonies, where the Europeans

could settle in numbers, the colonizers had incentives to establish good institutions protecting property rights for the majority of population. On the other hand, in colonies characterized by high settler mortality, the colonizers preferred to establish institutions to extract wealth from the indigenous population in favor of a small elite. In Acemoglu et al. (2001)'s theory, settler mortality determines colonial institutions, colonial institutions affect current institutions, and current institutions affect current economic development. To demonstrate their point, the authors show that settler mortality is correlated with current protection of property rights and convincingly argue that it does not directly affect current development, making settler mortality a good instrument. This work provides two valuable contributions to understanding why Africa is underdeveloped: 1) it demonstrates that institutions matter; 2) it shows that colonial history has an important role in shaping these institutions.

Nevertheless, Acemoglu et al. (2001) approach has some limitations. First, by regressing current institutions on settler mortality, the authors assume that colonial and current institutions are correlated. However, they do not fully test their theory. In particular, they have no direct measurements of institutions during the colonial period and treat them as a black box. Little is done to understand their origin and how they worked. This generates what has been called compression of history, increasing the risk of finding spurious relationships explaining the lack of development in Africa (Austin, 2008). Moreover, a deeper understanding of colonial institutions is necessary to explain the findings of more recent studies showing that there exists a large spatial and inter-temporal variation of income levels within Africa (Frankema and van Waijenburg, 2012; Jerven, 2011).

Second, Acemoglu et al. (2001) assume that the country is the right level of analysis and that institutions established at the national level are those that matter for economic growth. Yet, given the high within-country variation in the level of development, it is valuable to investigate whether institutions determined at the sub-

national level are actually more important (Michalopoulos, 2012). For example, labor market institutions might be affected mostly by local conditions, such as the kind of agricultural production of each region.

Third, Acemoglu et al. (2001) acknowledge the fact that institutions evolved during the colonial period and after independence, even if their extractive character persisted. However, focusing on identifying an exogenous source of variation for institutions, they overlook how institutions change. Nevertheless we need to understand these processes if we want to understand how to modify the extractive institutions that hinder economic growth in Africa.

The paper by Acemoglu et al. (2001) generated a substantial amount of work about colonialism and development in Africa. The subsequent literature moved away from asking whether history matters to asking how history matters, identifying precisely the channels of causality. This new approach relies on more sophisticated identification techniques and micro-level data. Huillery (2009) uses district-level data and matching estimators to show that colonial and current levels of schooling are correlated. Gallego and Woodberry (2010) and Nunn (2010) employ data at the province and ethnic group/village level to study the impact of colonial missionary activity on schooling and religious conversion. Michalopoulos and Papaioannou (2011) exploit ethnic group-level data to estimate the effect of arbitrary colonial borders on civil war. Berger (2009) uses the historical border between Northern and Southern Nigeria and a regression discontinuity approach to study the modern impact of colonial policies on public good provision. Cogneau and Moradi (2014) also employ a regression discontinuity technique to analyze the effect of colonial policies on education and religion across the border between the French and British partitions of Togoland.

Nevertheless, despite valuable progresses in explaining how various colonial features affect current development, the main limitations of Acemoglu et al. (2001) have not been overcome yet. Much more limited efforts have been undertaken to quantify

colonial extraction, open the black box of extractive institutions, and understand their role during the colonial period. To fully evaluate the implications of Acemoglu et al. (2001)'s insight, we need to decompress history more than what has been attempted so far in the literature. How can we define and quantify colonial extraction? Which institutions were involved? What determined these institutions? Was the level of extraction similar across colonies or economic activities? How did colonial extraction persist over time and still affect current development?

In this dissertation, I study these questions focusing on colonial French Africa. Lacking important mineral resources and having a very limited manufacturing sector, the economies of the French colonies were based on agriculture. The main agents of colonial activity were European trading and concessionary companies, whose goal was to maximize profit by obtaining agricultural commodities from Africa and reselling them at higher prices in Europe. To increase profit, the colonizers sought to reduce the price paid to the African producers with respect to the world market prices. In order to do so, the French colonial governments acted on two fronts. On one hand, they actively tried to reduce the prices to Africans by conceding *de iure* or *de facto* monopsony power to the European trading companies, who were the only allowed buyers of African production from specific areas. On the other hand, they tried to reduce the outside options of Africans by implementing coercive institutions such as compulsory cultivations and various forms of forced labor (Manning, 1998; Suret-Canale, 1971; Thompson and Adloff, 1957).

In chapter 2, I study the impact of these trade and labor policies on African gains from trade during the colonial period. Because systematic data on institutions and prices have been unavailable, this question has so far remained unanswered. By using statistical publications from French colonial archives and historical and ethnographic studies, I construct a new yearly dataset of labor institutions and prices paid to African producers for the main commodities exported from each French colony

between 1898 and 1959. By developing a theoretical model of trade under colonial extraction and using panel data methods, I show that monopsonies and coercive labor institutions reduced African gains from trade by at least 60%.

In chapter 3, I focus on the origin of coercive labor institutions by analyzing the colonial governments' incentives to choose between coerced and free labor. I argue that the choice of institutions was affected more by the properties of exported commodities, such as prices and economies of scale, than by the characteristics of colonies, such indigenous population density and ease of settlement for the colonizers.

In chapter 4, I look at the effects of colonial institutions on current development. Coercive labor institutions were abolished after independence, but de facto trading monopsonies persisted, and post-independence governments continued to practice price policies that discriminated against agricultural producers. I show that the extent to which prices to agricultural producers were reduced in the colonial period is strongly negatively correlated with current regional development, as proxied by luminosity data from satellite images. I argue that colonial extraction reduced development in rural areas and increased economic growth in cities. Despite this, the overall impact on development is negative and the different effects in rural and urban areas can actually be the reason why trade monopsonies and extractive institutions persisted long after independence. Chapter 5 provides concluding remarks and suggests directions for future research.

Chapter 2

Extractive Institutions and Gains From Trade: Evidence from Colonial Africa

2.1 Introduction

Many leading hypotheses about current African underdevelopment emphasize the role of colonialism. If the early literature underlined how colonial rule relegated Africa to exporter of primary commodities (Rodney, 1972), more recent works have instead focused on the long-term consequences of colonial extractive institutions (e.g.,, Acemoglu et al., 2001, 2002; Englebert, 2000; Herbst, 2000; Nunn, 2007).[1] Yet, to explain how colonial institutions affect *current* development, we need to understand the extent of extraction *during* the colonial period. Many of the institutions established by the colonizers were, in fact, maintained in the post-independence period. Moreover, the extent to which they were extractive in the colonial period affects how extractive

[1]Extractive institutions can be defined as those arrangements "designed to extract incomes and wealth from one subset of society [masses, African populations] to benefit a different subset [elite, colonizers]" (Acemoglu and Robinson, 2012).

they are after independence (Acemoglu et al., 2001; Bates, 1981). However, since colonial extraction is hard to quantify and its exact mechanisms are unclear, we still do not know precisely how successful the colonizers were in extracting wealth from Africans.

This chapter investigates this issue by exploiting the peculiar structure of labor and trade policies employed by the French colonizers. The focus on trade in the French colonies offers two main advantages for understanding the mechanisms of extraction in the colonial period. First, because of the low population densities of French Africa and the high cost of labor relative to land, the colonizers faced there powerful incentives to use coercive labor institutions.[2] Second, focusing on trade allows us to use price data in order to evaluate colonial extraction. By using the gap between prices to African agricultural producers and world market prices as a measure of extraction, I analyze how colonial trade monopsonies and coercive labor institutions affected African gains from trade during the colonial period.

Because of limited data on colonial institutions and prices in Africa, this question has so far remained unanswered. On one hand, historians have collected information about colonial institutions, but they have not attempted to systematically quantify the level of extraction. On the other hand, economists have overlooked the temporal variation in colonial extraction, increasing the risk of "compression of history" and making it difficult to understand how extractive institutions persist over time (Austin, 2008).[3]

[2]When coercion is a feasible option, a higher land/labor ratio might not translate into higher wages, but in an increase of coercion of labor (Domar, 1969). Fenske (2013) tests this hypothesis in the African context showing that lower population density is correlated to the extent of indigenous slavery.

[3]Previous works by economists exploited spatial variation in some colonial policy or institution, observed in one point in time. Huillery (2009) studies the impact of colonial investments in education in French Africa. Gallego and Woodberry (2010) and Nunn (2010) analyze the effect of colonial missionary activity on schooling and religious conversion. Michalopoulos and Papaioannou (2011) estimates the effect of arbitrary colonial borders on civil war. Berger (2009) studies the modern impact of colonial policies on public good provision in Nigeria Cogneau and Moradi (2014) analyzes the effect of colonial policies on education and religion across the border between the French and British partitions of Togoland.

My first contribution then is to provide a new yearly dataset of labor institutions and prices paid to African producers for the main commodities exported from each French colony between 1898 and 1959. I collected the data on labor institutions from historical and ethnographic studies and the data on prices from a variety of colonial publications, including, but not limited to, statistical reports of the Ministry of the Colonies, customs statistics, and *Bulletins Economiques* of the different colonies.

My second contribution is to use these data to understand how colonial extractive institutions affected African prices. The main difficulty in answering this question is that, since extractive institutions were used in all colonies, we cannot observe colonial trade in absence of extraction. However, since in a competitive market the prices to African producers should be equal to the difference between world market prices and transport costs, we can use this measure as a counterfactual.

Building on this insight, I proceed in three steps. First, I use my price dataset to check whether colonial extraction (monopsony and coercive labor institutions) implied a reduction in the prices to African producers. I show that the prices to Africans were reduced by about 30% with respect to what they would have been in absence of monopsonies and coercive labor institutions. Moreover, the level of extraction varied substantially across the different colonies and economic activities and decreased in the second half of the colonial period.

Second, I use newly collected data on labor institutions to disentangle the effect of coercive labor institutions on prices to producers from the effect of monopsony. I present evidence that the level of coercion of labor affected the extent of price reduction. Prices to Africans were reduced by 25% with respect to competitive prices if the colonizers used free peasant production, but they were reduced by almost 40% for crops that were produced under compulsory cultivations.

To make sure that the relationship between prices and institutions is not spurious, I need to consider potential omitted variables. One candidate is the price elasticity

of African supply. The colonizers might have in fact established coercive institutions and offered lower prices in colonies/crops where Africans responded less to price incentives. To account for this problem, I exploit the panel structure of the data and the historical evidence on change in institutions. Since the transition from compulsory to free production at the end of the colonial period was affected more by the political climate before independence than by changes in elasticity of supply, I can reduce the omitted variable bias by controlling for colony/commodity and year fixed effects.

Finally, I construct lower bounds for the losses that monopsony and coercive labor institutions together implied for African welfare: on average, colonial extraction reduced African gains from trade by over 60%. Moreover, by exploiting the insight of a simple model of colonial trade under extractive institutions, I am able to disentangle the effects of monopsony from those of coercive labor institutions. I show that, when the latter were used, they accounted for at least 60% of the total losses.

The chapter is structured as follows. Section 3.2 provides some historical background about French colonies in Sub-Saharan Africa, monopsonistic trading companies, and labor institutions. Section 2.3 proposes a theoretical model of colonial trade under extractive institutions. The following three sections test the implications of the model: Section 2.4 explores the effect of colonial extraction on prices to Africans, Section 2.5 focuses on the impact of coercive labor institutions, and Section 2.6 provides lower bounds for the reduction in the gains from trade with respect to competition. Section 2.7 offers concluding remarks and delineates directions of future research.

2.2 Historical Background

Most of the military conquest of French Africa occurred between 1880 and 1900. Towards the end of 19th century there still existed some small pockets of resistance (Mauritania did not fall under full French control until 1936), but the conditions

were ready for the development of the colonial system (Coquery-Vidrovitch, 1969; Suret-Canale, 1971).

The French government organized the colonies in two federations: French West Africa (1895)—including Mauritania, Senegal, French Sudan (now Mali), Niger, Upper Volta (now Burkina Faso), Guinea, Cote d'Ivoire, and Dahomey (now Benin)—and French Equatorial Africa (1908)—including Gabon, Congo, Ubangi-Shari (now Central African Republic), and Chad. After WW1, part of Togo and almost all of Cameroon were added to the French colonies in continental Sub-Saharan Africa (see Figure 2.1).

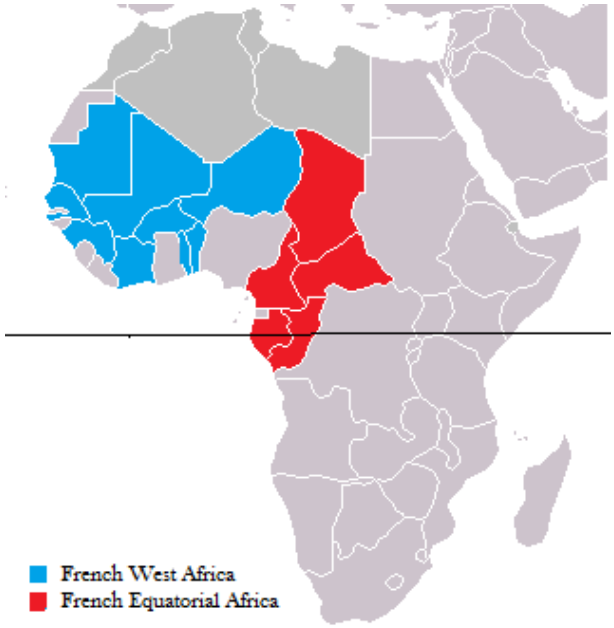


FIGURE 2.1
French West and Equatorial Africa

Togo and Cameron were not part of AOF and AEF, but they were traditionally included in West and Equatorial French Africa, respectively.

The extension of French possessions was reflected in the heterogeneity of their natural environment, including, from the coast towards the interior, tropical forests, savannas, and arid-desertic regions. The coastal forestry regions were suitable to

produce bananas, coffee, cocoa, and rubber, while the drier interior areas were suitable for peanuts and cotton. In general, Western colonies were more prosperous than Equatorial colonies and, with the exception of the peanut-producing areas of Senegal, coastal regions were usually wealthier with respect to interior regions because of the higher value of their crops and lower transportation costs (Hopkins, 1973).

Figure 2.2 shows the evolution of the total value of exports (in constant 1900 francs, evaluated with prices in France) from French Africa between 1900 and 1960.[4] Exports grew during the entire colonial period, slowed down throughout the Great Depression, and increased dramatically after 1945. On average, peanuts accounted for the highest share of exports (about 30% of the total value), followed by rubber (about 18%), oil palm produces (15%), coffee, cocoa, and timber (each of them accounting for about 10%). Cotton and bananas accounted for the remaining exports. Cote d'Ivoire, Senegal, and Cameroon were the richest colonies, generating 28%, 21%, and 16% of the total value of exports, respectively.

Given the variety of environments and commodities, the colonizers structured economic activity and trade in the colonies in different ways. In West Africa, exports were initially based only on African peasant production. European trading companies limited themselves to buying crops and reselling them at higher prices in Europe. After WWI, Europeans began to enter the productive sector, establishing plantations (e.g.,, cocoa and coffee in Cote d'Ivoire, bananas in Guinea) and exploiting forestry concessions. Mining was a minor activity. In Equatorial Africa economic activity was initially organized on the basis of concessionary companies with monopoly over given territories. African laborers were forced to collect crops, especially rubber, for the concessionaires who employed harsh coercive methods. The abuses of the concession system led to its termination in the 1920s, when trading companies on the model of West Africa were established (Suret-Canale, 1971).

[4]See Section 2.4.1 for details on the data.

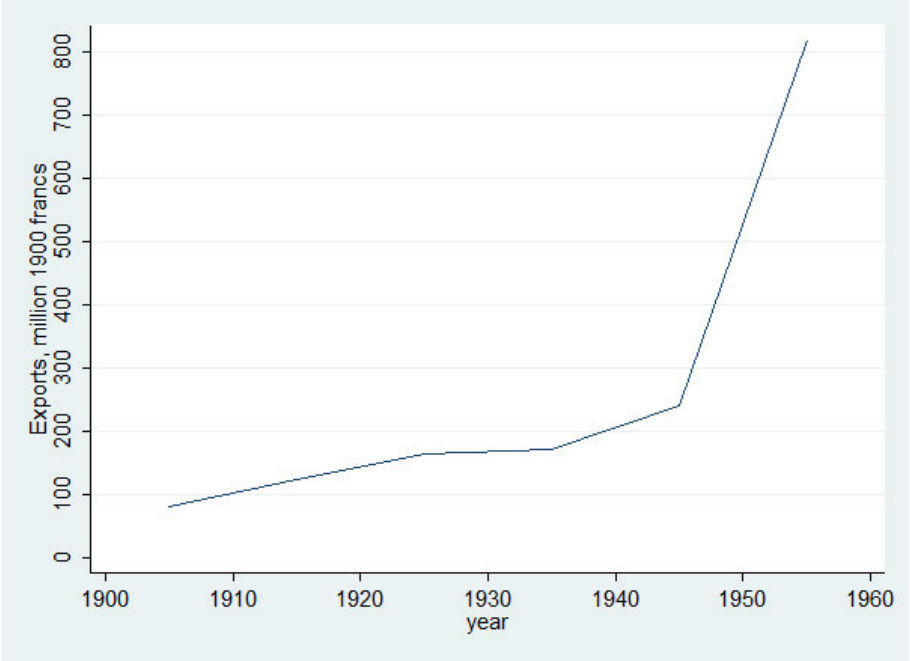


FIGURE 2.2
Total Value of Exports from French West and Equatorial Africa

The total value of exports is in millions of 1900 French francs, evaluated using prices in France net of trading costs. It includes all the main commodities (bananas, cocoa, coffee, cotton, peanuts, oil palm produces, rubber, and timber) and all colonies. Values are computed as 10-years averages to reduce the impact of outliers and to have at least one observation for each colony/commodity/decade. Missing data are interpolated.

The French administration fixed the import prices in France by ministerial decree, following world market prices, and the prices to African producers, usually as a percentage of the world market price. For example, cotton price paid to Ubangi-Shari farmers was 15% of the average FOB price of cotton in New York (DeDampierre, 1960).

Whether the economic activity was organized through European companies or African peasant agriculture, the French colonizers had incentives to reduce the cost of production in order to increase profit. Thus, the colonial government tried to establish *de iure* or *de facto* monopsonies for the trading and concessionary companies in order to reduce prices and wages to Africans (Coquery-Vidrovitch, 1972; Manning, 1998; Suret-Canale, 1971; Thompson and Adloff, 1957).

At the beginning of the 20th century, trade in the Senegal/Mali region was controlled by a group of eight Bordeaux trading firms, while Guinea and Congo were in the hands of business houses from Marseilles or Paris. Smaller traders were allowed a share of exports as long as they respected the prices fixed by the main trading firms. After WWI, the *de facto* monopsony of these companies grew stronger: economic crises eliminated competition from smaller companies, German business interests were canceled by the war, and protectionist measures were taken against British trade. Protectionist policies were not applied everywhere and did not completely eliminate non-French trade (especially in Guinea and Dahomey). Nevertheless, the number of the remaining trading firms became sufficiently small to allow agreement and ban entry into the African market (Suret-Canale, 1971). As a result, at the beginning of WWII, fewer than a dozen companies monopolized almost all of trade from French West Africa and two French companies (Société Commerciale de l'Ouest Africain, Compagnie française de l'Afrique Occidentale) and a British one (Unilever) controlled between 50% and 90% of exports (Suret-Canale, 1971, p. 167).

In addition to establishing monopsony power for the trading companies, the col-

onizers attempted to reduce price and wages to Africans by interfering with labor markets and implementing coercive institutions.[5] Since capital was relatively expensive, production relied on labor-intensive methods. French Africa's low population densities and abundant cultivable land in the indigenous sector implied that African incentives to enter the wage labor force or to produce cash crops were insufficient. For these reasons, the colonizers put in place specific institutions such as compulsory African cultivations and various forms of forced labor in European plantations. These institutions, by reducing the outside options of Africans, had to goal to further increase the ability of the colonial governments to lower prices to producers.

Three main kind of institutions were used (free peasant production, compulsory peasant production, and concession/forced labor production) and the type of coercive arrangements available to the colonizers depended on whether agricultural production was African-based or European-based. When the colonizers limited themselves to trade and production was left to African peasants, the colonial governments could introduce compulsory peasant production. In this case, they set quotas that Africans had to produce and sell for a fix price to the colonizers. The most notable example of this institution were the cotton quotas established by Felix Eboué in Ubangi-Shari in 1924 (DeDampierre, 1960). Under this arrangement, every village had to produce amounts of cotton in proportion to its population and sell it to trading companies with monopsony power over given territories. The costs for the recruitment of cotton producers were borne by the colonial government, and payments were often in the form of tax vouchers. Cotton quotas were abolished in 1956, just four years before independence.

