Why Is African Urbanization Different? Evidence from Resource Exports in Ghana and Ivory Coast

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JOB MARKET PAPER

Abstract

Africa has recently experienced dramatic urban growth. I argue that standard theories of structural transformation cannot account for this result, as it was not driven by a green revolution or an industrial revolution but by natural resource exports. I develop a new structural transformation model in which the Engel curve implies that resource windfalls are disproportionately spent on urban goods and services. This drives urbanization through the rise of "consumption cities". I then show that cocoa booms have led to increased urbanization in Ghana and Ivory Coast using decadal district panel data covering more than one hundred years. As an identification strategy, I use the fact that the location of cocoa production has shifted over time for exogenous reasons: (i) for agronomic reasons, farmers deforest a new area every 25 years, and (ii) for historical reasons, the cocoa frontier has started in the South-East and shifted westward in each country. I find that cities boom in newly producing districts and persist in old ones. I document how these cities arise as a result of rural-urban consumption linkages. I discuss how this type of agglomeration can then impact economic growth.

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"I had a marvelous dream... Close to a castle, I have seen a man all dressed in white who told me: several years ago, this region was covered with forests. It was only missing hands to work. Compassionately, some men have come. [...] The forest has been gradually disappearing in front of laborers, tractors have replaced the daba [hoe] and beautiful cities, beautiful villages, beautiful roads have replaced the tracks only practicable during the dry season."

Presidential Address of Houphouët-Boigny, President of Ivory Coast, 25 March 1974.

1 Introduction

At the turn of the 20th century, Sub-Saharan Africa was a region without cities. Its urbanization rate was less than 5%, the same level as in Medieval Europe (Bairoch, 1988). It was 10% in 1950, as low as in Renaissance Europe. It is now around 40%, as high as contemporary Asia, or developed countries after the Industrial Revolution.[1] Urbanization in Europe and Asia is usually seen as a consequence of economic development; as a country develops, people move out of the rural-based agricultural sector into the urban-based manufacturing and service sectors. Yet Africa's urban growth was achieved in a period with only modest economic growth and without widespread industrialization (see Figure 1 which contrasts urbanization and income for Africa and Asia). So why did Africa urbanize?

Standard structural transformation models distinguish "labor push" and "labor pull" factors as the main drivers of the rural-urban transition (Alvarez-Cuadrado and Poschke, 2011). The labor push approach shows how a rise in agricultural productivity - a *green revolution* - reduces the "food problem" and releases labor for the modern sector (Schultz, 1953; Gollin, Parente and Rogerson, 2002, 2007; Michaels, Rauch and Redding, 2008). The labor pull approach describes how a rise in non-agricultural productivity - an *industrial revolution* - attracts underemployed labor from agriculture into the modern sector (Lewis, 1954; Harris and Todaro,

[1] I alternatively use the expressions "Sub-Saharan Africa" and "Africa" in the rest of the paper to refer to 41 countries south of the Sahara for which I have relevant data. "Asia" includes Eastern Asia, South-Eastern Asia and South Asia (22 countries). Africa's urbanization rate was 37% in 2010, while it was 40% for Asia (United Nations, 2009). It was 45% in England in 1850 and 42% in the U.S. in 1910 (Bairoch, 1988). I also use data on cities larger than 750,000 to find that they make up 39% of urban population in Africa and 44% in Asia (United Nations, 2009).

1970; Hansen and Prescott, 2002; Lucas, 2004).[2] Alternatively, a country with a comparative advantage in manufacturing or tradable services can open up to trade and use imports to solve its food problem (Matsuyama, 1992; Teigner, 2011; Yi and Zhang, 2011). These mechanisms all lead to greater non-agricultural employment, and thus greater urban employment as a proportion of total workforce.