Alternatively, when the colonizers entered the productive sector, establishing concessions and plantations, forced labor could be implemented. It took the direct form of labor taxes and the indirect form of contract labor. With labor taxes, all males

[5]We can interpret these institutions as subsidies given by the colonial government to the European trading and concessionary companies.

between 18 and 60 had to contribute a certain number of days of unpaid labor (usually from 8 to 12 per year) to whatever enterprise the administration assigned them. Labor taxes were used mostly for porterage and public works, but not infrequently for private enterprises, especially in the early days of the colonial period. They were finally abolished for both the private and public sector in 1946 (Fall, 1993).[6] Contract labor was a system of formal labor recruiting used mainly for private enterprises. While not forced labor, it was far from a free market system. The most important figure in this system was the labor recruiter who rounded up manpower in villages. Local chiefs received payments for every man supplied and were therefore encouraged to cooperate with the recruiter. The compulsory nature of this system decreased in the late 1930s, when freer forms of recruitment started to appear.

However, coercive labor institutions were not implemented everywhere. When neither compulsory cultivations nor forced labor were used, the prices or wages were still fixed by the colonizers, but the African peasants could decide whether to work for the colonizers in the case of European-based production or how much crop to produce in the case of African-based production. Free peasant production was actually used in the majority of cases, accounting for almost 60% of the total value of exports; concession and compulsory production followed with about 30% and 10% of the export value, respectively.

Given such a variety of labor arrangements, one might ask which factors affected the kind of institutions that were implemented. In chapter 3, I will show that the choice was affected more by factors related to the characteristics of crops, such as economies of scale and world prices, than to the characteristics of colonies, such as settler mortality or population density. Free peasant production was used for low-value crops with limited economies of scale (peanuts, palm kernels, and cocoa). Compulsory peasant production was implemented for crop with limited economies

[6]Other institutions such as labor drafts, convict labor, and military labor worked in a similar manner.

of scale , but high value (cotton, wild rubber). Concession production with various forms of coercion for African workers was used for commodities whose production needed large capital investments and was characterized by large economies of scale (bananas, coffee, timber, plantation rubber).

Nevertheless, some variation in institutions existed across regions and time within the same crop. Free peasant production was much more diffuse in West African colonies, while concession production and especially compulsory production were employed more frequently in Equatorial Africa. Over time, and in particular after WWII, the political pressure to abolish coercive institutions increased. As a result, we observe a transition towards free peasant production in most colonies and crops. At the onset of independence, free peasant production accounted for almost 70% of the total value of exports, with the remainder produced under concessions.

2.3 A Model of Colonial Extraction

Although both economists and historians agree on the importance of colonial institutions, the extent of extraction has been difficult to assess. How much did colonial extractive institutions reduce African prices and gains from trade?

In order to answer this question, we need to identify the proper counterfactual. To do so, I outline a simple model of colonial trade under monopsony and coercive labor institutions. For the purpose of the model, institutions are treated as exogenous, and I will address the issue of their origin in the empirical part of the chapter.

There are two groups of actors: African Peasants and Trading Companies. The African Peasants produce one crop and sell it to the Trading Companies. The Trading Companies set the price to producers and resell the crop at the world market price in Europe.[7] Given the price to producers p_A, the African Peasants produce the quantity Q in order to maximize $\Pi_A = p_A Q - C(Q)$, where $C(Q)$ is a convex cost function.

[7]The traded quantity from Africa is too small to affect world prices. See Table 3.1.

The FOC implies that the quantity is such that the marginal cost is equal to the price and the African supply function is $Q(p_A) = MC^{-1}(p_A)$, where MC is the marginal cost function. Given this supply function, the Trading Companies choose the price p_A to maximize $\Pi_C = (p - t - p_A)Q(p_A)$, where p is the (exogenous) world market price and t are transportation costs. The price paid to Africans varies according to the kind of institutions governing trade and production: perfect competition among trading companies, simple monopsony, monopsony and coercive labor institutions. Let us consider each of the three cases.

1. *Perfect Competition*

   Suppose that there are (infinitely) many trading companies competing for African production. If one company sets a price $p_A < p - t$, then a second company might set a higher price, buy the entire production, and still make a positive profit. The equilibrium price to Africans is just the difference between price in Europe and transport costs,

   $$p_A = p - t \tag{2.1}$$

   In this case, the profit of the Trading Companies is zero.

2. *Simple Monopsony*

   Suppose that one Trading Company has the right to buy all African production. In this case, the FOC for the Trading Company's maximization problem implies

   $$p_A = p - t - \frac{Q(p_A)}{Q'(p_A)} \tag{2.2}$$

   Since both $Q(p_A)$ and $Q'(p_A)$ are positive, the price to Africans is lower under monopsony than under competition. In this case, the Trading Company makes a positive profit.

3. *Monopsony and Coercive Labor Institutions*

Suppose that, in addition to monopsony, the Trading Company has access to coercive labor institutions (various forms of forced labor and compulsory cultivations) in order to force African Peasants to produce more than they would produce at any given price. We can model African's supply function under coercive institutions as $Q_c(p_A) = Q(p_A + c)$, where c is the level of coercion. In this case, the FOC implies

$$p_A = p - t - \frac{Q(p_A + c)}{Q'(p_A + c)} \tag{2.3}$$

Since $Q(.)$ is increasing and concave, $\frac{Q(p_A+c)}{Q'(p_A+c)} > \frac{Q(p_A)}{Q'(p_A)}$. Thus, the price under monopsony and coercive labor institutions is lower than the price under simple monopsony. As a consequence, the profit of the Trading Company is higher in this last case.

Let us now consider the implications of these institutional arrangements for African gains from trade.

- *Simple Monopsony*

  Since the price under simple monopsony is lower than the price under competition, the traded quantity will also be lower. African gains from trade are thus lower under simple monopsony than under competition. Without coercive labor institutions the marginal cost of each unit is always lower than the price, so Africans still get some gains from trading, but less than if they were facing competition among trading firms.

- *Monopsony and Coercive Labor Institutions*

  With coercive labor institutions, the price is lower than under simple monopsony. Given the presence of coercion, the traded quantity is higher, but Africans will produce the additional quantity at a cost higher to the price. For this rea-

son, African gains from trade are lower under monopsony and coercive labor institutions than under simple monopsony. Moreover, notice that, because the Africans receive a price lower than the marginal cost, they might be worse off with respect to not trading at all.

The model yields three predictions about the features of colonial extraction in French Africa:

1. Prices to Africans were lower than they would have been with competition.
2. They were further reduced with respect to monopsony prices by the presence of coercive labor institutions.
3. Extractive institutions reduced African gains from trade.

In the rest of the chapter, I will empirically test these results.

2.4 Result 1: Prices to Africans and Competitive Prices

In this section I explore the first result of the model, checking whether the prices to Africans in the French colonies were lower than competitive prices.

2.4.1 Data

To test this hypothesis, I use newly-collected data on prices in Africa, prices in France, and transport costs. I focus on nine main commodities exported by French Africa: peanuts, palm kernels and oil, cotton, cocoa, coffee, rubber, timber, and bananas. The commodities included in the dataset account for 80% of the value of all exports from West and Equatorial Africa during the whole colonial period.

Prices in Africa and Quantities Exported

Colonial customs statistics reported the total quantity and value for each exported commodity from each colony every year. These statistics were registered at the local customs offices and then aggregated at the colony level. The reported values were usually official market prices in Africa (*valeurs mercuriales*), established by decree by the General Governor of the colonies on the basis of reports of local commissions of evaluation. After World War II, the reported evaluations were often values of the commodities at the loading port, including transportation costs to the port and exit taxes.[8]

TABLE 2.1
Components of Prices: Cocoa, 1958–59

	Togo	Congo	Cote d'Ivoire
price to producers	**100**	**82**	**90**
transport to port	4	12	5
taxes, insurances, stockage	32	30	31
price at African port	**136**	**124**	**126**

Source: elaboration from *Documents et statistiques—Ministre de la France d'Outre-mer, Service de statistique*, 1958–59. Prices are in current francs per kg.

Using these customs statistics, I collected data on prices in Africa and quantities exported from each colony for nine main commodities between 1898 and 1959. I exploited numerous yearly issues of different colonial publications, including, but not limited to, statistical reports of the Ministry of Colonies, *Bulletins Economiques* of the various colonies, and *Annuaire Statiques* of West and Equatorial Africa.[9]

Given the variety of the sources and the length of the period considered, the names of the territorial units for which the custom statistics are reported change over time and sometimes data are reported only for larger territorial units. To solve these issues, I first tracked the variation in the names of colonies. Then, I assigned each

[8]These values are a good proxy for the actual prices to producers: detailed data on prices to farmers, inland transport cost, and tariffs from the late 1950s show that, after controlling for transportations costs, differences in prices at African ports are almost exclusively due to differences in prices to producers. See Table 2.1.

[9]See the appendix for more details on the sources.

commodity from a larger territorial unit to the smallest territory (colony or group of colonies) that I could identify by excluding those colonies which do not produce that specific commodity.[10] I deflated all prices in 1900 French francs.[11]

Prices in France

I collected prices in France from various issues of the *Statistiques Mensuelles du Commerce Extérieur de la France*, a monthly publication by the *Direction Générale des Douanes* reporting the total values and quantities of the commodities imported from the French colonies in every year. As a control, I also used different issues of the *Annuaire Statistiques de France* reporting similar information. I deflated all prices in 1900 French francs.

Not all exports from French Africa went to France. Nevertheless, given the importance of the French market, using export prices in France is a good approximation. By 1949, France was the destination of about 80% of the total exports originating from its African colonies (Duignan and Gahan, 1975). Moreover, French prices are highly correlated with world market prices, as shown in appendix 2.8.1.

Transport costs

Since extensive data on transportation costs between Africa and France are not available, I constructed estimates of shipping costs for each colony-commodity-year in my dataset according to the following procedure. First, I computed the distance to Marseilles from the closest African port for each colony.[12] Then, I used data on average freight rates from the West African coast to France for the main exports in 1938 to compute the average shipping cost per km for each commodity in 1938.[13] Finally, I multiplied this measure by the distance to Marseilles for each colony (both

[10]For example, all cocoa exports 1898–1907 recorded as from French Congo (including Gabon and Congo) are assigned to Gabon because there was no registered cocoa production in Congo before 1927. Territorial units involved are AEF, French Congo, AOF, and Senegal-Haut Senegal-Niger.

[11]Inflation data come from France-Inflation.com (2013).

[12]The main ports are identified from the map reported at page 149 of Duignan and Gahan (1975). The distance to Marseille is computed by using http://ports.com/sea-route.

[13]Documents et statistiques—Ministère de la France d'Outremer, Service de statistique, 1949–52.

West and Equatorial Africa) and by an index of transportation costs between 1898 and 1959 with base 1938=1 from Mohammed and Williamson (2004).[14] In the empirical analysis, I will consider also inland transport costs, by controlling by the distance of each colony to the coast.

Overall, the dataset includes 1717 observations (colony-commodity-year) and I have data on prices in Africa, prices in France, and transportation costs for 1466 of them. The years covered are: 1898–1914, 1920–1951, 1953, 1956, 1958, and 1959. Table 2.2 reports the summary statistics.

TABLE 2.2
Summary Statistics

	mean	st.dev.	min	max	N
price in Africa	0.71	1.18	0.01	17.9	1714
transport cost	0.04	0.02	0.02	0.06	1717
price in France	1.28	2.34	0.06	19.63	1469

In 1900 French francs.

2.4.2 Empirical Strategy

Equations (2.2) and (2.3) imply that with perfect competition $p_A = p - t$, while under monopsony and coercive labor institutions $p_A = p - t - \frac{Q(p_A+c)}{Q'(p_A+c)}$, where p_A is the price to Africans, p is the price in France, t is transport costs, and $Q(.)$ is the African supply function. Defining the elasticity of African supply with respect to the price as $\epsilon(p_A) = Q'(p_A + c)\frac{p_A}{Q(p_A+c)}$, we can rewrite the expression for the price to Africans under extractive institutions as[15]

$$p_A = \frac{\epsilon(p_A)}{1 + \epsilon(p_A)}(p - t) \tag{2.4}$$

[14] I used the global real freight rate deflated by commodity prices, from table 3 of the paper.

[15] Notice that as the elasticity of African supply increases the gap between price to Africans and price in France minus transport cost decreases. The colonizer offers higher prices to those colonies/commodities with higher elasticity of supply.

We can thus test whether the prices to Africans were lower than they would have been with competition by running the following regression

$$p_{A,cit} = \beta(p_{ct} - t_{cit}) + u_{cit} \tag{2.5}$$

where c refers to the commodity, i to the colony, t to time, and u_{cit} is the error term. Under the null hypothesis and no colonial extraction, $\beta = 1$.[16]

However, the estimation of β is likely to be inconsistent because transport costs t might not include all of the costs that the trading companies had to face to export commodities from Africa to France (e.g.,, loading and storage costs, taxes and tariffs, insurances). Suppose that the true regression is $p_{A,cit} = \beta(p_{ct} - t_{cit} - c_{cit}) + \epsilon_{cit}$, where c_{cit} represents other omitted costs. Assume $Cov(p, \epsilon) = 0$, $Cov(t, \epsilon) = 0$, and $Cov(c, \epsilon) = 0$. Standard results imply that, estimating β by OLS from (2.5), $plim\beta_{OLS} = \beta(1 - \frac{Cov(p,c)-Cov(t,c)}{Var(p-t)})$. If $Cov(p, c) - Cov(t, c) > 0$, then the estimated coefficient is biased against the null hypothesis of no extraction.

Fixed transport costs (loading and unloading, warehousing, insurance, docking fees, etc.), inland transport costs from the interior to the port, and taxes and tariffs in Africa and in France are likely to be omitted costs. Even if it is reasonable to think that the correlation of fixed and inland transport cost with t is positive (implying a potential bias in favor of the null), the correlation between prices in France and omitted costs could also be positive, leaving the direction of the bias ambiguous.

Suppose, for example, that the price of a commodity in France is equal to the price of that commodity in a big supplier country plus fixed transport costs and shipping costs from there to France. If fixed transport costs in this country are the same or correlated with fixed transport costs in Africa, then $Cov(p, c) > 0$. Moreover, if

[16] In equation (2.5) the coefficient β is equal to $\frac{\epsilon(p_A)}{1+\epsilon(p_A)}$ and thus it might depend on p_A. This is not an issue if we assume a supply function with constant elasticity of supply, such as the one originated from a Cobb-Douglas production function with decreasing return of scale.

transport costs depend on some characteristics of commodities (perishability, stowage factors, etc.), inland and fixed transport costs might be positively correlated and consequently also inland transport costs and prices in France would be positively correlated. Finally, the colonizers might tax more heavily commodities with higher values, implying again $Cov(p, c) > 0$.

To reduce the impact of omitted variables, I pursue two strategies. First, I control for observables including proxies for fixed and inland transportation costs. Second, I control for unobservables using fixed effects.

Controlling for observables

To control for fixed transport costs, I use the value of fixed transport costs estimated by Maurer and Yu (2008, p.693) for the Panama Canal: 2.12 $ per ton in 1925 (3.12$ minus 1$ of Panama Canal tolls). Considering an exchange rate of 21 francs per $ in 1925 and deflating in 1900 francs, this corresponds to 9.64 1900 francs per ton in 1925. I multiply this value by the index in Mohammed and Williamson (2004) with base 1925 to get fixed transport costs for every year. Notice that including this fixed cost measure might mean double-counting fixed costs since they could be already included in my original shipping cost data.

To control for inland transport costs, for each colony I include in the regression the average distance from the interior to the coast.[17] Moreover, since the ratio volume/weight is an important determinant of both fixed (loading and warehousing) and inland transport costs, I also control for each commodity's stowage factor.[18]

Controlling for unobservables

I model unobservable costs as $c_{cit} = k_{ci} + \theta_t$. The first component k captures the differences in costs due to each commodity-colony; the second component θ captures the variation over time, common to all commodities-colonies. This is a mild assumption: I allow unobservable costs to vary across commodity-colony and time,

[17] GIS World Geography Datasets, Portland State University.
[18] Source is http://www.cargohandbook.com.

just assuming a common trend over time in all colonies and commodities. In the empirical specification, I implement this idea by using commodity/colony and time fixed effects. In this way, the relationship between price in France minus transport costs and price in Africa is identified exclusively from the variation within each commodity/colony over time, after taking into account common time shocks affecting all commodities and all colonies.

I estimate the following regression

$$p_{A,cit} = \beta(p_{ct} - t_{cit} - f_{cit}) + (X_{cit}\delta) + k_{ci} + \theta_t + \epsilon_{cit} \tag{2.6}$$

where f is the proxy for fixed transport costs, X is a vector of control variables including distance from the coast and commodity's stowage factor (excluded when I include fixed effects), and k and θ are commodity/colony and time fixed effects, respectively. If there is no extraction, $\beta = 1$ (null hypothesis). If there is extraction, $\beta < 1$.

A last concern regards measurement errors in my estimation of shipping costs described in Section 2.4.1. Classic measurement error in t, in fact, would bias the coefficient β towards zero, in favor of my hypothesis. To check whether this affects the results, I run an alternative specification in which shipping costs are estimated directly from the data. To do so, I exclude t from the regression and I control for the interaction of distance to France with decade/commodity dummies.[19] I run the following regression

$$p_{A,cit} = \alpha + \beta_1(p_{ct} - f_{cit}) + W_{ct} * D_i\eta + \epsilon_{cit} \tag{2.7}$$

where W_{ct} is a matrix of decade by commodity fixed effects and D_i is the distance

[19] If I interacted the distance with *year*/commodity dummies, I would have too many fixed effects and it would be difficult to estimate precisely the parameters.

from France. Each element of the vector of coefficients η measures the shipping cost per km for each commodity and decade.

2.4.3 Results

Before presenting the results of the regressions, let me show some preliminary evidence by comparing price gaps between Africa and France to those between US and UK. The idea is that if the Africa-France price gap was larger than the price gap between the United States and Britain, this would suggest that the difference between prices in Africa and in France was not due exclusively to trading costs.

To check this, I collected yearly data on wholesale cotton prices in New York and Liverpool between 1898 and 1938.[20] Table 2.3 reports the percentage price gap in the two markets for 5-year periods. The results show that, on average, the percentage price difference between France and the colonies was about 12 times higher than the difference between UK and US.

TABLE 2.3
Cotton Price Gap between UK and US vs. France and French Africa

	$\frac{\text{price UK- price US}}{\text{price US}}$	$\frac{\text{price France- price Africa}}{\text{price Africa}}$
1898–1902	0.12	..
1903–1907	0.10	6.27
1908–1912	0.09	1.62
1913–1917	0.19	2.25
1918–1922	0.12	0.77
1923–1927	0.06	1.40
1928–1932	0.17	0.32
1933–1938	0.15	0.54

Sources: see text.

Given its magnitude, this results is unlikely to be driven by differences in shipping costs. In the period under consideration, overall shipping costs from Africa to France

[20] My sources are the *Historical Statistics of the United States* (1975) and the Mitchell's *Abstract of British Historical Statistics* (1988).

were about 4 times higher than between US and UK.[21] Since prices in Africa were about half of prices in the US, if the price gap was due only to shipping costs, then the Africa-France relative price gap should have been only twice the US-UK price gap. Similarly, the result is not driven by inland transport costs which accounted for a small portion of the total costs.[22]

Table 2.4 presents the results of regression (2.6). Column (1) reports the simple regression of price in Africa on the difference between price in France and shipping and fixed transport costs: the coefficient is significantly less than 1 and we can reject the null hypothesis that the price to Africans was just equal to the price in France minus trading costs.

[21] Costs per km are on average 3.4 times higher between Africa and France than between US and UK (Maurer and Yu, 2008, table 4). Conversion rates are from www.measuringworth.com.) The distance between cotton producing French Africa to France (about 7300 km) is 15% higher that the distance from New York to Liverpool (about 6400 km).

[22] According to the estimates of column (2) of table (2.4), one standard deviation increase in distance from the coast makes the price to Africans decrease by only .03 standard deviations.

TABLE 2.4
Price in Africa vs. Price in France Net of Trading Costs

	Dependent variable is price in Africa			
	(1)	(2)	(3)	(4)
price in France net of shipping and fixed costs	0.47***	0.46***	0.41***	
	(0.03)	(0.03)	(0.05)	
price in France net of fixed costs				0.29***
				(.09)
stowage factor (m3/ton)		-0.10**		
		(0.04)		
distance from coast*(year<1945), 000s km		-0.12*		
		(0.07)		
year FE			Yes	
commodity * colony FE			Yes	
distance*decade*commodity				Yes
R^2	0.77	0.77	0.83	0.82
N	1466	1466	1466	1466

Results from regression (2.6). Standard errors clustered at the colony/commodity level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

In column (2) I control for other omitted costs, by including stowage factors and distance to the coast. Since prices in Africa are measured at the export port after WWII, I only include the distance from the coast for the years before 1945. The main result is unaffected. In column (3) I control for unobservable costs, by using commodity/colony and year fixed effects. Since fixed effects absorb all the variation in stowage factor and distance from the coast, I exclude these control variables from this specification. The coefficient of interest is still significantly less than 1.

The results of table 2.4 are unlikely to be driven by omitted costs. First, including fixed effects, the R^2 does not increase much: omitted costs are not a big determinant of the price in Africa. Second, consider that the price in Africa is on average 55% of the price in France and observable trading costs are about 5%: if the difference was just due to omitted costs, unobservable costs should be 8 times the observable costs. Finally, consider also that the ratio between origin FOB prices and destination CIF prices from the FAO Agricultural Trade Database since 1960 is 89%, much larger than the 55% ratio observed in the French colonies.