If these two approaches describe well the historical experience of developed countries in Europe and North America (Bairoch, 1988; Kim and Margo, 2004; Allen, 2009) and successful Asian economies (Young, 2003; Bosworth and Collins, 2008; Brandt, Hsieh and Zhu, 2008), they do not account for African urbanization. First, there has been no green revolution in Africa. Its food yields have remained low (Evenson and Gollin, 2003; Caselli, 2005; Restuccia, Yang and Zhu, 2008); in 2009, cereal yields were 2.8 times lower than in Asia, while yields were 2.1 times lower for starchy roots. Second, there has been no industrial revolution in Africa. Its manufacturing and service sectors are relatively small and unproductive (McMillan and Rodrik, 2011; Badiane, 2011); in 2007, employment shares in industry and services were 10% and 26% for Africa, but 24% and 35% for Asia, and African labor productivity was 1.7 and 3.5 times lower in industry and services, respectively (World Bank, 2010*a*). Third, while Asian urbanization is associated with manufacturing and services, the most urbanized African countries export natural resources.[3] This is confirmed by Figure 2 which plots the urbanization rate against GDP shares of "manufacturing and services" and "natural resource exports" (fuels, minerals and cash crops) for Asia and Africa in 2000.[4]

The effect of resource exports on urbanization could occur through a number of different channels, which I discuss in the African context. First, the production of natural resources could be concentrated in cities. However, point-source natural resources (e.g., oil and minerals) being capital-intensive, their numerical contribu-

[2]A rise in manufacturing productivity also facilitates the modernization of agriculture through better agricultural intermediate inputs. This industry-led agricultural transformation accelerates the structural transformation (Restuccia, Yang and Zhu, 2008; Yang and Zhu, 2010).

[3]African urban growth has also been attributed to rural poverty (Barrios, Bertinelli and Strobl, 2006; Poelhekke, 2010; de Janvry and Sadoulet, 2010). But the fact that this growth was concentrated in resource rich countries makes natural resources a more important factor.

[4]In 2000, 27 out of 41 Sub-Saharan African countries and 4 out of 22 Asian countries have more than 10% of their GDP coming from natural resource exports. In 1960, there were 31 African countries and 3 Asian countries satisfying this criterion. I obtain an "Asian" pattern for Latin American countries and an "African" pattern for Middle East and North African countries.

tion to urban employment is small.[5] Cash crops being produced in fields, they mostly contribute to rural employment. Second, natural resource exports could have backward and forward production linkages with the urban-based sectors. Nevertheless, mining equipment is often imported and the mode of production of cash crops has remained traditional, with limited use of modern inputs. There is no local transformation of natural resources and transportation activities generated by their export contribute little to urban employment.[6] Third, given differences between the international price and local production costs, the export of natural resources has often generated a considerable surplus for producing countries. If the Engel curve implies that this surplus is mainly spent on urban goods and services, this could account for the relationship between resource exports and urbanization. I thus develop a structural transformation model which captures this third channel. Because greater opportunities in the urban sector attract people to cities, the model is in line with the labor pull hypothesis, except it considers the resource sector, and not the manufacturing sector, as the main driver of this transformation. As wealth is created in the rural sector and spent in the urban sector, these "consumption cities" only arise due to demand factors. Such cities differ from "production cities" where wealth originates from urban-based production activities such as tradable manufacturing. Lastly, government taxation and spending affect the urban composition and spatial distribution, in favor of government services (e.g., civil servants) and government cities (e.g., the capital city).[7]

I provide reduced form evidence consistent with the results of the model by studying the impact of cocoa production booms on urbanization in 20th century Ghana and Ivory Coast (see Figure 1 which displays income and urbanization for

[5]For instance, Angola's urbanization rate was 15% before oil was discovered there, and it is 60% in 2010. Crude oil now accounts for over 50% of GDP, but it employs fewer than 10,000 nationals. Botswana has a similar urbanization rate, but while the diamond sector accounts for 36% of GDP, it provides employment for approximately 13,000 people. In Ghana, mining has historically represented 25% of exports, but the sector employs only 2% of the urban workforce.

[6]Why there is no local transformation of natural resources in Africa (e.g., oil refining or cash crop processing) is beyond the scope of this paper. Transformation is capital-intensive, and weak institutions have probably impeded the necessary modernization of production processes.

[7]Proponents of the urban bias theory argue that urban-biased policies have led to "overurbanization" in poor countries (Lipton, 1977; Bates, 1981). But this still presupposes that resource rich countries urbanize because of the surplus generated by resource exports. Governments amplify this urbanization effect by reallocating a even greater share of the surplus to cities.

both countries). I combine decadal district-level panel data on cocoa production and cities from 1891 to 2000 for Ghana, and 1948 to 1998 for Ivory Coast. As an identification strategy, I use the fact that the location of cocoa production has shifted over time for exogenous reasons. First, only forested areas are suitable for cocoa cultivation, which limits production to the South in each country. Cocoa is produced by "consuming" the forest (Ruf, 1995*a*,*b*); cocoa smallholders go to a patch of virgin forest and replace forest trees with cocoa trees. Second, yields begin to decline 20 years after planting. Cocoa trees become too old and must be replaced. However, the forest initially provides agronomic benefits (e.g., a high level of humidity and abundant rainfall) which are also extinguished after 20 years of local deforestation. Replanted cocoa trees die or are much less productive, which force farmers to move to a new forest a few years later, usually 25 years after cocoa trees were first planted. Third, for historical reasons, the cocoa front started in the East of each country. Production first spread out one century ago in the South-East of Ghana, in the vicinity of Aburi Botanical Gardens from where the British colonizer distributed cocoa seedlings to the local farmers. Production later started in the South-East of Ivory Coast because the local tribes had heard of the wealth of the Ghanaian cocoa farmers and also wanted to adopt the crop. These factors resulted in the cocoa front moving across the South of each country from East to West. As production moved westward, new cities appeared in the West, but cities in the East did not collapse. I can therefore use this framework to causally identify the effect of natural resources on urbanization. While controlling for both district and time fixed effects to capture any time-invariant spatial factor and any secular change over time, I instrument district production with a westward wave that I model using the fact that each potential plantation in each country is used in 25 years. I expect a large effect of the theoretical westward wave on districts that were originally highly suitable, and no effect for other districts, which I use as a placebo test of the identification strategy.

Using instrumental variables estimation, I find that district cash crop production has a strong impact on district urban growth. The estimates are robust to a number of sensitivity checks, such as including controls for other determinants of cash crop production and urban growth (e.g., transportation networks and demographic growth), changing the urbanization measure, or testing alternative specifications and instrumentations. To assess the magnitude of these effects, I calculate that local cash crop production explains 60-75% of local urban growth in both countries. Governments have historically captured around 40-50% of the surplus and reallocated around two thirds of it to government cities, which I define here as the capital and the second largest city. Using my estimates, I obtain that state capture accounts for 30-48% of the growth of these cities. I also use my analysis along with data on natural resource exports for Sub-Saharan Africa to estimate that 71% of its urban growth from 1960 to 2010 can be attributed to the latter.

Given the scarcity of data in both countries, I rely on historical and cross-sectional evidence to document how cocoa production has created consumption cities in both producing districts and districts that have the central government. I argue that these cities have arisen as a result of rural-urban consumption linkages, and that rural-urban production linkages were unlikely in this context. Cocoa has indeed few backward and forward production linkages with the urban-based sectors. Compared to cities in European, American and Asian countries at the same level of urbanization, these cities are relatively more agricultural and have smaller manufacturing and tradable service sectors. Government cities have a larger employment share of civil servants. I also observe that cities persist in old cocoa-producing districts despite the fact that production has been declining over time. These districts are now "urbanized but poor". I then more generally discuss how this type of agglomeration can impact economic growth.

This paper is related to a large body of work on the relationship between urbanization and growth. While the structural transformation literature cited above portrays urbanization as a by-product of economic development, the economic geography literature suggests that agglomeration promotes growth, in both developed countries (Rosenthal and Strange, 2004; Henderson, 2005) and developing countries (Overman and Venables, 2005; Henderson, 2010). Given that urbanization is a form of agglomeration, it has thus been argued that cities could promote growth in developing countries (Duranton, 2008; Venables, 2010; McKinsey, 2011).[8]

[8] For instance, McKinsey (2011) writes (p.3-19): "Africa's long-term growth also will increasingly reflect interrelated social and demographic trends that are creating new engines of domestic growth. Chief among these are urbanization and the rise of the middle-class African consumer. [...] In many African countries, urbanization is boosting productivity (which rises as workers move from agricultural work into urban jobs), demand and investment."