In column (4) I run regression (2.7), where shipping costs are estimated directly from the data. The coefficient of interest is again significantly less than 1. Moreover, since it is smaller than in column (1), this suggests that the bias of the estimates in column (1) is against my hypothesis. My estimates of transport costs are not affected by classic measurement errors and they are likely to overestimate real transport costs.

The evidence shows that prices in Africa were lower than competitive prices. Was the extent of price reduction common to all colonies and crops? To answer this question, I constructed an index measuring how much the price to Africans under monopsony and coercive labor institutions was reduced as a proportion of how much it should have been under competition and free labor

$$E = \frac{p_A^{competition} - p_A^{extraction}}{p_A^{competition}} = \frac{p - T - p_A}{p - T} = 1 - \frac{p_A}{p - T} \tag{2.8}$$

where T includes shipping costs, fixed costs, and inland transport costs.[23]

On average, prices to Africans were reduced by about 30% because of colonial extraction. Table 2.5 reports the average index for the different commodities in West and Equatorial colonies. The average reduction varied across commodities: the price was reduced by more than 40% for rubber and timber, by 35-40% for cotton and bananas, by 25-30% for cocoa, coffee, and peanuts; and by 20-25% for palm kernel and palm oil. Overall, the effects of colonial extraction were more severe in Equatorial Africa (reduction of 37%) than in West Africa (29%) and the difference was particularly large for palm kernel, coffee, palm oil, and timber.

TABLE 2.5
Reduction of African Prices, as Percentage of Competitive Prices

	(1) West Africa	(2) Equatorial Africa
average commodity	0.29	0.37
bananas	0.36	0.37
cocoa	0.27	0.32
coffee	0.21	0.30
cotton	0.37	0.35
palm kernel	0.15	0.30
palm oil	0.20	0.28
peanut	0.21	0.41
rubber	0.46	0.46
timber	0.38	0.46

The table shows the average of price reduction indexes defined in equation (4.1), by commodity and region.

Figure 2.3 shows the proportional reduction of prices to Africans due to colonial extraction over time, for an average commodity/colony. Excluding WWII, over time prices to Africans approach competitive prices. Looking at the figure, we can observe that there was a change around the middle of the colonial period: before 1930, the

[23]Since the trading costs T tend to be overestimated, the index is sometimes greater than 1 (if $T > p$) or less than 0 (if $T > p - p_A$). In my analysis, I will therefore exclude all observations whose index is not between 0 and 1.

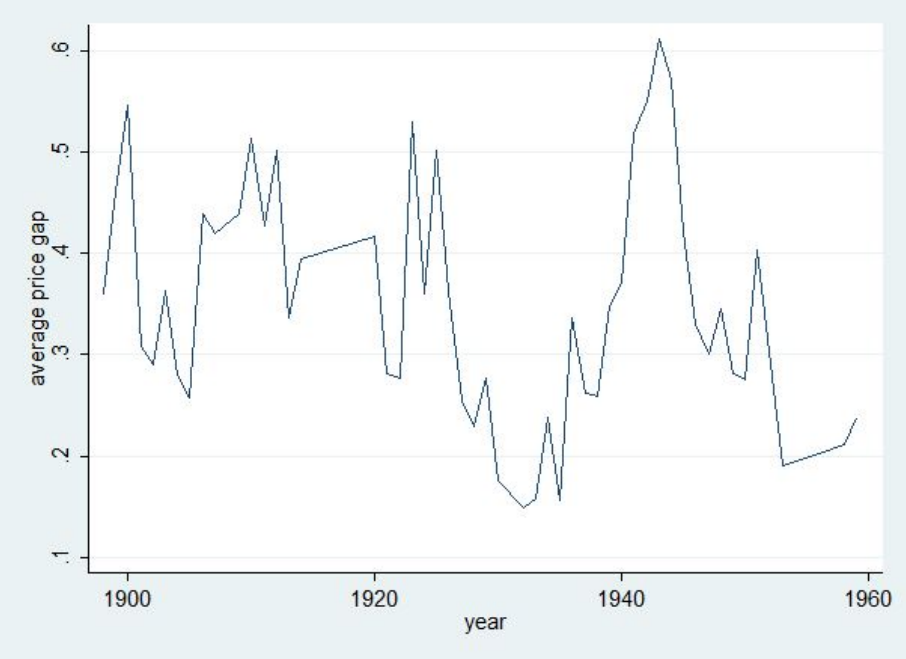


FIGURE 2.3
Reduction of African Prices, as Percentage of Competitive Prices

The figure shows the evolution of the average of price reduction indexes defined in equation (4.1), over all colonies and commodities, by year.

presence of monopsony reduced prices to Africans by 30-50%; after 1930, instead, prices were reduced by only about 20%.

Overall, the evidence suggests that monopsonies and coercive labor institutions reduced of prices to African producers with respect to competitive prices. Moreover, we observe a large variation in the extent of price reduction across colonies and across commodities. Can labor institutions explain this variation?

2.5 Result 2: Labor Institutions and Prices to Africans

In this section, I explore the second result of the model. Did coercive labor institutions allow the colonizers to reduce the prices even with respect to monopsony prices?

To test this hypothesis, I collected data about labor institutions in the French colonies of West and Equatorial Africa between 1898 and 1959. Three main kinds of

labor institutions were used.

- *Free peasant production*: the colonizer fixed the prices, but the African peasants were free to produce how much they wanted at the given price.
- *Compulsory peasant production*: the colonizer fixed both prices and compulsory quotas of production that had to be met by the African peasants.
- *Concession production*: production was run by the colonizer who used various levels of compulsion to get African labor force.

Historians and ethnographers have gathered information about the institutional arrangements used in the production of different crops in the various colonies, in general works about French colonization or country-specific studies. For example, Coquery-Vidrovitch (1972) wrote about rubber quotas in Congo in 1910s, while Suret-Canale (1971) analyzed free peasant production of peanuts in Senegal. By systematically extracting information from this literature, I was able to associate one of the three labor institutions - free production, compulsory production, or concession production - with each colony, commodity, and year.[24]

As shown in section 3.2, most of the variation in institutions was across crops: peanuts and palms were mostly produced by free peasant production; cotton and rubber by compulsory peasant production; timber, coffee, and bananas were usually produced in European concessions. Equatorial colonies relied heavily on concessions and compulsory production, while in West Africa free peasant production was more diffused. Over time, we observe a decrease in the level of compulsion and an increase in the extent of free peasant production.

I start the analysis of the impact of extractive institutions on prices to Africans by treating institutions as exogenous. I will address the endogeneity issue later in this section. To check whether coercive labor institutions can explain price gaps, I

[24]See the appendix for the sources.

regress the price to Africans on institution dummy variables

$$p_A cit = \alpha + \beta_1(COMPULSORY) + \beta_2(CONCESSION) + Z_{cit}\gamma + \eta(p-T)_{cit} + \epsilon_{cit} \tag{2.9}$$

where free peasant production is the omitted category, Z_{cit} is a vector of control variables (including elasticity of African supply and colony/commodity, and year fixed effects) and $(p-T)_{cit}$ is the competitive price.

We expect $\beta_1 < 0$: the prices should be lower under compulsory peasant production than under free peasant production. Instead, we expect $\beta_2 > 0$: the prices should be higher when European companies run production than when production is run by African peasants. In the case of concessions, in fact, since the profit from colonial trade has to be shared between the trading and the concessionary company, the prices at African ports should be higher. Notice that this does not necessarily mean that the level of extraction from African workers is lower under concession production, but just that the export prices of commodities should be higher with respect to peasant production.[25]

A potential concern with this approach is that the price elasticity of African supply might have affected both prices and institutions. The colonizer might have, in fact, given lower prices to those colonies/commodities that responded less to price incentives (low elasticity of supply). At the same time, the colonizer might have needed to establish coercive institutions to stimulate production where Africans responded less to price incentive. If this was the case, the coefficient β_1 would be biased in favor of my hypothesis and the negative relationship between compulsory production and prices would be spurious.

To solve this problem, I use two strategies. As a first strategy, I exploit the model

[25]We can write a similar model to that of section 2.3 in which: 1) Africans choose the number of workers L to maximize $wL - c(L)$, where w is the wage and $c(L)$ convex is the outside option; 2) the concessionary company chooses w to maximize $p_A f(L(w)) - wL$, where $f(.)$ is the production function; 3) the trading companies chooses the price p_A to pay to the concessionary company.

FOC to directly compute the elasticity of supply $\epsilon(p_A) = Q'(p_A)\frac{p_A}{Q(p_A)}$ for the different colonies/crops/years. We have data on prices p_A and quantities Q, but we have no measure of the derivative of African supply with respect to price $Q'(p_A)$. Nevertheless, the FOC for the Trading Company's maximization problem implies $p_A = p - t - \frac{Q(p_A)}{Q'(p_A)}$ that we can rewrite as $Q'(p_A) = \frac{Q(p_A)}{p-t-p_A}$. Thus, we can express the elasticity of supply as a function of only known variables as $\epsilon(p_A) = \frac{p_A}{p-t-p_A}$.[26]

Using this measure, I can check whether the elasticity of supply affects institutions and prices. I first regress the free peasant dummy on the elasticity of supply with a probit model. I omit concession production observations, so that the coefficient measures the effect of elasticity on the probability of using free vs. compulsory peasant production. Column (1) of Table 2.6 shows the results: the coefficient of elasticity of supply is positive, but the marginal effect is very small.

TABLE 2.6
Effects of Elasticity of Supply on Institutions and Prices

	Dependent variable	
	free peasant production	price to Africans
	(1)	(2)
elasticity of supply	0.041**	0.042
	(0.020)	(0.030)
competitive price		0.46***
		(0.03)
R^2	..	0.80
N	640	1158

Column (1) reports the result of a probit model regressing a free peasant production dummy on elasticity of supply. Column (2) reports a linear regression of prices to Africans on elasticity of supply. Standard errors clustered at the colony/commodity level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

I then check whether elasticity affects prices, by regressing price to Africans on elasticity and controlling for competitive prices. The results are reported in column

[26]Since transport costs tend to be overestimated, for some observations $p - t - p_A < 0$ and the estimated elasticity is negative. I omit these observations for all the subsequent analyses involving elasticities.

(2). The coefficient of elasticity of supply is non-significant. We get similar results if we control for colony/commodity and year fixed effects. Notice that since my expression of elasticity is a positive function of the price to Africans p_A, the estimate of the coefficients tends to be biased away from zero: the real impact of elasticity on prices is even smaller. This provides evidence that African elasticity of supply was not an important determinant of prices or institutions. Thus, the omitted variable problem is not very serious.

As a second strategy, I estimate regression (2.9) with colony/commodity and year fixed effects: the relationship between institutions and prices is identified by variations within the same commodity and the same colony over time, taking into account common time shocks.[27] Intuitively, this is a solution if the change in institutions within each colony/crop over time did not depend on changes in the elasticity of supply. Both the results of Table 2.6 and the historical evidence support this view: the transition from compulsory to free production was common to almost all colonies/crops at the end of the colonial period and it was more likely to reflect the political climate before independence (taken into account by year fixed effects) than changes in elasticity of supply.

Table 2.7 reports the estimates of regression (2.9). In column (1) I regress price in Africa on institution dummies, competitive price, and fixed effects. The coefficient of compulsory production is negative and significant: within each commodity/colony a change over time from free to compulsory peasant production was associated with a decrease in prices. The coefficient of concession production is positive and significant: the prices at African ports were higher under concession production than under free peasant production. This provides further evidence that institutions are important: the pressure to reduce prices in Africa was lower when production was based on

[27]The crops/colonies that experienced variations over time from compulsory cultivations to free peasant production are: all cotton producing colonies; cocoa in Congo and Gabon; rubber in Cameroon, Congo, Gabon, and Ubangi-Shari. Most changes in institutions happened in the post-WWII period.

European concessions instead of African peasant production.

TABLE 2.7
Labor Institutions and Prices in Africa

	Dependent variable is price in Africa		
	(1)	(2)	(3)
compulsory production	-0.17***	-0.17***	-0.18**
	(0.06)	(0.06)	(0.06)
concession production	0.38*	0.37*	0.39*
	(0.21)	(0.21)	(0.21)
competitive price	0.42***	0.42***	0.42***
	(0.05)	(0.04)	(0.05)
elasticity of supply		0.001	
		(0.001)	
quantity (10,000s tons)			0.004
			0.007
commodity*production territory FE	Yes	Yes	Yes
year FE	Yes	Yes	Yes
R^2	0.85	0.85	0.85
N	1158	1158	1158

The omitted category is free peasant production. Standard errors clustered at the colony/commodity level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

In column (2) I control directly for the elasticity of supply. As expected, the coefficient of elasticity is positive, but not significant, and the main result remains unchanged. In column (3) I control for another potential determinant of prices, the size of the market, by including the total quantity produced as a control variable. The effect of larger markets is not significant the coefficients on institutions are not affected.

The use of compulsory production allowed the colonizers to reduce the prices to Africans even with respect to monopsony prices. The effect of institutions on prices is not only statistically significant, but also economically meaningful. Considering that the average price in Africa for free peasant production is .37 francs per kg, a change in institutions from free to compulsory production implies an average reduction in prices by about 45%.

The evidence shows that the type of institutions put in place by the colonizers

affected the price received by African producers. Prices were lower than what they would have been with competition between trading companies and coercive labor institutions allowed the colonizers to reduce prices even further. Using these results, I can now ask how much monopsonies and coercive labor institutions reduced African gains from trade.

2.6 Result 3: Colonial Extraction and Gains from Trade

In this section, I explore the third claim of the model: colonial extraction reduced African gains from trade. The idea is to measure gains from trade as the surplus of African producers, computed as the difference between price received and cost of production, times quantity produced. Using an insight from the theory, I construct lower bounds for the reduction of gains from trade due to colonial extraction and I disentangle how much of this reduction was due to monopsonies and how much was due to labor institutions.

Figure 2.4 describes the loss of gains from trade under the different institutional arrangements. Subscripts C, M, and ME denote competition, monopsony, and monopsony with extractive labor institutions, respectively. Taking competition as a benchmark, area 1 is the African loss due to monopsony. The sum of areas 1, 2, 3, 4 is the loss due to monopsony and extractive labor institutions (areas 1 and 2 are the loss due to the reduction in price; areas 3 and 4 are the loss due to receiving a price lower than the marginal cost). The sum of areas 1, 2, 3, and 4 is slightly larger than $(p_C - p_{ME})Q_{ME}$, which can be computed as a lower bound for the absolute loss.

We can also construct a lower bound for the relative loss. Since the supply function is convex and $Q > 1$, the African gains from trade under competition is less than

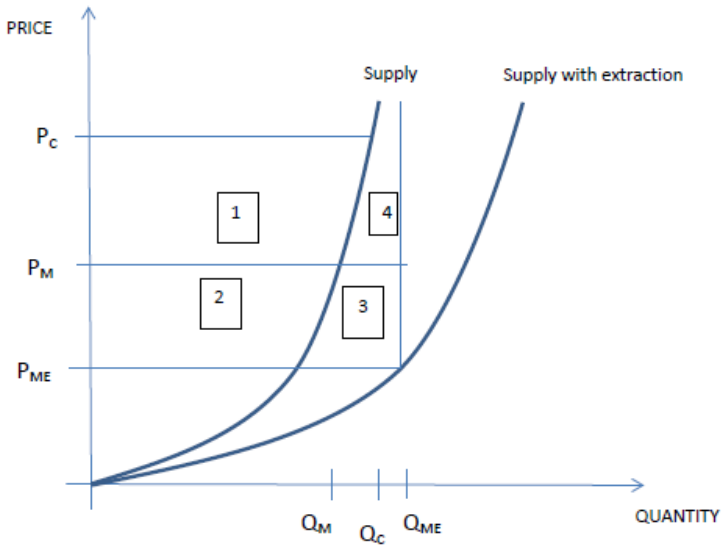


FIGURE 2.4
African Gains from Trade

C subscript refers to competition, M to monopsony, and ME to monopsony and extractive labor institutions.

$\frac{1}{2}p_C Q_{ME}$. A lower bound for the relative loss is then $\frac{(p_C - p_{ME})Q_{ME}}{\frac{1}{2}p_C Q_{ME}}$, that is[28]

$$L = 2(1 - \frac{p_{ME}}{p_C}) \tag{2.10}$$

Notice that this lower bound for the relative loss is equal to twice the price gap index, defined in equation (4.1), where $p_A = p_{ME}$ and $p - T = p_C$.

Table 2.8 presents the results. On average, Africans lost at least 65% of the possible gains from competitive trade due to colonial extraction (including monopsonies and extractive institutions). It is important to remember that exports to Europe accounted for a large part of African income, while imports from Africa accounted for a relatively small proportion of French GDP. Given the volume of trade, colonial extraction implied small gains for Europeans at a cost of big losses for Africans.

[28]The underlying assumption to construct this lower bound is that the quantity produced under monopsony and extractive institutions is higher than the quantity produced under competition. If this was not true, then the loss would be lower than areas 1, 2, 3, and 4. The historical evidence, however, is consistent with this assumption: one of the reasons why the colonizers introduced extractive institutions was in fact to increase African production.

TABLE 2.8
Lower Bounds for Percentage Reduction of Gains From Trade

	(1) All	(2A) pre-1930	(2B) post-1930	(3A) West Africa	(3B) Equatorial Africa
average commodity	0.65	0.73	0.47	0.58	0.74
palm kernel	0.39	0.48	0.27	0.30	0.60
palm oil	0.46	0.48	0.38	0.40	0.56
coffee	0.52	0.76	0.32	0.42	0.60
peanut	0.55	0.62	0.39	0.42	0.82
cocoa	0.60	0.62	0.44	0.54	0.64
bananas	0.72	0.63	0.75	0.72	0.74
cotton	0.73	0.93	0.46	0.74	0.70
timber	0.86	0.73	0.63	0.76	0.92
rubber	0.92	0.92	0.90	0.92	0.92

The table reports lower bounds for the relative losses of gains from trade due to colonial extraction. Lower bounds are estimated according to equation (2.10).

Column (1) reports the reduction in gains from trade for the different commodities: the reductions were particularly high for rubber and timber (at least 85% of the gains), at least 70% for cotton and bananas, at least 50% for coffee, peanuts, and cocoa, and at least 40% for palm kernel and oil. Notice that the crops produced under free peasant production, such as peanuts and oil palm produces, suffered the minor losses of gains from trade.

Columns (2A) and (2B) report the lower bounds for the periods before and after 1930.[29] On average, the losses due to extraction were lower in the second part of the colonial period (at least 47% vs. at least 73%). This change involved all commodities, with the exception of bananas and only marginally rubber. Again, this is evidence of the importance of institutions: in the second half of the colonial period coercive labor institutions started to disappear and African prices increased.

Column (3A) and (3B) compare West and Equatorial Africa. For almost all commodities, the Equatorial colonies, characterized by the presence of more coercive labor institutions, lost more from colonial extraction than Western colonies (on average, at

[29]Since price gaps were anomaly higher during WWII, I exclude the years 1939-1945 from the computations in column (2B).

least 74% vs. at least 58%).

To disentangle the effects of coercive labor institutions from those of monopsony, notice that area 1 of Figure 2.4 represents the loss of gains from trade due to monopsony, while areas 2, 3, and 4 represent the loss due to coercive labor institutions. Thus, we can construct an upper bound for the absolute loss due to monopsony as $(p_C - p_M)Q_{ME}$. The upper bound for the share of loss due to monopsony is then $\frac{p_C - p_M}{p_C - p_{ME}}$. By consequence, coercive labor institutions account for at least

$$1 - \frac{p_C - p_M}{p_C - p_{ME}} \tag{2.11}$$

of the total loss due to extraction.

To compute this measure, we need data on p_{ME}, p_C, and p_M. We have direct measures for the price under monopsony and coercive labor institutions p_{ME} and we can compute the price under competition p_C as the difference between prices in France and trading costs, but we do not observe the price under simple monopsony p_M for all observations.

To solve this problem, I use the results from the regression of prices on institutions (Table 2.7), where the coefficient β of the compulsory production dummy measures the effect of coercive labor institutions on prices (difference between p_{ME} and p_M). Using the estimate of β, I can compute the price under simple monopsony as $p_M = p_{ME} + \beta$.

Disentangling the effects of monopsony and coercive labor institutions, I estimate that the upper bound for the share of loss due to monopsony was on average (for all compulsory production observations) 37%. Thus, when coercive labor institutions were used, they accounted for at least 63% of the losses in gains from trade.

2.7 Conclusion

Extractive colonial institutions are considered one of the main causes of current African underdevelopment (Acemoglu et al., 2001; Nunn, 2007). Yet, since colonial extraction is hard to quantify and its precise mechanisms are not well understood, we still do not know exactly how successful the colonizers were in extracting wealth from Africans.