Yet evidence that urbanization drives growth is rather weak in cross-country regression frameworks (Henderson, 2003). Whether urbanization promotes growth is likely to depend on the type of cities. This paper will show that natural resource exports may create consumption cities, with small manufacturing and tradable service sectors. If these "missing" sectors are more likely to exhibit agglomeration effects and provide incentives for skill accumulation, consumption cities could have a relatively lower positive impact on growth than production cities.[9]

This paper also contributes to the Dutch disease and resource curse literatures (Corden and Neary, 1982; Matsuyama, 1992; Sachs and Warner, 2001; Robinson, Torvik and Verdier, 2006; Caselli and Michaels, 2009; Michaels, 2011). Relatively little is known about the effect of cash crop windfalls (Bevan, Collier and Gunning, 1987; Angrist and Kugler, 2008). Many countries are still dependent upon one agricultural commodity. Amongst 125 developing countries in 2000, agricultural exports represent more than 50% of total exports for 20 countries, and more than 20% for 50 of them (FAO, 2010).[10] Contrary to point-source natural resources, a large share of profits go to producing areas, which might develop as a result. Whether such effects hold in the long run is also an important issue. Resource exports have fostered African economic growth till the late 1970s, but the subsequent period was characterized by macroeconomic disequilibria, social unrest and general impoverishment. Growth has now resumed, but it could be due to favorable terms of trade. Michaels (2011) explains that resource rich regions can have higher population densities and better infrastructure, which gives rise to agglomeration economies. I show that old producing areas in Ghana and Ivory Coast are more urbanized and have better infrastructure, but I do not find any long-term effect of cash crop production on per capita income.[11] More generally,

[9]Consumption cities arise as market towns (Von Thunen, 1826; Christaller, 1933; Bleakley and Lin, 2010) or as places offering better consumption amenities (Glaeser, Kolko and Saiz, 2001; Ottaviano and Peri, 2006; Rappaport, 2008; Chen and Rosenthal, 2008). Government cities are also consumption cities because their growth is related to the government consumption of urban goods and services (e.g., civil servants) in specific urban locations (Braudel, 1985; De Long and Shleifer, 1993; Ades and Glaeser, 1995; Davis and Henderson, 2003; Galiani and Kim, 2008).

[10]Many of them are in Africa. Except Ghana and Ivory Coast, one can find tea and coffee in Kenya, Rwanda and Uganda, coffee in Burundi and Ethiopia, tobacco in Malawi, groundnut in Senegal and Gambia, cashew nuts in Guinea-Bissau, or cotton in Benin, Burkina-Faso or Mali.

[11]In line with Dercon and Zeitlin (2009) and Collier and Dercon (2009), this casts doubt on the ability of the agricultural sector to generate long-run growth in Africa. Diao et al. (2007),

I argue that African countries are "urbanized but poor" because resource exports have permitted their urbanization without producing long-term growth.

Finally, my research is related to the literature on the respective roles of geography and history in development. The locational fundamentals theory argues that natural advantages have a long-term impact on economic activity (e.g. Sokoloff and Engerman, 2000; Davis and Weinstein, 2002; Holmes and Lee, 2009; Bleakley and Lin, 2010), while the increasing returns theory posits that there is path dependence in the location of economic activity (e.g. Krugman, 1991; Rosenthal and Strange, 2004; Henderson, 2005; Redding, Sturm and Wolf, 2011). As in Nunn and Qian (2011), areas suitable for agricultural production are more developed today. But I look at cash crops while they consider food crops, for which we expect different mechanisms at play. Here the natural advantage is transitory, not known before the arrival of cocoa cultivation and not existing after exploitation. The fact that old-producing areas are still relatively more urbanized, but not necessarily wealthier, indicates path dependence in population patterns at least.

The paper is organized as follows: The next section presents the background of cocoa production and cities in Ghana and Ivory Coast and introduces the data used in this study. In section 3, I outline a model of structural transformation. Section 4 presents the empirical strategy and results. Section 5 discusses the results. Section 6 concludes.

2 Background and Data

In this section, I discuss some essential features of the Ghanaian and Ivorian economies, and introduce the data I have collected to analyze how cash crop production has contributed to urbanization. The Data Appendix contains more details on how I construct the data.

2.1 New Data on Ghana and Ivory Coast, 1891-2000

To evaluate the impact of cash crop production on urbanization, I construct a new panel data set on 79 Ghanaian districts, which I track almost decadally from 1891

de Janvry and Sadoulet (2010) and Gollin (2010) are more optimistic as regards the potential impact of agriculture on growth and poverty reduction in Africa.

to 2000, and 50 Ivorian districts, which I track decadally from 1948 to 1998.[12]

I first collect data on cocoa production in tons for Ghanaian and Ivorian districts for available years. I use linear interpolation for missing years. Knowing the producer price for each year, I calculate the district value of production in year 2000 U.S. dollars. Since Ivory Coast is a major coffee exporter and since Ivorian cocoa farmers also produce coffee, I proceed similarly for this crop.[13] In the end, I obtain an annual panel data set with the value of cash crop production (cocoa and coffee) from 1891 to 2000 in Ghana and from 1948 to 1998 in Ivory Coast.

I construct a GIS database of cities using census reports and administrative counts. My analysis is limited to those years for which I have urban data, which is approximatively decadal in both countries.[14] Historical studies on urbanization define a city as any locality with more than 5,000 inhabitants (e.g. de Vries, 1984; Bairoch, 1988; Acemoglu, Johnson and Robinson, 2002).[15] Using the same approach, Ghana had 9 cities in 1901 and 324 cities in 2000, while Ivory Coast had 0 cities in 1901 and 376 cities in 1998.[16] Since the production data is at the district level, I use GIS to construct district urban population for the above-mentioned years.[17] I also add district total and rural populations to the Ivorian panel. This is not possible for Ghana, as the "cocoa districts" for which I have production data differ from the administrative districts for which population data is available.

I complement the panel data set with various statistics at the country, regional

[12]The number of Ghanaian districts has been decreasing over time, while the number of Ivorian districts has been increasing over time. I use various sources and GIS to reconstruct the data set using the same boundaries for the whole period; 1960 cocoa district boundaries for Ghana and 1998 administrative district boundaries for Ivory Coast.

[13]I alternatively use the expressions "cocoa production" and "cash crop production" in the rest of the paper, although both expressions always include coffee for Ivory Coast. As discussed later, Ivorian coffee production shares the same agronomic features as cocoa and has shifted westward.

[14]These years are 1891, 1901, 1911, 1921, 1931, 1948, 1960, 1970, 1984 and 2000 in Ghana, and 1901, 1911, 1921, 1931, 1948, 1955, 1965, 1975, 1988 and 1998 in Ivory Coast.

[15]Bairoch (1988, p.217-219) discusses why the 5,000 population threshold is optimal: "In the instances where use is made of the criterion of size (that is, in most censuses), the limit of 5,000 most nearly approximates the average of the various limits employed." For 91 countries that use a size criterion in 2010, I find that the average threshold is 4,156 inhabitants (United Nations, 2009). Only 11 countries adopt a size criterion of 10,000 and 3 countries a size criterion of 20,000. Later in the paper, I will use different population thresholds as a robustness check.

[16]Using Google Earth, I verify that each city can be clearly identified as such for the most recent census year. I also aggregate localities that actually belong to a same agglomeration.

[17]Cash crop production only booms from the 1960s in Ivory Coast. I use urban data before 1948 to understand urban patterns before the boom.

and district levels, such as economic geography (e.g., transportation networks and Euclidean distance to the coast), physical geography (e.g., soil suitability for cocoa cultivation, rainfall and altitude), employment composition, migration and income. This data was obtained from GIS data sets, household surveys, census microdata and reports, country-level databases and agronomic studies.

2.2 Agronomic Background on Cocoa

Cocoa is produced by consuming tropical forests (Ruf, 1995*a*,*b*; Petithughenin, 1995). Cocoa smallholders go to a patch of virgin forest and replace forest trees with cocoa trees.[18] Pod production starts 5 years after planting and peaks after 20 years. Pods give beans that are dried and sent unprocessed to a port for export.