In this chapter, I investigated this issue by exploiting the peculiar structure of trade and labor employed by the French colonizers. By using a new dataset of prices in Africa and labor institutions, I showed that the colonizers were very successful in extracting income from Africans and that they were able to do so by reducing the prices to producers through a combination of trading monopsonies and coercive labor institutions. Without extractive institutions, colonial trade should have raised income for African populations. However, the lack of competition between trading firms and the presence of coercion of labor forced Africans to accept prices lower than their marginal cost of production, thus reducing their welfare. My estimates show that colonial extractive institutions reduced African gains from trade by at least 60%.

Having clarified the mechanisms and the extent of extraction during the colonial period, the next step is to understand the details of the impact of colonial extractive institutions on current economic development. The level of extraction, in fact, varied greatly across colonies and across crops and this variation can help explaining the different paths of growth in African countries and regions. Moreover, there are reasons to believe that the extractive character of colonial institutions persisted after independence. Preliminary results in appendix 2.8.2 show that the price gap between prices in Africa and in France is still large in the post-independence period. Coercive labor institutions were abolished by independence, but trading monopsonies persisted and post-independence governments kept practicing price policies that reduced prices to agricultural producers (Bates and Block, 2009). Our clearer understanding of ex-

traction during colonialism calls now for future research aimed at examining how institutions established in colonial times still affect current agricultural trade policies and economic development.

2.8 Appendix

2.8.1 Prices in France and World Market Prices

One of the assumptions of the model is that prices in France are exogenous and follow world market prices. In this section, I provide evidence in favor of this assumption by comparing prices in France to prices in Great Britain.

To do so, I use British commodity prices collected by Jacks et al. (2011) from various yearly statistical publications, such as Sauerbeck's *Prices of Commodities* and The Statist's *Wholesale Prices of Commodities*.[30] Since the prices are reported in different units (shillings per hundredweight, pence per pound, shillings per timber load), I convert all in pounds per kg.[31] Then, I use the exchange rates dollar-sterling and dollar-franc reported by Officer (2013) to convert all prices in francs per kg.

The commodities for which I have both prices in France and in Great Britain are: coffee, cotton, palm oil, and timber.[32] Because exchange rates are available only since 1913 and the WWII and post-war periods are characterized by strong appreciation and then depreciation of the franc, I focus my analysis on the period 1913-1940.

Figure 2.5 compares British and French prices between 1913 and 1940 for the four commodities. For all of them, British and French prices follow the same trend: the data for French prices are closely tied to world market prices.

[30] http://www.sfu.ca/ djacks/data/publications.

[31] The conversion rates used are: 20 shillings per 1 sterling; 50 kg per hundredweight; 1 timber load=50 cubic feet= 1.4 cubic meters=1.12 tons.

[32] British coffee is Brazilian from Rio; cotton is American-middling.

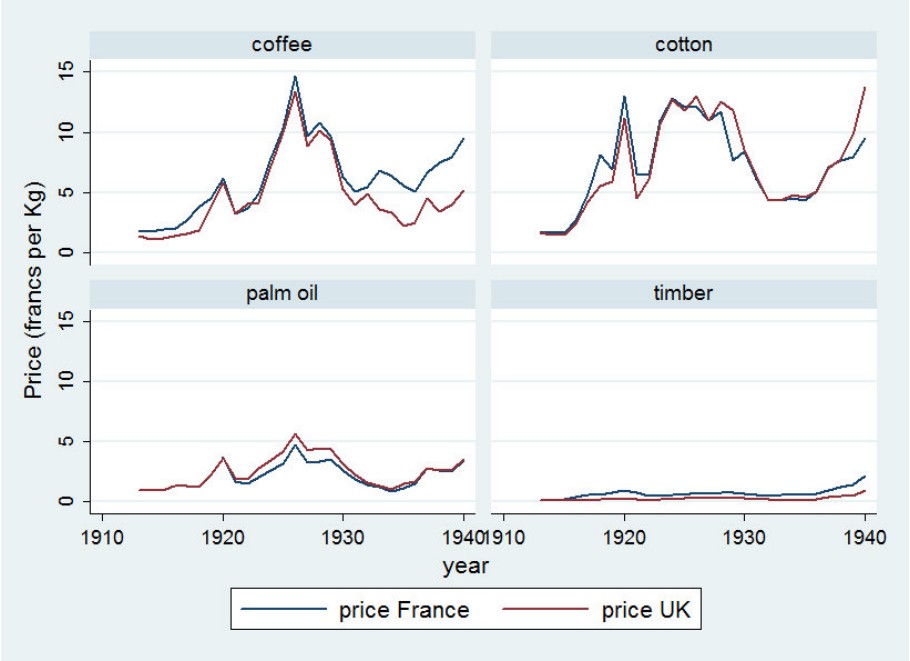


FIGURE 2.5
Prices in France and UK

2.8.2 Post-Independence Prices

In this section, I explore preliminary data on prices in Africa and in France after independence. I collected the data from the FAO Trade Statistics Database (2013a), reporting yearly CIF and FOB prices by country and commodity since 1961.

Figure 2.6 reports the joint evolution of prices for four commodities: cocoa, coffee, cotton, and peanuts. The price in Africa is the average of prices of all ex-colonies producing that commodity. The price in France is the CIF import price. All prices are in dollars per kg. The gap between prices in Africa and in France is small right after independence, but, with the exception of cotton, gets larger since the 1970s.

Figure 2.7 shows the price in Africa as a percentage of the price in France for cotton, between 1900 and 2010.[33] I choose cotton because it is one of the commodities for which colonial institutions were more extractive. The general trend is increasing and the ratio of prices is higher after independence. Interestingly, prices in Africa

[33]The price in Africa is the average price of all cotton producing colonies, excluding five years for which the price in Africa was higher than the price in France.

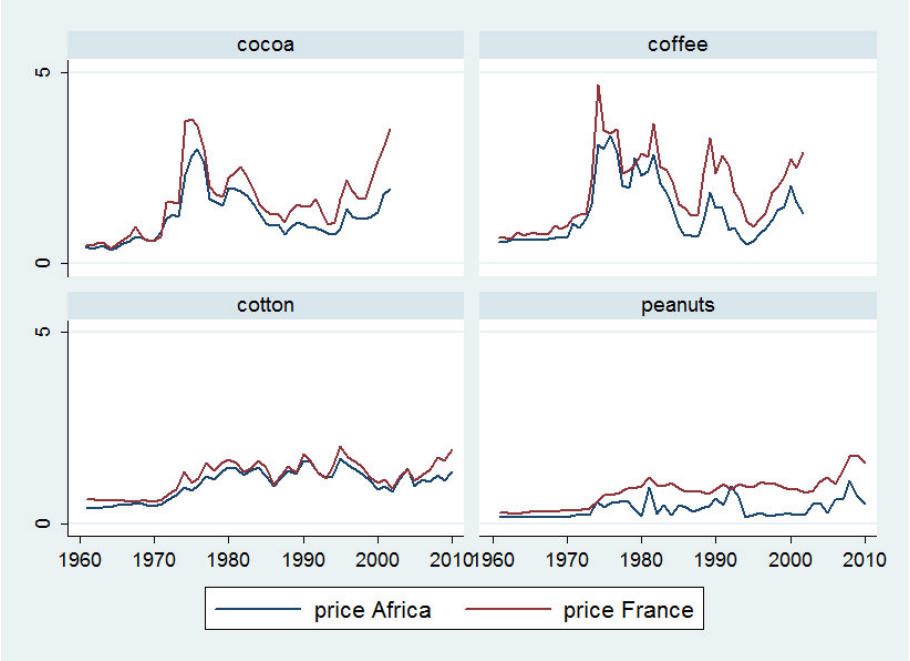


FIGURE 2.6
Post-Independence Prices
Prices are in dollars per kg.

catch up with prices in France already after WWII.

2.8.3 Data Sources

This section describes in detail the sources of the data on prices, quantities, and institutions.

Prices in Africa and Quantities. Prices are in 1900 French francs per kg. I obtain them by diving the total value by the total quantity of exports. Quantities are in tons. Cocoa and coffee are in grains; peanuts can be shelled or unshelled; cotton is ginned. Timber quantities are sometimes reported in cubic meters or steres and I convert them into tons by using the average specific weight of timber (0.8 tons per cubic meter).

Values in Africa are either in French francs or in francs CFA (franc des Colonies Françaises d'Afrique). The conversion rate is 1 franc CFA=1 FF before 1946, =1.7 FF between 1946 and 1948, =2 FF after 1949. Exchange rates between francs, pounds,

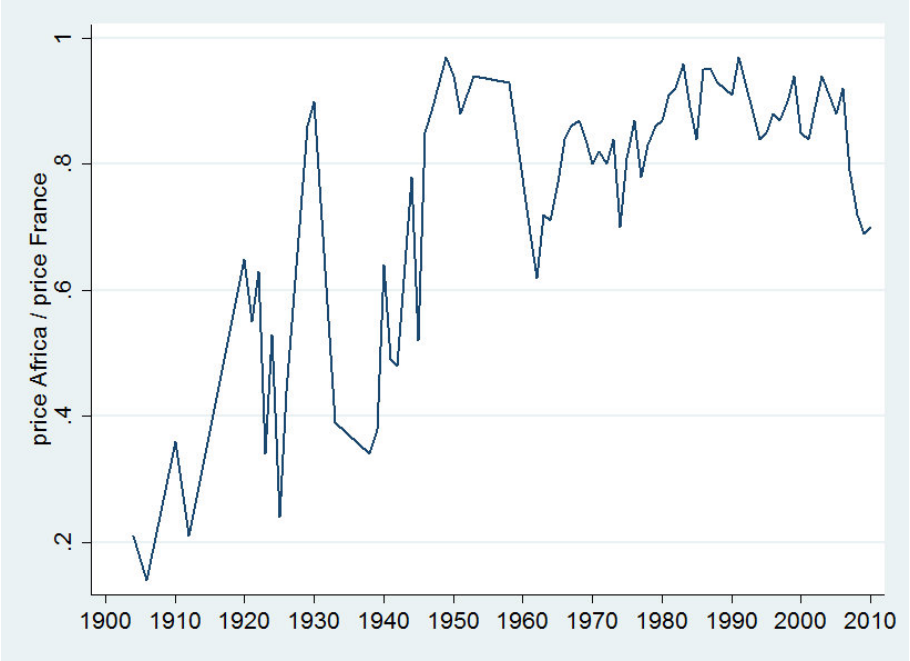


FIGURE 2.7
Price in Africa as Percentage of Price in France, Cotton

and dollars come from Officer (2013). To deflate prices in 1900 FF, I use data from France-Inflation.com, reporting inflation rates since 1901. For 1898-1900, I assume the same inflation as in 1901.

The sources are: *Statistiques coloniales. Commerce* volumes from 1898 to 1906; *Statistiques du commerce des colonies françaises*, volumes from 1907 to 1914 (excluding 1908); *Reinsegnements generaux sur le commerce des colonies françaises et la navigation* volumes from 1920 to 1928; *Bulletin Economique de l'Afrique Equatoriale française*, volumes from 1931 to 1936; *Bulletin mensuel de l'Agence économique de l'Afrique Occidentale Française*, volumes from 1930 to 1939; *Bulletin mensuel d'information. Cameroun, Togo*, volumes from 1933 to 1937; *Annuaire statistique de France 1935*; *Annuaire Statistique de l'AOF, 1933-38*; *Chambre de Commerce du Cameroun. Statistiques Commerciales 1935-37*; *Statistique du Commerce Exterieur de l'AEF, 1936-47*; *Annuaire Statistique du Cameroun, 1938-45*; *Annuaire Statistique de l'AOF et du Togo* volumes 1949 and 1950-54; *Annuaire Statistique de*

l'AEF volumes 1936-50 and 1951-55; *Bulletin de la Statistique Generale de l'AOF, 1956*; *Bulletin Statistique Mensuel du Togo, 1957*; *Bulletin Mensuel Statistique et Economique 1959-60*; *Ministère de la France d'Outremer. Documents et Statistiques, 1949-67*.[34]

For some colonies and years, sources are not available. In particular: 1922, 1929-32, 1939-55, 1957 for Togo; 1922-23, 1929-31, 1946-57 for Cameroon; 1908, 1915-19, 1931, 1939-55, 1957 for West Africa colonies; 1908, 1915-19, 1937-50 (at colony level), 1953-57 for Equatorial Africa colonies.

Prices in France. In 1900 French francs per kg. I obtain them by dividing the total value by the total quantity of imports to France from the colonies. The sources are *Statistiques du commerce extérieur de la France*, volumes from 1902 to 1959.

Labor Institutions. The main sources are: Berg (1965), Coquery-Vidrovitch (1972), Cordell and Gregory (1982), DeDampierre (1960), Duignan and Gahan (1975), Fall (1993), Gray and Ngolet (1999), Hopkins (1973), Suret-Canale (1971), Thompson and Adloff (1957), and the *Cambridge History of Africa* (1986). An appendix with the specific sources for each colony/crop is available from the author.

2.8.4 Appendix Figures and Tables

TABLE 2.9
Share of Exports, by Institutions

	(1) All French Africa	(2a) West Africa	(2b) Equatorial Africa
free peasant production	0.57	0.70	0.26
compulsory production	0.10	0.02	0.29
concession production	0.33	0.28	0.45

The table shows the share of the total value of exports produced under each of the main labor institutions.

[34]Details about the sources used for each specific colony, commodity, and year are available upon request.

TABLE 2.10
Variance of Institutions

	% variance explained	F-stat	p-value
crop fixed effects	0.50	204.4	0.00
colony fixed effects	0.07	15.4	0.00
year fixed effects	0.02	1.2	0.16

ANOVA of institutions, N=1717.

TABLE 2.11
Shares of World Production, 1961

	Main Producer	Share Main Producer	Share French Africa
cotton	Chad	0.2%	0.5%
rubber	Cameroon	0.4%	0.5%
palm oil	Cameroon	0.5%	1.2%
bananas	Cameroon	0.7%	2.1%
coffee	Cote d'Ivoire	4.1%	5.9%
palm kernels	Cameroon	5.0%	13.8%
cocoa	Cote d'Ivoire	7.2%	14.9%
peanuts	Senegal	7.2%	12.7%

The table shows the share for the main producing country in ex-French Africa and for the entire ex-French Africa as a proportion of the total world production for the different commodities in 1961. Source: elaboration from FAO (2013a). During the colonial period, these shares are even lower: in the late 1940s, coffee from Cote d'Ivoire and peanuts from Senegal account for only 2% of world production, cocoa from Cote d'Ivoire and palm kernels from Cameroon account for 4%.

Chapter 3

The Origins of Extractive Institutions: Labor in Colonial French Africa

As long as the trading firms and the European colonial enterprises have to rely on their personal authority to make the inhabitants do work that is remunerative in itself and to their firms, they will fail almost completely, and at great cost.

Governor Angoulvant, justifying compulsory labor institutions (Cote d'Ivoire, 1910).[1]

3.1 Introduction

The colonizers were extremely effective in extracting income from the African populations. The analysis in chapter 2 showed that trade monopsonies and labor coercion cut African gains from trade by over 60%. In doing so, coercive labor institutions were particularly important. When used, they accounted for at least 60% of the total losses.

Despite their importance, extractive institutions have been often treated as a

[1] Cited in Suret-Canale (1971), p. 229.

black box in the previous literature and little has been done to understand their origin.[2] In this chapter, I address these issues by focusing on the determinants of labor institutions in the French Africa.

In a continent characterized by low population densities and high value of labor relative to land, labor institutions became one of the main feature of colonial extraction.[3] The French colonies, characterized by one of the lowest population densities in the whole Africa, represent a particularly good sample to study this problem. Moreover, they show a large variation in labor arrangements, varying from forced labor, to compulsory cultivation policies, to free labor.

Studying the determinants of extractive institutions, two main lines of research have emphasized, in different ways, the environmental conditions in the colonies. In the first one, environmental factors affect the settler mortality rate (Acemoglu et al., 2001). In areas where the colonizers could not settle in numbers, the incentives to establish good institutions were weaker and the colonial policies led towards a severe extraction of the colony's resources. The second line of research, focusing on the Americas, emphasizes how environmental conditions lead to the cultivation of different crops (Engerman and Sokoloff, 2002). Some crops are produced more efficiently with small scale farms, others with large plantations using slave labor. These different productive arrangements have consequences for political and economic inequality and for subsequent economic development.

In this chapter, I provide evidence that the kind of crops matters more than the location of the colony for the choice of institutions. To do so, I use data on labor institutions in the French colonies from the 1910s to the 1950s, obtained by using

[2] An exception is Arias and Girod (2011), where colonial institutions are linked to pre-colonial indigenous institutions.

[3] In Equatorial Africa, in particular, we observe reduction and impoverishment of indigenous populations as effect of colonial labor policies. Examples include the 1929 famine in Gabon due to the forced recruitment of labor for road constructions (Gray and Ngolet, 1999) and the 30% decline in population from 1890 to 1930 in intensively exploited rubber areas of Equatorial Africa (Coquery-Vidrovitch, 1972).

information from colonial publications and secondary sources. Then, I show that simple crop fixed effects account for a large portion of the variance in institutions, while the explanatory power of colony fixed effects or settler mortality is much lower. Since crops might be endogenous to institutions, it is not yet possible to argue that crops *determine* institutions. However, the lack of relationship between colonies and institutions and the historical evidence make it unlikely that causality runs in the opposite direction.

Nevertheless, even if crop fixed effects account for a large part of the variance, they do not really "explain" institutions. In the second part of the chapter I focus on this issue, by trying to understand what is behind the crop fixed effects. First, I develop a theoretical model linking the choice of institutions to the price of crops and the scale of production. The basic intuition for the model is simple. Compulsory institutions (forced labor or compulsory productions) are more costly to implement than free labor institutions, but generate more production because the colonizer can ignore the Africans' outside option. When the price of crops is low, the total revenue from the colony is not enough to pay for the cost of implementing compulsory institutions and market institutions are chosen. When the price is high, instead, compulsory institutions are profitable. Then, I use data from colonial statistical reports to test the predictions of the model. The evidence suggests that price of crops and scale of production are important factors explaining the choice of institutions.

The chapter is structured as follows. Section 3.2 summarizes the historical background about French colonies and labor institutions provided in chapter 2. Section 4.2 describes the construction of the dataset. Evidence on the predominance of crops vs. colonies in explaining institutions is provided in section 3.3. Section 3.4 tackles the problem of explaining why crops matter, by developing a theoretical model and providing some suggestive evidence. Section 3.5 draws concluding remarks.

3.2 Historical Background and Data

Colonial economic activity in the French colonies was mainly based on trade of agricultural commodities, which could be produced by small African farmers or in European-owned plantations. As capital was expensive, production relied on labor intensive methods. However, in the absence of the right incentives for Africans, the colonial demand of labor was not easily satisfied. One reason was the sparse population of most of French Africa. With low population densities, cultivable land was abundant in the indigenous sector and the incentives to enter the wage labor force or to produce cash crops were weak. One of the places where the labor problem was most troublesome, French Congo, was also characterized by the lowest population densities. Another reason was the low level of wages and of prices paid to producers. With no wage at which both African workers wanted to work and European employers wanted to employ, shortages of labor were endemic (Hopkins, 1973).

Facing the Africans strong incentives to remain in the indigenous sector and weak incentives to work for the Europeans, the colonizers had to deal with the labor problem by putting in place specific institutions. We can organize the variety of labor institutions in three broad categories: free peasant production, compulsory production, and contract labor.

1. With free peasant production, the colonizers left the production to Africans farmers, bought this production, and resell it at higher prices in the international markets.

2. With compulsory production, the colonizers still left the production to Africans, but set compulsory quotas of produce that had to be provided to the colonizers, for a fix price. Examples of this institution were the rubber quotas in Equatorial Africa in 1900-1930 (Coquery-Vidrovitch, 1972) and the forced production of cotton established by Felix Eboué in Ubangi-Shari in 1924 (DeDampierre, 1960).

3. With contract labor, the colonizers recruited workers to employ in European plantations and concessions. A varying level of compulsion was associated to this kind of institutions, ranging from actual force labor to forms more similar to a free labor market.

In addition to these institutions, the colonizer used also other institutional arrangements such as labor taxes, drafts, and military labor (days of forced labor for porterage, public works, and private enterprises) and indirect methods, such as poll taxes.[4] Introduced to raise the revenue of colonial governments, they also had the function to force Africans to enter the wage labor force or to produce cash crops in order to earn the money needed for taxation. In Equatorial Africa, for example, poll taxes were introduced in 1902 as a way to facilitate rubber collection by the concessionary companies.

Such a variety of institutional arrangements requires an explanation. Which factors determined the choice of labor institutions in the various colonies of French Africa? To understand the determinants of institutions, I use data on labor institutions in the French colonies of West and Equatorial Africa in the 1910s, 1920s, 1930s, 1940s, and 1950s. As described in more detail in chapter 2, I first identify the main crops that were exported in each colony in each of the five decades, by using data from various colonial statistical publications. I include all agricultural activities whose value of exports accounts for at least 1% of the total value of the exports from the relevant federation. Second, by extracting information from secondary literature, I associate a labor institution -free peasant production, compulsory production, or contract labor- for each colony/crop. Since poll taxes had the function of both generating labor force and raising revenue for the government and were used in all colonies, I exclude them from the current analysis.[5]

[4]Given the low population densities, land alienation was a less attractive option to generate a labor force than it was in East Africa.

[5]See the appendix for the sources.

Free peasant production covers those instance where Africans sell their produce to Europeans at local market prices. *Compulsory production* includes all cases in which they have to sell compulsory quantities at a fixed, lower than market, price. *Contract labor* covers the cases in which Africans receive a wage (that can be equal or below the market wage) to work as laborers in European plantations or forestry concessions.

The dataset includes labor institutions for 325 colony/crop/year observations, 13 colonies, 9 commodities (bananas, cocoa, coffee, cotton, palm kernel, palm oil, peanuts, rubber, and timber), and 5 decades.[6] It does not include non-export crops (mainly food crops), fisheries, livestock, ivory, manufacturing and mining activities. However, the coverage is satisfactory: the activities included in the dataset account for 80% of the value of all exports from West and Equatorial Africa during the whole period.

3.3 Crops or Locations?

We want to understand whether the choice of labor institutions is more affected by factors related to the kind of crops or by factors related to the location of the colonies.[7] Before addressing this issue, I show some summary statistics.

3.3.1 Preliminary Analysis

Table 3.1 reports the shares of the three institutions in the sample. In Panel A the simple shares of colony/crop observations are reported, while in Panel B all observations are weighted by the export value of that colony/crop observation. To allow comparisons between different decades, the value of exports are deflated in 1900 francs. Column (1) shows the shares of institutions considering the whole dataset. Free peas-

[6]Since not all crops are produced in all colonies and periods, the number of observation is less than 13x9x5.

[7]The correlation between colonies and crops is not strong: colonies are not specialized in one only kind of crop.

TABLE 3.1
Percentage Shares of Institutions

	PANEL A: BY NUMBER OF CASES							
	(1)		(2)			(3)		
	Full	West	Equatorial	1910	1920	1930	1940	1950
free peasant prod.	0.51	0.53	0.48	0.33	0.46	0.43	0.56	0.72
compulsory prod.	0.17	0.11	0.26	0.24	0.24	0.20	0.16	0.03
contract labor	0.32	0.36	0.26	0.43	0.30	0.36	0.28	0.24
	PANEL B: BY VALUE OF EXPORTS							
	(1)		(2)			(3)		
	Full	West	Equatorial	1910	1920	1930	1940	1950
free peasant prod.	0.54	0.61	0.38	0.49	0.71	0.49	0.57	0.51
compulsory prod.	0.09	0.01	0.27	0.18	0.09	0.08	0.12	0.07
contract labor	0.37	0.38	0.35	0.32	0.20	0.43	0.31	0.40

ant production is used in the majority of cases, accounting for more than 50% of exports; contract labor and compulsory production follow with about one-third and one-sixth of exports, respectively.

Column (2) presents the shares of institutions by macro-region. Free peasant production and contract labor are more diffused in West Africa, while compulsory production is more diffused in Equatorial Africa. This difference is even more striking if we look at the shares by value: free peasant production accounts for 61% of exports from West Africa and only 38% from Equatorial Africa, while compulsory production accounts for 27% of exports from Equatorial Africa and only 1% of exports from West Africa.

Column (3) shows the shares by period. Considering the number of cases, the trend is an increase of free peasant production and reduction of the share of contract labor and compulsory production. We get a different picture by observing the value of exports: the share of free peasant production remains constant, contract labor increases, and compulsory production decreases.

3.3.2 Empirical Analysis

In this section, I analyze more in detail the relationship between crops and institutions. Table 3.2 shows the shares of observations for each institution, by crop. There are groups of crops that are clearly associated with one particular institution. Seven out of nine crops have about 75% of their observations associated with one only institution. Cotton is associated with compulsory production; palm kernel and peanuts with free peasant production; timber, bananas, and coffee with contract labor. Only cocoa and rubber are not clearly associated with any institution.

TABLE 3.2
Share of Institutions, by Crop (Number of Cases)

	compulsory production	contract labor	free peasant	N
bananas	0.00	1.00	0.00	14
cocoa	0.23	0.27	0.50	26
coffee	0.00	0.74	0.26	31
cotton	0.77	0.05	0.18	44
palm kernel	0.00	0.00	1.00	44
palm oil	0.00	0.00	1.00	41
peanut	0.00	0.00	1.00	47
rubber	0.32	0.57	0.11	46
timber	0.00	1.00	0.00	32
all commodities	0.17	0.32	0.51	325

In Table 3.3 I check whether the association between crops and institution disappears if we consider the value of exports instead of the number of observations. Overall, the strong relationship between groups of crops and institutions is confirmed: most of the exports for each crop are generated using one only institution.

In Table 3.4, I perform the same analysis, computing the share of exports by institution for each colony. As for crops, there are some colonies that are clearly associated with one specific institution. However, only 5 colonies out of 13 produce more than 75% of their exports with one only institution.

Overall, the relationship between institutions and colonies seems weaker than the relationship between institutions and crops. It is also possible that a colony

TABLE 3.3
Share of Institutions, by Crop (Value of Exports)

	compulsory prod.	contract labor	free peasant	000s francs
bananas	0.00	1.00	0.00	81,340
cocoa	0.01	0.13	0.86	273,098
coffee	0.00	0.90	0.10	289,518
cotton	0.86	0.01	0.13	118,663
palm kernel	0.00	0.00	1.00	124,182
palm oil	0.00	0.00	1.00	60,367
peanut	0.00	0.00	1.00	393,831
rubber	0.34	0.62	0.04	131,050
timber	0.00	1.00	0.00	127,407
all commodities	0.09	0.37	0.54	1,599,456

TABLE 3.4
Share of Institutions, by Colony (Value of Exports)

	compulsory prod.	contract labor	free peasant	000s francs
Cameroon	0.04	0.35	0.61	262,435
Chad	0.99	0.00	0.01	49,714
Congo	0.39	0.38	0.23	64,637
Dahomey	0.03	0.03	0.94	95,632
Gabon	0.15	0.75	0.10	60,967
Guinea	0.00	0.70	0.30	113,336
Haut-Senegal	0.02	0.64	0.34	11,456
Haute-Volta	0.00	0.01	0.99	2,230
Cote d'Ivoire	0.01	0.67	0.32	447,827
Niger	0.01	0.02	0.97	45,651
Senegal	0.01	0.05	0.94	341,854
Togo	0.11	0.17	0.72	51,645
Ubangi-Shari	0.75	0.20	0.05	52,073
all colonies	0.09	0.37	0.54	1,599,457

is associated with one institution just because it is specialized in the crop that is associated with that institution. To tackle this issue, I run a series of regressions including at the same time both crop and colony fixed effects. I run the following

$$Y_{ijt} = \alpha + CROPS\beta + COLONIES\gamma + TIME\delta + \epsilon_{ijt} \tag{3.1}$$

where $CROPS$ is a vector of crop fixed effects, $COLONIES$ is a vector of colony fixed effects, $TIME$ is a vector of time fixed effects.

Table 3.5 shows the results. Panel A reports the results with a dummy variable for free peasant production as dependent variable. Column (1) shows the results for crop fixed effects alone: they explain 71% of the variance and they are jointly very significant, as shown by the F-statistics. Column (2) reports the results for colony fixed effects alone: they explain only 4% of the variance and, according to the F-test, they are not significant. In column (3) I include both colony and crop fixed effects; in column (4) I include crop and time fixed effects; in column (5) I consider all fixed effects at the same time. In all regressions the main result remains the same: crop fixed effects account for a very high proportion of the variance and are statistically significant, while colony and time fixed effects add little explanatory power. In column (6), I exclude crop fixed effects from the regression: as expected, the R-squared falls from 78% to 11%.

Panel B reports the results for compulsory production. Crop fixed effects account for less of the variance (51%), but the main results are qualitatively similar. Panel C, with contract labor as dependent variable, generates similar conclusions.

In Table 3.6, I check whether the results are driven by particularly small or big observations. To do so, I exclude from the sample all observations with value of exports below the 10th and above the 90th percentile. For any institution, the variance explained by crops (column 1) is much higher than the variance explained by colonies

TABLE 3.5
Crops or Colonies?

PANEL A
Dependent variable is free peasant production

	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.71	0.04	0.73	0.76	0.78	0.11
F-crops	167.80***	n/a	595.64***	331.65***	260.64***	n/a
F-colonies	n/a	1.38	1.88*	n/a	2.15**	1.27

PANEL B
Dependent variable is compulsory production

	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.51	0.10	0.57	0.54	0.61	0.16
F-crops	58.23***	n/a	21.28***	26.24***	24.34	n/a
F-colonies	n/a	6.83***	3.40***	n/a	3.95***	5.15***

PANEL C
Dependent variable is contract labor

	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.66	0.07	0.69	0.68	0.70	0.08
F-crops	39.04***	n/a	376.98***	1340.26***	20.78***	n/a
F-colonies	n/a	13.51**	3.70***	n/a	1.00	7.17***

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors. N=325

(column 2).

TABLE 3.6
Crops or Colonies? Dropping Extreme Observations

PANEL A						
Dependent variable is free peasant production						
	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.68	0.08	0.71	0.76	0.77	0.17
F-crops	10.24***	n/a	293.74***	187.83***	149.77***	n/a
F-colony	n/a	21.37***	1.63*	n/a	1.79*	2.37***
PANEL B						
Dependent variable is compulsory production						
	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.46	0.09	0.53	0.51	0.60	0.16
F-crops	41.73***	n/a	15.73***	21.04***	19.89***	n/a
F-colony	n/a	6.21***	3.23***	n/a	4.22***	4.92***
PANEL C						
Dependent variable is contract labor						
	(1)	(2)	(3)	(4)	(5)	(6)
Crop FE	Yes	No	Yes	Yes	Yes	No
Colony FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
R^2	0.61	0.09	0.66	0.63	0.67	0.09
F-crops	32.60***	n/a	184.67***	950.29***	158.49***	n/a
F-colony	n/a	10.67***	3.39***	n/a	2.93***	5.02

*** p<0.01, ** p<0.05, * p<0.1. N=260. Robust standard errors.

We observe a strong relationship between crops and institutions. However, it is also possible that institutions are assigned by exogenous administrative decisions and that the colonizers choose then the crops that are more suitable for those institutions. Nevertheless, if this were the case we should observe much bigger colony fixed effects. Moreover, the historical evidence supports the view that crops affects institutions. For

example, poll taxes were introduced in Equatorial Africa to facilitate the collection of rubber for the concessionary companies and compulsory quotas were established in Ubangi-Shari in order to increase cotton production.

Finally, it is interesting to note that the explanatory power of settler mortality is limited. In Table 3.7 I check how much of the variance of institutions can be explained by (Acemoglu et al., 2001) settler mortality, a factor related to colonies and not crops. To do so, I simply regress a dummy variable for each institution on the log of settler mortality from the appendix of (Acemoglu et al., 2001). In none of the cases we are able to reject the null of no effect of settler mortality on labor institutions. At least concerning labor institutions in French Africa, settler mortality does not explain institutions. Overall, the evidence suggests that crops are more important than colonies in determining labor institutions.

TABLE 3.7
Settler mortality and Labor Institutions

	free peasant prod.	compulsory prod.	contract labor
ln(settler mortality)	-0.029	0.007	0.022
	(0.046)	(0.038)	(0.044)
R^2	0.002	0.000	0.001
F-stat	0.40	0.03	0.26
N	255	255	255

Chad, Dahomey and Ubangi-Shari are excluded since they miss settler mortality data. Robust standard errors are reported in parenthesis.

3.4 What is Behind Crop Fixed Effects?

Crops account for a large portion of the variance in institutions, but they do not *explain* the choice of institutions. In this section I explore which factors could be behind the crops fixed effects, by developing a theoretical model and by providing some quantitative evidence.

3.4.1 Theoretical Framework

Model

There are two agents: Europeans and Africans. The Europeans make profit by buying or producing crops in Africa and reselling them at higher prices in Europe. They decide whether to leave the production to Africans (peasant agriculture) or to establish plantations. If they decide to establish plantations, they use contract labor to procure the workers they need.[8] If the production is left to Africans, the Europeans can choose between two institutional arrangements: free peasant production or compulsory production. If the free peasant production is chosen, Africans decide whether to produce cash crops for the colonizers or to stay in the native economy. If compulsory production is chosen, the Africans have to provide the established quantity at a price fixed by the colonizers.

The total population is L. The only input for production is labor l and production functions are $y = E(l)$ in the European sector (plantation or peasant agriculture) and $N(L - l)$ in the native economy. All production functions are increasing and non-convex. The costs for Europeans of the different institutional arrangements are the following: $F(y)$ increasing with $F(0) > 0$ if they use contract labor; $Q(y)$ increasing with $Q(0) > 0$ if they use compulsory cultivation; $p_A E(l)$ if they use , where p_A is the price paid to Africans for production.[9]

If the Europeans use free peasant production, the price p_A is determined in equilibrium. In particular it is such that the marginal utility of labor for Africans is the same in the native economy and in the peasant agriculture sector. That is $p_A = N'(L - l)/E'(l)$.

The Europeans choose l to maximize their profit under each of the three institu-

[8] The level of compulsion under contract labor varies. Formally, Africans work for the colonizers for a wage $f \in [0, w]$, where 0 is the wage when contract labor is equal to forced labor and w is the free labor wage.

[9] These costs include the cost of collecting the produce or recruiting the workers, monitoring costs, and enforcement costs.

tions and compare the payoffs. The profit functions are the following:

- $\Pi_M = (p - \frac{N'(L-l)}{E'(l)})E(l)$ if free peasant production
- $\Pi_Q = pE(l) - Q(E(l))$ if compulsory production and peasant agriculture
- $\Pi_P = pE(l) - F(E(l))$ if contract labor and plantation where p is the world market price.

To derive an explicit solution, let us assume specific functional forms. In particular: $N(l) = log(l)$, $E(l) = \alpha l$, $Q(y) = Q + qy$, $F(y) = F + fy$.[10] f and q may include respectively the non-market wage and the non-market price of crops paid to Africans. The market price of crops in equilibrium is $p_A = 1/\alpha(L - l)$.

Let us assume that the fixed cost of establishing plantations and using contract labor is higher than the fixed cost of relying on peasant agriculture and using compulsory cultivation, that is $F > Q$.

Consider now the profit functions under each labor arrangement.

- **Free peasant agriculture**. The profit function is $\Pi_M = (p - \frac{1}{\alpha(L-l)})\alpha l$. This is maximized when $l = L - \sqrt{\frac{L}{\alpha p}}$.[11] The maximum profit is then $\Pi*_M = (\sqrt{\alpha L p} - 1)^2$ if $p \geq 1/(\alpha L)$, $\Pi*_M = 0$ otherwise.
- **Compulsory cultivation and peasant agriculture**. The profit function is $\Pi_Q = p\alpha l - Q - q\alpha l$. This is maximized when $l = L$ if $p > \frac{Q}{\alpha L} + q$; $l = 0$ otherwise. The maximum profit is $\Pi*_Q = p\alpha L - Q - q\alpha L$ if $p > \frac{Q}{\alpha L} + q$; $\Pi*_Q = 0$ otherwise.[12]

[10] The main predictions of the model are not affected by these specific functional forms. See end of section.

[11] The 'plus' solution is not acceptable because it would imply $l > L$. Since l must be greater or equal to zero, we must have $p \geq 1/(\alpha L)$.

[12] $l = L$ is consistent with the universalistic character of French colonial institutions: no one is excluded from corvée labor and quotas obligations.

- **Contract labor and plantation**. The profit function is $\Pi_P = p\alpha l - F - f\alpha l$. This is maximized when $l = L$ if $p > \frac{F}{\alpha L} + f$; $l = 0$ otherwise. The maximum profit is then $\Pi*_P = p\alpha L - F - f\alpha L$ if $p > \frac{F}{\alpha L} + f$; $\Pi*_P = 0$ otherwise.

The following proposition defines the choice of the colonizer.

Proposition 1 *The colonizer chooses the following institutions:*

- *free peasant production, if the price is low,* $1/(\alpha L) < p < min\left\{\frac{(1+F+f\alpha L)^2}{4\alpha L}, \frac{(1+Q+q\alpha L)^2}{4\alpha L}\right\}$.
- *compulsory production, if the price is high and either the marginal cost of compulsory production or the scale of production are low. In particular if* $p > \frac{(1+Q+q\alpha L)^2}{4\alpha L}$ *and* $q < f$ *or if* $p > \frac{(1+Q+q\alpha L)^2}{4\alpha L}$, $q > f$, *and* $\alpha L < \frac{F-Q}{q-f}$.
- *contract labor, if the price is high and both marginal cost of compulsory production and scale of production are high. In particular if* $p > \frac{(1+F+f\alpha L)^2}{4\alpha L}$, $q > f$, *and* $\alpha L > \frac{F-Q}{q-f}$.
- *no production, otherwise.*

Proof. Compare the maximized profits for each of the three institutions. The profit from free peasant production is higher than the profit from contract labor if $p < \frac{(1+F+f\alpha L)^2}{4\alpha L}$ and higher than the profit from compulsory production if $p < \frac{(1+Q+q\alpha L)^2}{4\alpha L}$. The profit of contract labor is higher than the profit of compulsory production when $q > f$ and $\alpha L > \frac{F-Q}{q-f}$.

The profit of compulsory production is higher than the profit of contract labor when $q < f$ or when $q > f$ and $\alpha L < \frac{F-Q}{q-f}$. Moreover, notice that $\frac{(1+Q+q\alpha L)^2}{4\alpha L} > \frac{Q}{\alpha L} + q$: if the profit from compulsory production is higher than the profit from free peasant production , then the profit from compulsory production is positive. Similarly $\frac{(1+F+f\alpha L)^2}{4\alpha L} > \frac{F}{\alpha L} + f$: if the profit from contract labor is higher than the profit from free peasant production, then the profit from contract labor is positive ■

Notice that the proposition is true in the most general case. As long as the marginal productivity of labor is decreasing in the indigenous sector, free peasant production is chosen only when the price is low. When the price is high:

- compulsory production is chosen when $F(0) > Q(0)$ and $F'(.) > Q'(.)$, or when $Q(0) > F(0)$, $Q'(.) < F'(.)$, and production is high;
- contract labor is chosen when $Q(0) > F(0)$ and $Q'(.) > F'(.)$, or when $F(0) > Q(0)$, $F'(.) < Q'(.)$, and production is high.

In the next subsection, I provide the intuition for these results.

Intuition Figure 3.1 shows the choice of institution for a given crop as a function of the colony's total productive capacity αL and prices p in each of the two possible cases: $f < q$ or $f \geq q$.[13] Green regions represent contract labor/plantation, yellow regions represent compulsory cultivation/peasant agriculture, red regions represent free peasant production, white regions represent absence of production.

Effect of price (p). Given the decreasing productivity of labor in the indigenous economy, the marginal cost of labor under free peasant production is increasing. For this reason, when the colonizers use free peasant production they do not use the whole labor force of the colony. On the other hand, under contract labor and compulsory production all the labor force is employed since the cost of labor is linear. Thus, an increase in price increases the colonizer's revenue more under contract labor /compulsory production than under free peasant production .

If the price of the crop is low, then the total revenue from the colony is not enough to pay for the fixed costs of compulsory production or plantation. Free peasant production is chosen. As the price increases, the revenue from free peasant production increases less than the revenue from the other two institutions. At a certain price,

[13]The values of parameters F and Q are 10 when low and 20 when high; the values of parameters f and q are 4 when low and 8 when high; $\alpha = 1$.

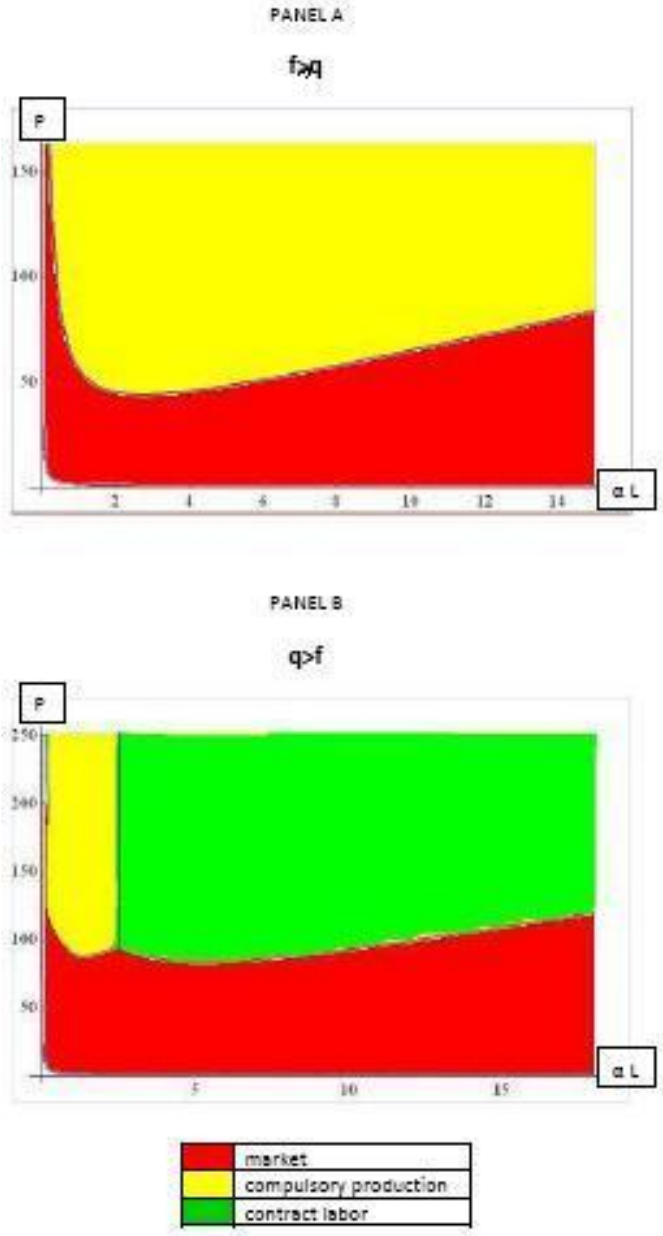


FIGURE 3.1
Institutional regions

the revenue is high enough to compensate the fix cost and contract labor/compulsory production is chosen.

Effect of scale of production (αL). The fixed cost of establishing a plantation is higher than that of establishing compulsory cultivation ($F > Q$). Thus, in places where the cost of an additional unit is higher under contract labor than under compulsory production ($f > q$), the colonizer will only choose between compulsory production and free peasant production. This is the situation of panel A of figure 3.1.

In places where the cost of an additional unit is higher under compulsory production than under contract labor ($q > f$), when the scale of production increases enough contract labor becomes more attractive than compulsory production, as shown in panel B of figure 3.1.

3.4.2 Testable Implications and Evidence

The model yields the following predictions about the effects of scale of production and prices.

1. **H1. Price**. In colony/crops where the price of crop is low, we should observe only free peasant production.

2. **H2. Scale of production**. Colony/crops that use contract labor have higher scale of productions than those that use compulsory production cultivation.

I perform the following tests.

1. To test H1, I regress a dummy for free peasant production on price, controlling for quantity.[14] I expect a negative coefficient.

2. To test H2, I restrict the sample to contract labor and compulsory production

[14] I need to control for quantity because the model predicts free peasant production when $p < min\left\{\frac{(1+F+f\alpha L)^2}{4\alpha L}, \frac{(1+Q+q\alpha L)^2}{4\alpha L}\right\} = min\left\{\frac{(1+F+fY)^2}{4Y}, \frac{(1+Q+qY)^2}{4Y}\right\}$.

and I regress a dummy for contract labor on the total quantity produced. I expect a positive coefficient.

Table 3.8 reports the results. Panel A tests H1. As expected, there is a negative and significant relation between the price of crops and the use of free peasant production: a standard deviation increase in price decreases the probability of free peasant production by 16 percentage points. As shown in columns (2) to (4) this relationship is robust to the inclusion of colony, time, and crop fixed effects. As expected, since we are looking for which factors are behind the crop fixed effects, when we include crop fixed effects the coefficient of price drops. Crops explain, in fact, more than 40% of the variance in price.[15]

Panel B tests H2. As expected, the coefficient of quantity is positive and significant: a larger scale of production is associated with more contract labor and less compulsory cultivation. A standard deviation increase in quantity increases the probability of contract labor vs. compulsory production by 10 percentage points. The relationship is robust to the inclusion of colony and time fixed effects (columns 2 and 4). However, the coefficient of quantity becomes insignificant when we control for the kind of crops (column 4).

Overall, prices seem to be important in determining the choice between market and non-market institutions, while the scale of production has explanatory power for the choice between compulsory production and contract labor.

3.5 Conclusion

The main theories attributing African underdevelopment to extractive institutions established by colonizers explain the origin of these policies with factors that are

[15]The high explanatory power that crop fixed effects still have can be explained by the fact that the test assumes common costs of production (Q and q, F and f) for all colonies, crop, and periods. Thus, when we observe free peasant production we cannot be sure if it is because the price p is low or because the costs of production Q and q are high.

TABLE 3.8
Testing the Effects of Price and Scale of Production

PANEL A				
	free peasant			
	(1)	(2)	(3)	(4)
price net of trading costs	-0.0597***	-0.0571***	-0.0582***	-0.0135**
	(0.00662)	(0.00708)	(0.0086)	(0.00662)
quantity	-0.000314	-0.000253	-0.00067	0.000122
	(0.000797)	(0.000755)	(0.000865)	(0.000156)
Colony FE		Yes		
Time FE			yes	
Crop FE				Yes
N	325	325	325	325
R^2	0.094	0.125	0.145	0.714

PANEL B				
	contract labor			
	(1)	(2)	(3)	(4)
quantity	0.00264***	0.00252***	0.00203***	0.000137
	(0.000615)	(0.000669)	(0.000547)	(0.000126)
Colony FE		Yes		
Time FE			yes	
Crop FE				Yes
N	159	159	159	159
R^2	0.041	0.252	0.061	0.593

colony-specific, such as settler mortality (Acemoglu et al., 2001). However, the precise details are not clear and the origin of extractive institutions remains a black box. In this chapter, I contribute to this literature, by focusing on the determinants of labor institutions in the French colonies.

By using a dataset of labor institution, I find that the relationship between colonies and institutions is much weaker than expected. On the other hand, I show that there exists a strong correlation between labor institutions and kind of crops and that this relationship takes into account most of the variation in labor arrangements. This evidence suggests that factors related to crops, such as prices, are more likely to explain labor institutions than factors related to colonies, such as settler mortality. To interpret these findings, I develop and test a theoretical model, linking the choice of labor arrangements to differences in price of crops, cost of institutions, and scale of production. The results suggest that these variables are key factors explaining the correlation between crops and institutions.

3.6 Appendix

3.6.1 Definition and Sources

See appendix 2.8.3.

3.6.2 Appendix Figures and Tables

TABLE 3.9
Summary Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
compulsory production	325	0.169	0.375	0	1
contract labor	325	0.320	0.467	0	1
free peasant production	325	0.511	0.501	0	1
equatorial	325	0.403	0.491	0	1
quantity (tons)	325	12340	35256	10	281504
price France net of trading costs (per kg)	325	1.30	2.58	0.01	17.91
price Africa (per kg)	325	0.75	1.27	0.01	9.30

Chapter 4

Colonial Institutions, Prices to Producers, and Current African Development

4.1 Introduction

Since early 2000s, a growing body of studies has pointed to institutions as one of the main causes of African underdevelopment. One line of research emphasizes colonial institutions at the national level, blaming in particular their extractive character and the low level of property rights protection (Acemoglu et al., 2001). A second line of research focuses instead on pre-colonial conditions at the local level, affected by the slave trade (Nunn and Wantchekon, 2011) and the political centralization of ethnic institutions (Michalopoulos and Papaioannou, 2013).

This chapter connects these two literatures, by exploring the relationship between *colonial extraction at the local level* and current development.[1] Measuring colonial

[1]Recent works have emphasized how local features of colonial rule, such as investments in education (Huillery (2009) and Cogneau and Moradi (2014)), arbitrary borders (Michalopoulos and Papaioannou, 2013), and missionary activity (Nunn, 2010) affect current development.

extraction, in particular at the sub-national level, is challenging for lack of data and absence of clear counterfactuals. Since colonial extractive institutions were used in all colonies, we cannot observe subsequent development in the absence of extraction. To solve these problems, I exploit the peculiar structure of trade and labor policies employed by the French colonizers. In French Sub-Saharan Africa, trade monopsonies and forced labor were introduced to reduce prices to African agricultural producers and increase the profit margin of the European trading companies. The gap between observed prices and theoretical "free market" prices can thus be used as a proxy for the extent of colonial extraction. Using data collected in the French colonial archives, I compute colony-level price gaps for the main crops produced, as the difference between prices to producers and prices in France net of trading costs. Then, I combine the gaps for each crop/colony with GIS data on crop suitability in order to construct price gaps at the sub-national level.

I show that price gaps are strongly negatively correlated with current development, as proxied by luminosity data from satellite images (Michalopoulos and Papaioannou, 2013). The relationship is not driven by observable differences in land endowments, geography, disease environment, resources, population density, urbanization, or access to markets. Neither, it is driven by pre-existing differences in economic development during the colonial period, as proxied by the value of agricultural production in 1950s. Moreover, the correlation is robust to the inclusion of country fixed effects: colonial price gaps account for differences in development both across and *within* countries. Finally, the negative relationship between price gaps and development is not only statistically significant, but also economically meaningful: for a median district, one standard deviation increase in the price gaps is associated with a 10 to 30% decrease in luminosity.

I then explore the channels which mediate the relationship between colonial price gaps and current economic development, by looking at luminosity in urban and rural

areas. I show that price gaps are negatively correlated with size of urban areas and level of development in rural areas. Interestingly, the relationship between price gaps and development in urban areas is instead positive. The overall impact is negative, but colonial extraction benefited cities, increasing the urban-rural development gap. The economic benefits that urban sectors of society obtained can be the reason why trade monopsonies and extractive institutions persisted long after independence, despite their negative influence on overall development.

The chapter is structured as follows. Section 4.2 presents the historical background and discusses price gaps and luminosity data. Section 4.3 shows the results of the empirical analysis, both across and within countries. Section 4.4 focuses on potential channels of causality. Section 4.5 provides concluding remarks and directions for future research.

4.2 Historical Background and Data

About one-third of Sub-Saharan Africa and one-fifth of its population was subject to French colonization between 1880 and 1960. Compared to the neighboring British colonies, the French territories were much poorer. For this reason, the colonizers, instead of focusing on productive investments, limited themselves to trade with African populations. Trading companies bought agricultural production at low prices from African producers and resold it at higher prices in Europe. However, since population density was low and labor expensive, the market price of crops was too high, eliminating in this way any profit for the trading companies.

In order to maintain profits, the companies lobbied the colonial government to establish trade monopsonies and specific labor institution. If trade monopsonies were common to almost all colonies (fewer than a dozen companies monopolized all trade from West Africa), labor institutions varied across colonies, crops, and over time.

They ranged from free labor, as in the case of peanuts production in Senegal, to compulsory cultivations, as in the case of cotton in Ubangi-Shari or rubber in Congo.

Tadei (2013) shows that monopsonies and coercive labor institutions proved extremely effective in allowing the colonizers to pay African producers prices far below world market prices, cutting African gains from trade by over 60% during the colonial period. With independence coercive labor institutions were abolished, but trading monopsonies tended to persist, and post-independence governments continued to practice price policies that discriminated against agricultural producers.

4.2.1 Price Gaps

A way to measure how much prices to producers were reduced is to compare them to counterfactual prices under competition among trading firms and free labor. The idea is that without monopsonies and labor coercion the price to producers should be equal to the world market prices net of trading costs. To do so, I construct the following price gap index

$$G = 1 - \frac{p_A - t}{p - T - t} \tag{4.1}$$

where p_A is the price at the African port, p is the price in France, t are inland transport costs between the interior of the interior of the colony and the port, and T includes shipping and fixed costs.

I collect yearly data on prices in Africa and in France for each crop in 1950s from colonial custom statistics [2]. To take into account price shocks in specific years (e.g., fluctuation of supply due to climatic conditions), I use the average of prices across all the years in the 1950s for each crop/colony. Moreover, since data for the various crop/colonies might come from different years, I compute the average price in France in 1950s for each crop and I recompute prices at the African ports proportionally.

[2]See Tadei (2013) for detailed information about the sources. Prices in Africa are measured at the port also for landlocked colonies. In fact, prices for the same crop are not significantly different for coastal and landlocked colonies. See table 4.7 in the Appendix.

I estimate shipping and fixed costs according to the procedure described in 2 and I compute inland transport costs by using colonial maps and reports. To do so, I first put together a map of current ports, rivers, and railroads. Then, I eliminate all railroads segments that were constructed after independence, all portions of rivers that were not navigable, and all ports that were not used during the colonial period, by using a map of colonial transports in French Africa in 1956 (Duignan and Gahan, 1975, p.149, vol.4) and the accounts in Suret-Canale (1971) and Thomas (1957). Figure 4.1 represents the final colonial transport network map. According to Thomas (1957), four ports (Dakar, Conakry, Abidjan, and Cotonou) handled 95% of all the trade from French West Africa and 75% of exports were moved to ports via railroads. Finally, by using information from a variety of colonial reports (see Data Appendix), I construct estimates of the cost per km for each mean of transport (railroad, river, and roads) and with GIS I compute the total cost from the centroid of each district to the closest port, along the cheapest route.[3]

Colonial data on prices are aggregated at the commodity/colony level. To construct a price gap index specific for each district, I combine colonial prices with data on crop suitability from the FAO Global Agro-Ecological Zones project, which reports potential productivity (kg/hectare) for each crop globally at a 5 by 5 km resolution, given climatic and soil constraints and input levels (FAO, 2013b). I proceed in the following way:

1. First, I compute a crop/pixel-level price gap for each crop. A crop is considered to be produced in the pixel if colonial data report non-null production in the colony in which the pixel is located and if inland transport costs from the pixel district to the port are lower than the reported price at the port. I focus the analysis on four agricultural commodities: cocoa, cotton, palm kernel, and peanut, accounting for over half of the total value of exports from French Africa.

[3]I connect the centroids of districts to the railroad/ rivers networks, by using a 50 km by 50 km grid of "roads".

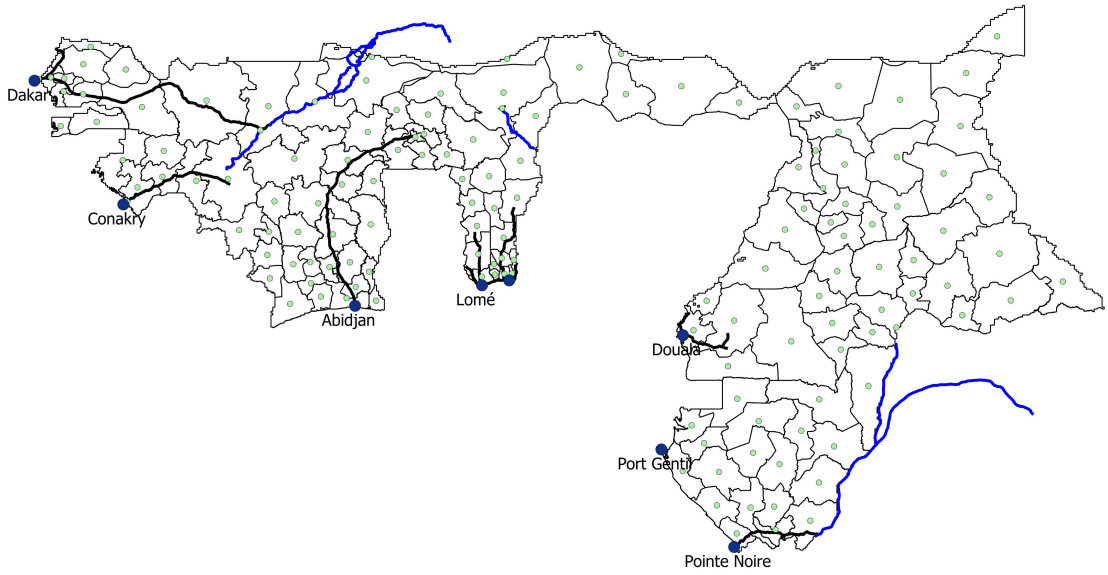


FIGURE 4.1
Transportation Network in Colonial French Africa, 1950s

The figure represents the transportation network of French Africa during the colonial period, including railroads (black), navigable rivers (blue), and main ports (dark blue). The green dots are the centroid of each district.

These crops were produced by African peasants, unlike coffee or bananas that were produced under European plantation. For this reason, the price in Africa does not include the profit of the European planter and it is a better measure of the income of African producers.

2. Second, I compute a pixel-level price gap, by averaging the crop/pixel-level gaps weighted by each crop's value per hectare (price to African producer times productivity) in the given pixel. The underlying idea is that the land in each pixel is assigned to each crop in proportion to its value.

3. Finally, by using GIS, I compute a district-level price gap as the average of pixel-level price gaps within each districts. I consider second-level administrative divisions of 13 ex-French colonies, adding up to 539 districts. Districts that did not produce any of the four crops are excluded.

4.2.2 Luminosity

As a proxy for local economic development, I employ luminosity data from satellite images of the world at night. The use of luminosity as measure of development builds on the work of Michalopoulos and Papaioannou (2013). Given the high correlation with wealth, electrification, and schooling, they show that light density at night is particularly useful as a proxy for economic activity in areas where no other local-level measures are widely available, such in the case of Sub-Saharan Africa.

The data come from the Earth Observation Group of the NOAA National Geophysical Data Center (2013) which reports the intensity of light radiation at a 15 arc-sec resolution (about 500 square meters) for the entire globe. This measure uses cloud-free observations in 2012/4/18-26 and 2012/10/11-23 and includes electric lights, fires, and gas flares. The unit of measurement is nano-Watts/(cm2*sr). To construct my development measure at the district level, I average pixel-level lu-

minosity at the desired level of aggregation by using GIS.

4.3 Colonial Price Gaps and Current Development

Before formally exploring the relationship between price gaps and luminosity, let us observe some preliminary evidence. Figure 4.2 represents French Sub-Saharan Africa. The red area is the focus of the analysis, including all districts in which at least one crop was produced, among cocoa, cotton, palm kernel, or peanut.

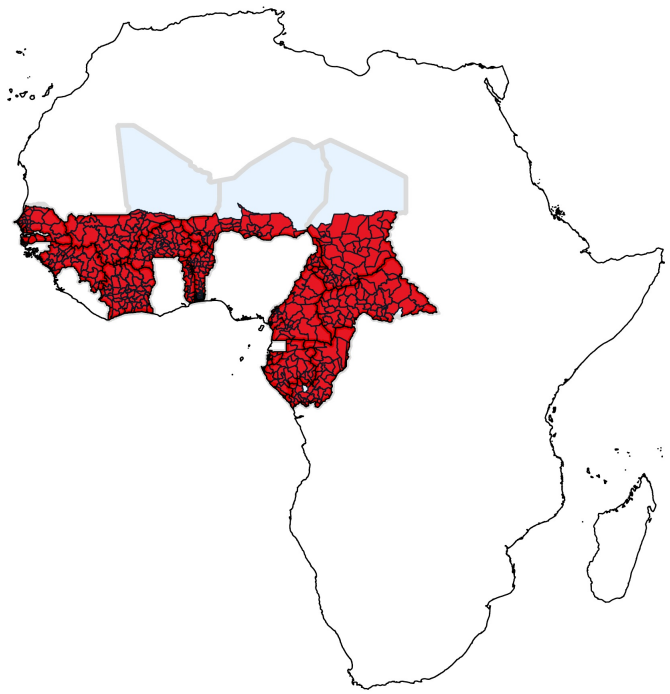


FIGURE 4.2
French Africa and Area of Analysis

The figure represents French Sub-Saharan Africa, excluding Madagascar and Djibouti. The analysis is focused on the districts in the red area, where it was produced at least one of the four crops considered (cocoa, cotton, peanut, palm kernel).

Figure 4.3 shows the average price gaps and luminosity for each district. It is easy to notice a negative correlation between the two variables On average, districts below the median price gap are about 45% brighter than districts above the median (0.26

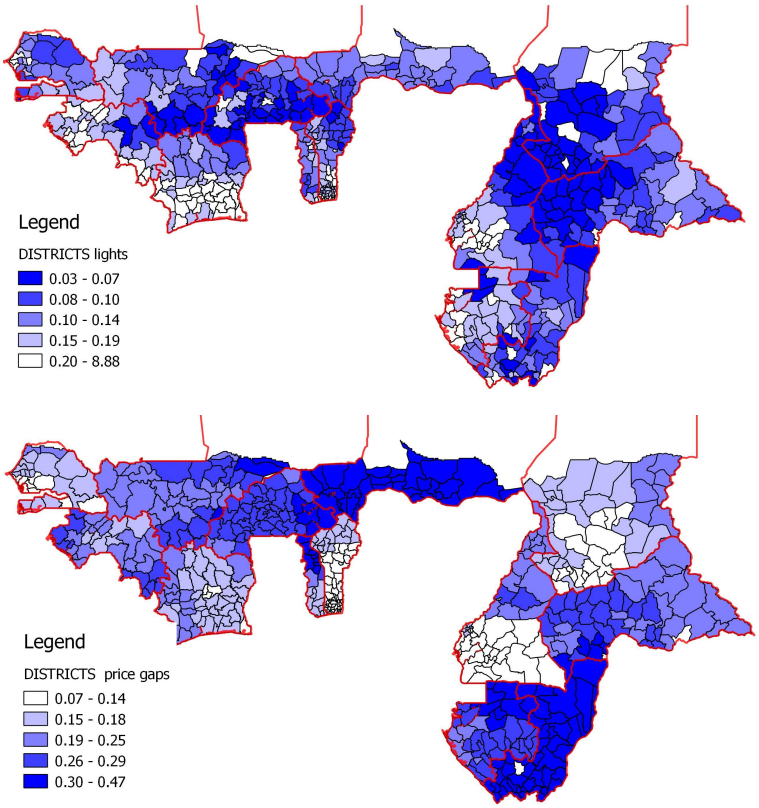


FIGURE 4.3
Average Current Luminosity and Colonial Price Gap by District

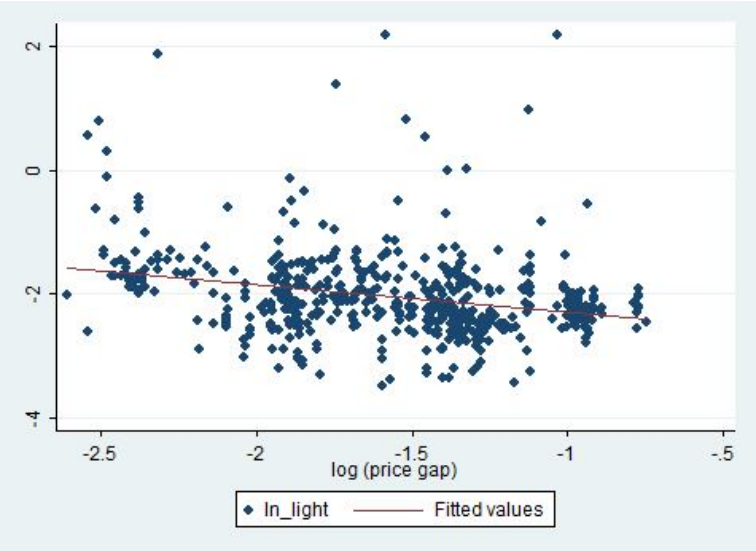
The top and bottom panel report the average luminosity the average colonial price gap and in each district, respectively. Districts are color-coded according to five quantiles.

vs. 0.18).

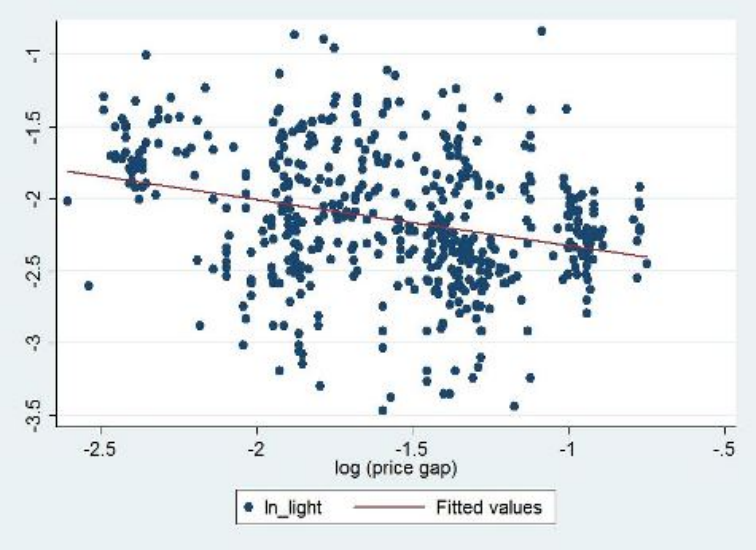
Figure 4.4 shows the relationship between log(light) and log (price gap). I use logs to reduce the impact of extreme value observations and to have a more direct interpretation of regression coefficients as elasticities.[4] The top panel shows the relationship within the full sample: the presence of a negative correlation is evident. This relationship is not driven by the presence of cities or outliers, as it is even stronger when excluding districts with luminosity values higher than the 90th percentile (bottom panel).

To formally analyze the correlation between lights and price gaps, I run the fol-

[4]Kernel densities in figure 4.7 shows that the log of the variable follow more closely a normal distribution.



(a) Full Sample



(b) Excluding +90 Percentile of Luminosity

FIGURE 4.4
Colonial Price Gaps and Current Luminosity

The top panel reports the scatterplot and the linear fitting for the regression of log (light) and log (price gap) for the full sample. In the bottom panel I exclude district with luminosity higher than the 90th percentile, in order to control for outliers and the presence of cities.

lowing regression

$$log(L_i) = \alpha_0 + \alpha_i + \beta log(G_i) + X_i\gamma + \epsilon_i \tag{4.2}$$

where $log(L_i)$ is the natural logarithm of the average luminosity in district i, $log(G_i)$ is the natural log of price gap, X_i is a vector of control variables, α_i are country fixed effects (used in some specifications), α_0 is a constant, and ϵ_i is the error term. Since price data are at the colony level, I cluster standard errors at the country level. All variables are averages of the values per pixel within each district.

Control variables include a variety of geographic, economic, and ecological factors, such as the percentage of land covered by forest, desert, and water, the percentage of cultivated land, elevation, malaria suitability index, livestock, value of agricultural production, population density, distance to port, and presence of oil. These controls are important for several reasons. First, controlling for the presence of forest allows us to take into account the impact on development of wood exports, particularly large in Gabon and Congo. The percentage of land covered by desert and water is useful to control for the blooming of satellite light images due to deserts and water bodies. Including the percentage of cultivated land allows us to control both for the presence of unproductive land and for urbanization. Elevation is important as Nunn and Puga (2012) show that ruggedness of the terrain is negatively related to slave exports and Michalopoulos (2012) demonstrates that variability in elevation is positively correlated with ethnic fractionalization. The inclusion of the malaria index is warranted by several studies showing the impact of malaria and disease environment on development (Gallup and Sachs, 2001). Livestock allows us to control for an important source of income in countries less suitable to agriculture such as Mali, Niger, and Chad, while the value of agricultural production accounts for variations in land suitability and crop endowments. Population density is a common proxy for economic development, accounts for urbanization, and reflects the availability of labor. The distance to the port is included to take into account variations in the

access to world markets. Finally, it is important to control for oil both for its positive impact of income and negative impact on the quality of institutions

Table 4.1 reports the OLS cross-sectional estimates, without country fixed effects. The simple regression of log (light) on log (price gap) is shown in column (1). The coefficient is negative and statistically significant at 1% level. In column (2) I control for geographic characteristics and land cover, including the percentage of land covered by forest, desert, and water, the percentage of cultivated land, elevation, and a malaria suitability index. In column (3) I condition on resources characteristics and access to markets, by including a measure of livestock, the log of the average value of current agricultural production, population density, linear distance to the closest port, and a dummy for districts with oil. Column (4) reports the results controlling for both geography and resources.[5] Despite this rich set of controls, in all specifications, the coefficient of price gap, even if decreases a little in absolute value, remain negative and highly significant. In the specification with all control variables, elevation, malaria, and livestock have negative and significant coefficients, while population density enters the specification with a positive coefficient.

[5]Please see the Data Appendix for detailed definitions and sources for all the variables.

TABLE 4.1
Colonial Price Gaps and Current Development: Cross-Sectional Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log (price gap)	-0.444**	-0.364**	-0.315***	-0.290***	-0.419**	-0.276**	-0.314***	-0.312***	-0.269***	-0.319***
	(0.146)	(0.126)	(0.0994)	(0.0820)	(0.160)	(0.101)	(0.0721)	(0.0881)	(0.0789)	(0.0812)
Geography Controls		Yes		Yes		Yes	Yes	Yes	Yes	Yes
Resources Controls			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Pre-colonial State Centralization					Yes	Yes				
Equatorial Africa Dummy								Yes		
Excluding Outliers							Yes			
Excluding High Luminosity									Yes	
Excluding Highly Built										Yes
N	539	539	539	539	478	478	528	539	513	512
R^2	0.075	0.191	0.155	0.232	0.078	0.256	0.241	0.291	0.269	0.210

The table reports OLS estimates of the relationship between colonial price gaps and current development, as proxied by luminosity. The simple regression of log (light) on log (price gap) is reported in column (1). In column (2) I control for geographic characteristics, including the percentage of land covered by forest, desert, and water, the percentage of cultivated land, average elevation, and a malaria suitability index. In column (3) I control for resources characteristics, by including a measure of livestock, the log of the average value of current agricultural production, population density, linear distance to the closest port, and a dummy for districts with oil. Column (4) reports the results controlling for both geography and resources. In column (5) and (6) I control for pre-colonial state centralization, without and with the full set of geography and resources variables. In columns (7) to (10) I perform further robustness checks on the specification with the full set of controls, by excluding outliers (7), adding an Equatorial Africa dummy (8), excluding districts with luminosity higher than the 90th percentile (9) and excluding districts higher than the 90 percentile in built-up land. Please see the Data Appendix for detailed definitions and sources for all the variables. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

In column (5) and (6) I control for pre-colonial state centralization, without and with the full set of geography and resources variables. This control is due to Michalopoulos and Papaioannou (2013), who shows that the centralization of ethnic groups in the colonial period is positively correlated to current luminosity. Since data on pre-colonial institutions are not available for all districts, the sample size is slightly smaller. However, the coefficient of price gap is unaffected. Interestingly, the coefficient of pre-colonial centralization is negative, and significant at 10% in the specification with the full set of controls. This is contrary to the finding in Michalopoulos and Papaioannou (2013) and could be explained by the "direct rule" style of the French which may have reduced the importance of pre-colonial institutions.

In columns (7) to (10) I perform further robustness checks on the specification with the full set of controls, by excluding outliers (7), adding an Equatorial Africa dummy (8), excluding districts with luminosity higher than the 90th percentile (9) and excluding districts higher than the 90 percentile in built-up land.[6] Controlling for the percentage of build-up land allows us to make sure that the relationship is not driven by cities and urbanization. Again, the coefficient of price gap is negative and significant across all specifications.

The relation between price gaps and development is is not only statistically significant, but also economically meaningful: a 1% increase in price gap is associated with a 0.3 % decrease in luminosity. To get a better idea of the intensity, consider that, for the average district, one standard deviation increase in log(price gap) is associated with a decrease in log(light) by about 10%.

Table 4.2 reports the results including country fixed effects. In this case, the coefficient of price gap measures the relationship between price gap and luminosity *within* countries. Moreover, adding fixed effects allows us to control for a variety of country-level characteristics, such as the quality of national institutions. Column (1)

[6]Outliers are identified using the method in Hadi (1993). The Equatorial dummy is negative and highly significant.

reports the simple fixed-effect regression. The coefficient of log (price gap) is negative and highly significant, and about three times larger than in the specification without fixed effect (compare to table 4.1, column 1). In column (2) I control for geographic characteristics, in column (3) I control for resources, and column (4) conditions on both geography and resources together. In all specifications, the coefficient of interest remains negative and significant. In column (5) I control for pre-colonial state centralization, while in column (6) I include the full set of controls (geography, resources, and pre-colonial centralization). The coefficient of price gaps decreases, but is still negative and significant.[7]

[7]The coefficients of control variables are generally consistent with the cross-sectional estimates.

TABLE 4.2
Colonial Price Gaps and Current Development Within Countries: Fixed Effects Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Log (price gap)	-1.123***	-0.862**	-0.775**	-0.679*	-1.012***	-0.637*
	(0.294)	(0.348)	(0.261)	(0.341)	(0.322)	(0.332)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Geography Controls		Yes		Yes		Yes
Resources Controls			Yes	Yes		Yes
Pre-colonial State Centralization					Yes	Yes
N	539	539	539	539	478	478
R^2	0.096	0.195	0.150	0.228	0.112	0.257

The table reports OLS estimates of the relationship between colonial price gaps and current development, as proxied by luminosity, including country fixed effects. The simple regression of log (light) on log (price gap) is reported in column (1). In column (2) I control for geographic characteristics (percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index) and in column (3) I control for resources (livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy). Column (4) reports the results controlling for both geography and resources. In column (5) I control for pre-colonial state centralization. In column (6) I include the full set of controls (geography, resources, and pre-colonial centralization). Please see the Data Appendix for detailed definitions and sources for all the variables. The R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

Price gaps explain variation in luminosity not only across countries, but also within the districts of the same country. The magnitude of the fixed effects estimates is even larger than that of the cross-sectional estimates. For the average district, one standard deviation increase in log (price gap) is associated with a 30% decrease in luminosity.

Obviously, despite the large set of control variables employed, we might still be concerned that the negative relationship between price gaps and development is driven by omitted variables. For example, if the colonizers reduced prices to producers more in districts that were already poor in the colonial period and these districts are still the poorest today, then the observed correlation would be spurious. This might be the case if poorer districts responded less to price incentives or if the colonizers did not reduce agricultural prices in rich and highly urbanized districts, where agriculture was not important.

However, there are reasons to believe that these should not be big concerns. First, Tadei (2013) shows that price elasticity is uncorrelated with the extent of price reduction. Second, the relationship between price gaps and luminosity holds even when excluding highly urbanized districts and controlling for population density (see table 4.1).

To provide further evidence, I study the relationship between colonial agricultural production and price gaps. In column (1) of table 4.3 I regress log (price gap) on the log of the potential value of agricultural production in 1950s. For each pixel and crop, I estimate the potential value as the product of the price in France net of trading costs times the productivity per hectare times the cultivated land area. Then, I compute the value per pixel by weighting each crop by its value and I average within districts. Using potential instead of actual production has two advantages. First, it allows us to use the full sample since colonial data on actual production at the district level are available only for a minority of districts. Second, potential value

is not affected by price gaps and we can rule out the possibility of reverse causality. According to the estimates of column (1), prices are reduced less in richer districts. Nevertheless, the correlation between potential agricultural production and price gaps becomes insignificant when including country fixed effects.

TABLE 4.3
Colonial Agricultural Production, Price Gaps, and Current Development

Dependent Variable	(1) Log (price gap)	(2) Log (price gap)	(3) Log (light)	(4) Log (light)	(5) Log (light)	(6) Log (light)
Log (potential value 1950s)	-0.0921**	0.00289	0.0379	0.103	-0.0252	0.0675
	(0.0331)	(0.0130)	(0.0303)	(0.0656)	(0.0314)	(0.0476)
Log (price gap)			-0.391**	-0.285***	-1.119***	-0.655*
			(0.164)	(0.0883)	(0.287)	(0.332)
Country Fixed Effects		Yes			Yes	Yes
Geography Controls				Yes		Yes
Resources Controls				Yes		Yes
N	539	539	539	539	539	539
R^2	0.127	0.000	0.082	0.241	0.098	0.231

The table reports OLS estimates of the relationship between colonial agricultural production and price gaps and between price colonial price gaps and current development, as proxied by luminosity. The simple regression of log (price gap) on the log of the potential value of agricultural production in 1950s is reported in columns (1) and (2), with and without country fixed effects. In columns (3) to (6) I report the regression of log (light) on log (price gap), controlling for the value agricultural production in 1950s: column (3) reports the simple regression; column (4) controls for geography (percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index) and resources (livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy); column (5) includes country fixed effects to the simple regression; column (6) includes country fixed effects to the specification with the full set of controls. In the specifications with fixed effects, the R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

In column (3) to (6) I directly estimate the relationship between price gaps and lights, including colonial agricultural production as a control variable. Column (3) reports the simple regression, column (4) controls for geography and resources, column (5) includes country fixed effects to the simple regression, and column (6) adds country fixed effects to the specification with the full set of controls. In none of the specifications the coefficient of agricultural production in 1950s is significant. On the other hand, the coefficient of price gaps is negative, significant, and of similar magnitude as the specifications without colonial agricultural production (tables 4.1 and 4.2).

4.4 Channels of Causality: Effects on Rural and Urban Areas

Colonial price gaps are negatively correlated with current development. The relationship is robust to a variety of specifications and cannot be explained by differences in geography, natural resources, population density, urbanization, and pre-existing levels of economic development

In this section, I explore the channels through which price gaps might affect subsequent economic growth. A negative relationship between price gaps and average district luminosity suggests four possible channels of causality. Colonial extraction may affect current economic growth by reducing

1. the size or the number of cities;
2. the size of rural settlements vs. not-inhabited areas;
3. the level of development in cities, without changing their number or size;
4. the level of development in rural areas (intensive agriculture, capital investments, machinery), without changing their size.

I start by exploring channels 1 and 2. To test whether the effect goes through the size or the number of cities (channel 1), I consider the share of pixel in each district that are within the top one percentile of luminosity. The idea is that the most lit pixels are those belonging to urban areas. Figure 4.5 shows the top percentile pixels together with the locations of major cities. The relationship is evident: the top percentile is a good threshold to identify cities.

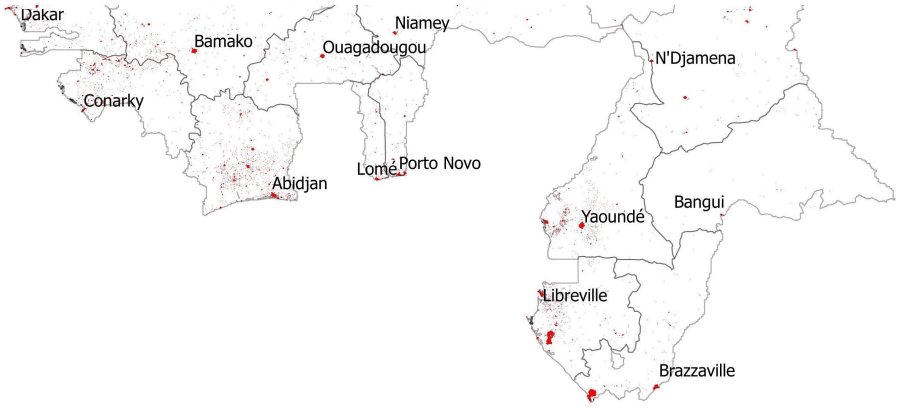


FIGURE 4.5
Top Percentile Lights and Capitals

The figure shows in red the pixels within the top one percentile and the location of country capitals. The red area south of Libreville is Lake Nkomi (water areas magnify satellite image luminosity), while the area west of Brazzaville is the city of Pointe-Noire.

Notice also that the two distributions of light within and below the top percentile are much closer to normals than the distribution from the full sample (compare the top panels of figure 4.8 to figure 4.7).[8]

In table 4.4, I regress the share of top percentile/urban pixels in each district on price gaps. Column (1) reports the simple regression: the coefficient of price gaps is negative and significant. Larger price gaps are associated with a lower share of urban pixels. The result is unchanged if we control for geography, natural resources, and agricultural production in the colonial period (column 2). Moreover, the relationship is even stronger within countries, in fixed effect specifications both without and with

[8]The situation is very different if we consider another threshold to identify cities, i.e the top fifth percentile (compare the bottom two panels of figure 4.8 to figure 4.7).

controls (columns 3 and 4).

TABLE 4.4
Rural Underdevelopment or Lower Urbanization: Extensive Margin

	(1)	(2)	(3)	(4)				
	% top percentile							
Log (price gap)	-0.043***	- 0.0203**	-0.127***	-0.0850***				
	(0.0114)	(0.00851)	(0.0251)	(0.0248)				
Country Fixed Effects			Yes	Yes				
Geography Controls		Yes		Yes				
Resources Controls		Yes		Yes				
Log (potential value 1950s)		Yes		Yes				
N	539	539	539	539				
R^2	0.035	0.171	0.053	0.197				
	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	% below top percentile						% unlit	
Log (price gap)	0.0318	0.0116	0.104***	0.0521	0.0112	0.00875	0.0231	0.0329
	(0.0192)	(0.00817)	(0.0337)	(0.0324)	(0.017)	(0.0117)	(0.0197)	(0.0241)
Country Fixed Effects			Yes	Yes			Yes	Yes
Geography Controls		Yes		Yes		Yes		Yes
Resources Controls		Yes		Yes		Yes		Yes
Log (potential value 1950s)		Yes		Yes		Yes		Yes
	539	539	539	539	539	539	539	539
	0.014	0.185	0.028	0.162	0.006	0.156	0.006	0.054

The table reports OLS estimates of the relationship between colonial price gaps and the share of pixels within each district with zero luminosity (columns 9-12), luminosity below the top percentile (columns 5-8), and above the top percentile (columns 1-4). Geography controls include percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index; resources controls include livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy. In the specifications with fixed effects, the R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

Price gaps are negatively related to the size of urban areas. In the bottom panel of the table, I check whether they are also related to the size of rural areas (channel 2). In column (5) to (8) I regress the share of lit pixels below the top percentile, measuring the size of inhabited rural areas, on price gaps. The coefficient is positive in all specifications and almost always non-significant.[9] Price gaps have no effect on the size of rural areas. In column (9) to (12), I check this by regressing the share of unlit pixel on price gaps. In all specifications, the coefficient is not significant: there is no effect of price gaps on the size of inhabited areas. Colonial extraction is negatively correlated with the number and size of cities, but it is uncorrelated with the extent of rural settlements.

In table 4.5, I explore whether price gaps are related to the level of development in urban and rural areas (channels 3 and 4), by using as dependent variable the (log) average luminosity above the top percentile (urban development) and below the top percentile, excluding unlit pixels (rural development). Columns (1) to (4) report the relationship between price gaps and urban development. Surprisingly, the coefficient of price gaps is now positive and significant in all specifications, with or without controls and with or without fixed effects. Price gaps are positively related with urban development, as proxied by average luminosity in urban areas. In columns (5) to (8) I look at the relationship between price gaps and rural development. Price gaps are negatively associated with average luminosity in rural areas, as expected from the main result from section 4.3.

[9]The coefficient of column (7) is positive and significant because larger price gaps are associated with lower urbanization, which is in turn associated with smaller rural areas.

TABLE 4.5
Rural Underdevelopment or Lower Urbanization: Intensive Margin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log (light, top percentile)				log (light, below top percentile)			
Log (price gap)	1.222***	0.542**	1.820***	1.809***	-0.298**	-0.223**	-0.672**	-0.367
	(0.299)	(0.194)	(0.555)	(0.409)	(0.133)	(0.0859)	(0.279)	(0.216)
Country Fixed Effects			Yes	Yes			Yes	Yes
Geography Controls		Yes		Yes		Yes		Yes
Resources Controls		Yes		Yes		Yes		Yes
Log (potential value 1950s)		Yes		Yes		Yes		Yes
N	505	505	505	505	539	539	539	539
R^2	0.121	0.349	0.074	0.202	0.096	0.346	0.128	0.276

The table reports OLS estimates of the relationship between colonial price gaps and the average luminosity within each district, computed among pixels above (columns 1-4) and below the top percentile (columns 5-8). Geography controls include percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index; resources controls include livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy. In the specifications with fixed effects, the R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

The data are consistent with channels 1 and 4, but not consistent with channels 2 and 3. Price gaps are associated with less developed rural areas, but have no effect on their size. In addition, districts with larger price gaps in the colonial period have now fewer, but more developed cities.[10]

Given the negative effect on size and the positivity effect on urban development, one might wonder what the net effect is on urban areas. According to the estimates from the cross-sectional specifications with the full set of controls, a one percent increase in price gaps is correlated with a 2 percentage points decrease in the number/size of cities, and a 0.5% increase in urban luminosity. We can compute the marginal net effect on cities development (total urban luminosity) as $1.005l_u(u - 0.02) - ul_u$, where u is the original share of urban pixels and l_u is the original average urban luminosity. Since $u \leq 1$, simple algebra shows that the net effect is negative. Colonial price gaps negatively affect development both in rural and urban areas.

Despite the negative overall effect, price gaps are still positively related with luminosity in the top percentile. Colonial extraction is bad for rural areas, but good for small urban segments of the population. This results is consistent with Bates (1981, 1983) analysis of agricultural price policies in the post-colonial period.

After independence post-colonial governments tended to maintain similar trade monopsonies to those established by the colonizers. The most famous example is the persistence of marketing boards (*caisses de stabilisation* in French Africa). Farmers, instead of directly selling their production in the world markets, had to sell it at a fixed price to a government institution, the marketing board, which had monopsony power. Originally created to insure farmers against fluctuations of crop prices (paying

[10]In table 4.4 and 4.5 in the appendix, I replicate the analysis with a different threshold to identify cities: the top fifth percentile. The results are similar regarding the size of rural and urban areas (table 4.4) and regarding rural development (table 4.5, columns 5–8) However, the relationship between price gaps and urban development is now non-significant (table 4.5, columns 1–4). This gives us confidence that top percentile is actually the correct threshold to identify cities, while the top fifth percentile includes both urban and rural areas, with confounding effects.

them prices lower than world market when the price was high and higher than world market when the price was low), they soon became a way to extract income from rural areas. Who benefited from this institution were the urban elites, who gained from both lower agricultural prices and from income transfers from rural to urban areas. Since post-colonial governments had most of their political supports in cities, these discriminatory policies against farmers tended to persist.

Colonial policies reducing prices to agricultural producers are negatively correlated with subsequent economic growth. In particular, they are related with a decrease in the number/size of cities and a decrease in development in rural areas. Nevertheless, they are correlated with higher development in urban areas, increasing the inequality between cities and countryside.

4.5 Conclusion

Colonial trade monopsonies and coercive labor institutions allowed the colonizers to reduce prices to African agricultural producers far below world market prices, cutting African gains from trade by over 60% (Tadei, 2013). In this chapter, I looked at the long-term effects of these institutions.

I showed that the extent of price reduction is negatively correlated with current regional development, as proxied by luminosity data from satellite images. Even if a correlation does not necessarily imply a causal relationship, the results are robust to a rich set of controls, including geographic characteristics, natural resources, population density, urbanization, and pre-existing differences in the level of economic development. Moreover, the correlation holds both across and within countries. Finally, the negative relationship between price reduction and development is not only statistically significant, but also economically meaningful: for a median district, a standard deviation increase in the price reduction is associated with a 10 to 30%

decrease in luminosity. Prices to producers can be used as a measure of African economic performance over the long run.

By looking at luminosity in urban and rural areas, I suggest that colonial extraction affected subsequent growth by reducing both urbanization and development in rural areas. Surprisingly, at the same time colonial extraction benefited urban segments of society, by increasing economic growth in cities. Despite this, the overall impact on development is negative and the different effects in rural and urban areas can actually be the reason why trade monopsonies and extractive institutions persisted long after independence.

4.6 Appendix

4.6.1 Definitions and Sources

Built. Within district pixel-average of percentage of total land that is covered by buildings, from FAO (2013b).

Cultivated. Within district pixel-average of percentage of total land that is covered by cultivations, from FAO (2013b).

Forest. Within district pixel-average of percentage of total land that is covered by forest, from FAO (2013b).

Desert. Within district pixel-average of percentage of total land that is covered by desert, from FAO (2013b).

Elevation. Within district pixel-average of elevation in meters, from FAO (2013b).

Light. Luminosity at night. Data come from the Earth Observation Group of the NOAA National Geophysical Data Center (2013) which reports the intensity of light radiation at a 15 arc-sec resolution (about 500 square meters) for the entire globe.

Livestock. Within district pixel-average of a 1 to 8 categorical variable measuring the presence of livestock. Data come from FAO (2013b).

Malaria. Data come from GIS spatial distribution of Plasmodium falciparum malaria endemicity map in 2010 in AFRO, from Gething (2011) (*http* : *//www.map.ox.ac.uk*).

Distance to port. Linear distance in km of the centroid of each administrative district to the closest port, computed with GIS.

Oil. Dummy variable which assumes value of one if oil is present in the district (www.prio.no).

Potential value in 1950s. For each pixel and crop, I estimate the potential value as the product of the price in France net of trading costs times the productivity per hectare times the cultivated land area. Then, I compute the value per pixel by weighting each crop by its value and I average within districts.

Pre-colonial state centralization. Average of index of pre-colonial centralization for all ethnic groups falling in each district. The measure of ethnic state centralization comes from the Ethnographic Atlas by Murdock (1967), which reports categorical values from 0 to 4 according to the level of complexity of political organization, from tribal level to state level.

Price gaps. Reduction of price to African producers relative to world market prices net of trading costs, defined in equation (4.1). Data on prices in Africa and in France for each crop in 1950s come from colonial custom statistics. See Tadei (2013) for detailed information about the sources. Shipping and fixed costs come from Tadei (2013) and inland transport costs are computed by using colonial maps and reports, according to the procedure described in the text. The current location of ports, rivers, and railroads comes from GIS maps available at http://www.naturalearthdata.com/. For crop suitability maps, I use the agro-climatically attainable yield for low input level rain-fed (crop) for baseline period 1961–1990 from FAO (2013b). The shapefiles for current administrative units come from the GADM database of Global Administrative Areas and MapMaker.co.uk (for Burkina Faso). I eliminated from the map the district that were included in the British Cameroon.

Population density. Within district pixel-average of a 1 to 5 categorical variable measuring population density. Data come from FAO (2013b).

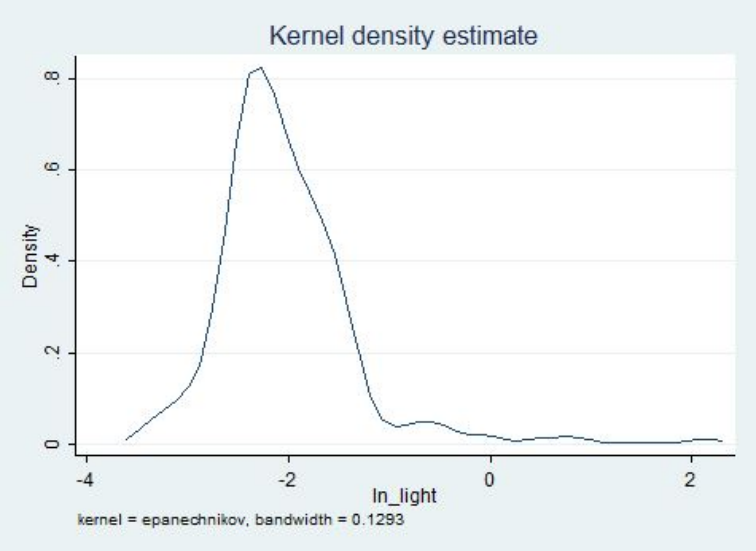
Value today. Within district pixel-average of total value of agricultural production in thousands dollars, from FAO (2013b).

Water. Within district pixel-average of percentage of total land that is covered by water bodies, from FAO (2013b).

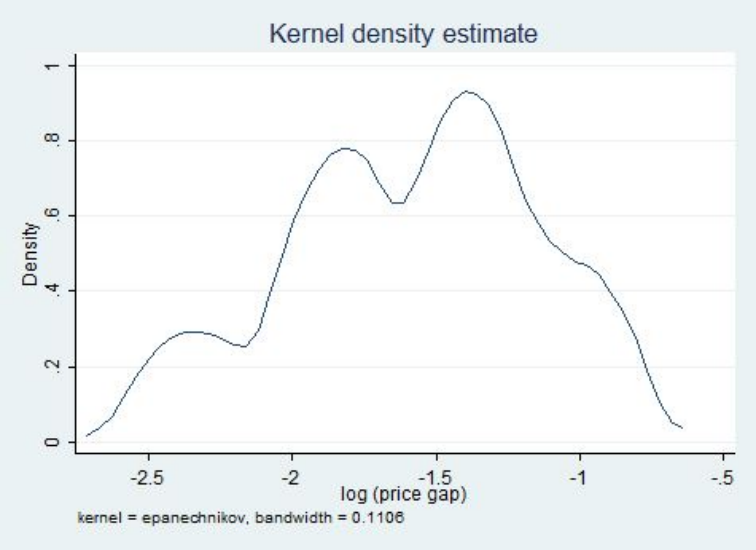
4.6.2 Appendix Figures and Tables

FIGURE 4.6
Colonial Price Gaps and Current Luminosity (Country Averages)

The figure reports the scatterplot and the linear fitting for the regression of the country averages of log (light) and log (price gap).



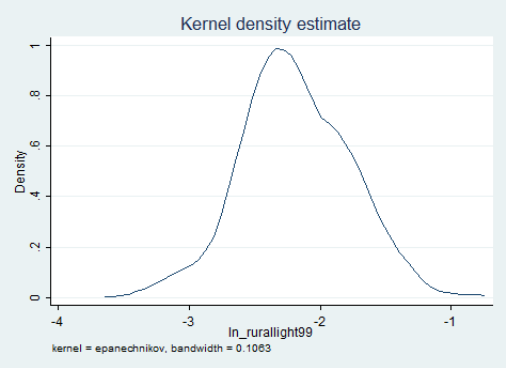
(a) Log(Light)



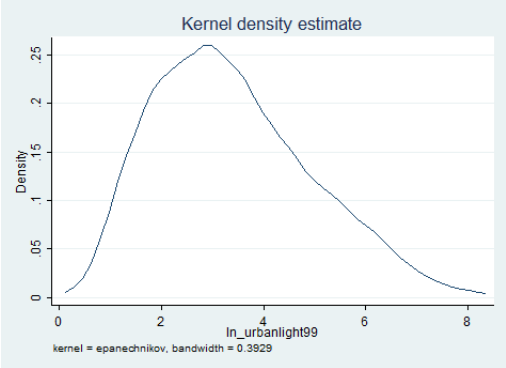
(b) Log(Price Gap)

FIGURE 4.7
Kernel Densities

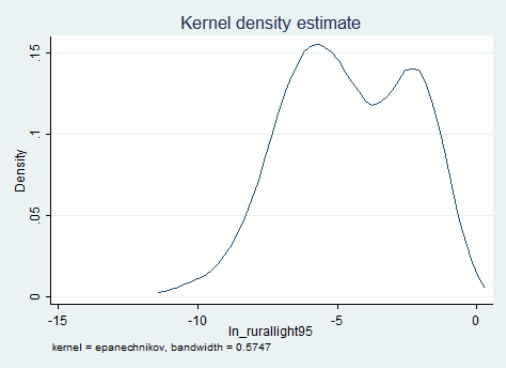
The top and bottom panel reports the kernel density of log (light) and log (price gap), respectively.



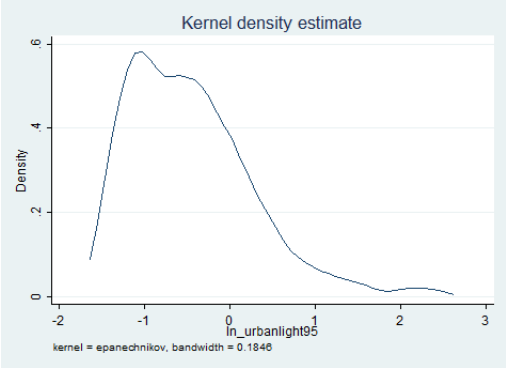
(a) Log(Light), Below Top Percentile



(b) Log(Light), Above Top Percentile



(c) Log(Light), Below Top Fifth Percentile



(d) Log(Light), Above Top Fifth Percentile

FIGURE 4.8
Kernel Densities, Above and Below Top and Fifth Top Percentiles

Panel A and B report the kernel density of the log of average luminosity excluding pixels above and below the top percentile, respectively. Panel D and C report the kernel densities excluding pixels above and below the top fifth percentile, respectively.

TABLE 4.6
Summary Statistics

Variable	N	mean	sd	p25	p50	p75	min	max
price gap	539	0.225	0.093	0.151	0.215	0.275	0.074	0.473
log (price gap)	539	-1.582	0.433	-1.890	-1.537	-1.291	-2.604	-0.749
potential value 1950s	539	616.947	670.223	112.205	418.430	844.163	0.088	3388.870
log (potential value 1950s)	539	5.589	1.675	4.720	6.037	6.738	-2.430	8.128
pre-colonial state centralization	478	1.047	0.792	0.500	1.000	1.500	0.000	3.000
Luminosity								
light	539	0.218	0.654	0.088	0.117	0.174	0.031	8.882
log (light)	539	-2.031	0.701	-2.430	-2.146	-1.749	-3.474	2.184
% unlit	539	0.023	0.062	0.000	0.002	0.017	0.000	0.651
% rural	539	0.948	0.115	0.954	0.984	0.995	0.001	1.000
% urban	539	0.029	0.099	0.001	0.004	0.016	0.000	0.999
urban light	505	110.506	282.524	9.794	23.245	76.090	1.678	2894.370
rural light	539	0.122	0.054	0.085	0.108	0.150	0.029	0.429
ln (urban light)	505	3.390	1.516	2.282	3.146	4.332	0.518	7.971
ln (rural light)	539	-2.190	0.416	-2.465	-2.226	-1.897	-3.540	-0.846
Geography Controls								
forest	539	29.200	26.358	5.122	25.303	40.528	0.000	88.874
water	539	0.681	1.888	0.000	0.000	0.259	0.000	16.478
desert	539	1.529	6.787	0.000	0.000	0.000	0.000	63.350
elevation	539	350.970	220.424	220.971	327.237	462.451	0.000	1312.000
cultivated	539	17.972	16.195	2.915	14.803	29.196	0.017	74.712
malaria	539	0.458	0.145	0.378	0.478	0.556	0.016	0.726
Resources Controls								
livestock	539	3.131	1.476	1.810	3.294	4.357	0.246	7.591
oil	539	0.069	0.253	0.000	0.000	0.000	0.000	1.000
distance to port	539	5.157	3.683	2.082	4.415	7.848	0.059	16.863
value today	539	343.784	334.997	52.406	255.449	557.644	0.013	1539.752
log (value today)	539	4.971	1.761	3.959	5.543	6.324	-4.343	7.339
population density	539	3.412	.919	3 .000	4.000	4.000	1.000	5.000

Please see the Data Appendix for detailed definitions and sources.

TABLE 4.7
Prices Are Measured at Exit Ports

	(1) Price Africa
Price France	0.747***
	(0.00617)
Landlocked Colony	-0.0171
	(0.0113)
N	39
R^2	0.951

The table reports OLS estimates of the relationship between price in Africa, price in Africa, and whether the country has a port (landlocked colony dummy). Please see the Data Appendix for detailed definitions and sources. Robust standard errors clustered at the commodity level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

TABLE 4.8
Rural Underdevelopment or Lower Urbanization: Extensive Margin (Top Fifth Percentile)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	% below top fifth percentile				% top fifth percentile			
Log (price gap)	0.118**	0.0772***	0.278***	0.140*	-0.129***	-0.0860***	-0.301***	-0.173**
	(0.0509)	(0.0252)	(0.0665)	(0.0681)	(0.0417)	(0.0211)	(0.0661)	(0.0642)
Country Fixed Effects			Yes	Yes			Yes	Yes
Geography Controls		Yes		Yes		Yes		Yes
Resources Controls		Yes		Yes		Yes		Yes
Log (potential value 1950s)		Yes		Yes		Yes		Yes
N	539	539	539	539	539	539	539	539
R^2	0.077	0.347	0.094	0.235	0.104	0.315	0.115	0.249

The table reports OLS estimates of the relationship between colonial price gaps and the share of pixels within each district with zero luminosity (columns 1-4), luminosity below the top fifth percentile (columns 5-8), and above the top fifth percentile (columns 9-12). Geography controls include percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index; resources controls include livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy. In the specifications with fixed effects, the R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

TABLE 4.9
Rural Underdevelopment or Lower Urbanization: Intensive Margin (Top Fifth Percentile)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log (light, top fifth percentile)				log (light, below top fifth percentile)			
Log (price gap)	0.0359	0.116	-0.0371	-0.109	-1.685**	-1.271***	-2.962**	-1.453*
	(0.179)	(0.112)	(0.228)	(0.206)	(0.649)	(0.382)	(1.011)	(0.774)
Country Fixed Effects			Yes	Yes			Yes	Yes
Geography Controls		Yes		Yes		Yes		Yes
Resources Controls		Yes		Yes		Yes		Yes
Log (potential value 1950s)		Yes		Yes		Yes		Yes
N	535	535	535	535	530	530	530	530
R^2	0.000	0.217	0.000	0.075	0.106	0.421	0.102	0.234

The table reports OLS estimates of the relationship between colonial price gaps and the average luminosity within each district, computed among pixels above (columns 1-4) and below the top fifth percentile (columns 5-8). Geography controls include percentage of land covered by forest, desert, and water, percentage of cultivated land, average elevation, and malaria suitability index; resources controls include livestock, log value of current agricultural production, population density, linear distance to the closest port, and oil dummy. In the specifications with fixed effects, the R^2 measures the explained variance *within* countries. Robust standard errors clustered at the country level are reported in parenthesis. *** p<10%, **p<5%, *p<10%.

Chapter 5

Conclusion

In the recent years, a growing body of studies about current African underdevelopment has emphasized the role of extractive institutions established by the colonizers. However, much more limited efforts have been undertaken to understand the details of colonial extraction, why extractive institutions were adopted, and how they evolved over time. In this work, I attempted to "decompress history" more than what has been done so far in the literature, opening the "black box" of extractive institutions, analyzing their role during the colonial period, and quantifying colonial extraction.

In doing so, I focused on the relatively under-studied French colonies. I demonstrated that the colonizers were extremely successful in extracting income from Africans and that they were able to do so by reducing the prices to agricultural producers through a combination of trading monopsonies and coercive labor institutions.

Such extractive institutions, however, were not adopted everywhere and the level of extraction varied greatly across colonies. To explain this finding, I showed that the choice of institutions was affected more by the kind of commodities that were produced than by the local conditions of the colonies.

This variation in extraction, together with the persistence of colonial institutions after independence, can explain the different paths of growth in African countries and

regions. My analysis suggests that colonial extraction affected subsequent growth in particular by reducing development in rural areas to the benefit of a urban elite, increasing in this way the rural-urban development gap. The different impact on rural and urban areas can be the reason why colonial extractive institutions persisted long after independence.

These results call for future research. First, it would be interesting to explore the post-colonial governments' incentives to maintain such institutions, despite their negative effect on economic growth. Are these incentives affected by local factors, such as the type of political support (urban or rural based) that independent government received? Or are they shaped by international factors, such as trade relationships between Africa and the rest of the world? What was then the impact of the trade liberalizations in the 1980s and 1990s?

Another promising line of research is a comparison with the British colonies. Since the extent of monopsonies was more limited than in the French colonies, British Africa stands as a natural counterfactual to study the effects of colonial institutions. To understand the differences between French and British policies towards African farmers, it would be particularly interesting to analyze prices to producers in colonies that were partitioned into a British and a French part after WWI, such as Togo or Cameroon. Finally, the higher population density of the British colonies allowed the colonizer to implement different coercive institutions, such as land alienation, in order to acquire the African labor force. Comparing British and French colonies would provide the opportunity to disassociate the effects of land coercion and labor coercion.

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