The forest initially provides agronomic benefits in growing cocoa (Ruf, 1995*b*, p.7): "weed control, soil fertility, protection against erosion, moisture retention for soil and plants, protection against disease and pests, protection against drying winds, [...] stabilizing effect on precipitation."[19] After 20 years, cocoa trees become too old and need to be replaced or the farmer will face a continuous decline in yields. However, the agronomic benefits of the forest are also extinguished after 20 years of local deforestation, and replanted cocoa trees die or are much less productive (Petithughenin, 1995, p.96-97). Establishing a new cocoa farm in a cleared primary forest requires 86 days of manual labor, against 168 days for manual replanting (Ruf, 1995*b*, p.9). Also, it is twice as expensive to opt for a replanting strategy as intermediate inputs (fertilizers, pesticides) are needed to compensate for tree mortality and low yields (Ruf, 1995*a*, p.240). As a result, farmers look for a decline in pod production over the course of a few years - which normally occurs 25 years after planting - as a sign to move to a new patch of virgin forest and initiate a new production cycle. These agronomic patterns at the plantation level, and the abundance of forested land for most of the 20th century, explain why African cocoa farmers have always preferred an extensive production strategy.

The aggregation of household migration patterns gives rise to regional cocoa booms that last several decades (Ruf, 1995*a*, p.190-203). Regional production at

[18] The involvement of multinationals in cash crop production in Africa is very recent.

[19] (Ruf, 1995*b*, p.95-100) describes how rainfall has diminished and become more erratic in old producing areas due to deforestation.

a given point in time is equal to cocoa land area times cocoa yields. Cocoa land area depends on the regional forest endowment and the number of farmers, while yields reflect soil nutrients and the age distribution of trees. Booming regions experience massive in-migration of cocoa farmers. In the words of Ruf (1995*b*, p.15), "It seems that all it takes is for people to see money from the first sale of a crop in the hands of the first migrant planters before a cocoa migration and boom is triggered". This is for several reasons. First, land is cheap to buy.[20] Second, farmers do not need much capital to start their own plantation (Ruf, 1995*b*, p.22); they only use land, axes, machetes, hoes, cocoa beans and labor to produce cocoa. Third, cocoa farmers can easily intercrop cocoa with food crops such as cassava, taro and yam. Lastly, yields are high in the early years of production.

A few decades later, trees are old, yields have decreased and regional production declines, although production decreases can be slowed or even reversed if formerly protected forests in the region are opened to cultivation. Cocoa cultivation becomes less profitable and farmers must accept an income loss. Ruf (1991, p.87) writes: "Planting cocoa gives social status, reflecting the ownership of capital yielding a huge profit. It's the golden age [...]. Then comes the phase of ageing cocoa trees: owning an old farm, attacked by insects, bearing a less valuable product, does not give any status anymore. Everything happens as if a biological curse [...] was inherent to any golden age, as if a recession should succeed any cocoa boom." After 25 years, young adult males of producing households move to a new forest, participating in a new regional cycle elsewhere, while the old members remain on the old farm which they convert into farmland for food production.[21]

When the forest is exhausted, cocoa moves to another country or continent. Production was dominated by Caribbean and South American countries till the early 20th century, then moved to Africa and is now spreading in Asia (Ruf, 1995*a*,

[20]Ruf (1995*a*, p.252-260) documents how the land price is initially low in unexploited forests. Migrant farmers buy large amounts of land from the chiefs of forest tribes, which causes the price to rise. This land colonization process was encouraged by the government. Ivorian President Houphouët-Boigny liked to say that "land belongs to him who cultivates it."

[21]Ivorian cocoa farmers also produce Robusta coffee. Contrary to Arabica coffee which is grown at higher altitudes, Robusta coffee shares the same agronomic features as cocoa. It is grown in tropical forests and necessitates high levels of rainfall and humidity. Cherry production starts after 5 years and declines after 20 years, as the coffee tree becomes too old. This explains why cocoa and coffee have moved across regions together in Ivory Coast.

p.63-70). Economic and political factors can accelerate or decelerate regional cycles (Ruf, 1995*a*, p.300-359): changes in the international and producer prices, land regulations, migration policy, demographic growth, etc.

2.3 The Cash Crop Revolution in Ghana and Ivory Coast

Ghana and Ivory Coast have been two leaders of the African "cash crop revolution" (Austin, 2008). They are the largest cocoa producers, and cocoa has been the motor of their development (Teal, 2002; Cogneau and Mesplé-Somps, 2002). Figure 3 shows that production boomed after the 1920s in Ghana and the 1960s in Ivory Coast. The cocoa boom was accompanied by a coffee boom in Ivory Coast, as cocoa farmers also produce coffee there.[22] Cocoa and coffee have accounted for 60.2% of exports and 20.6% of GDP in Ivory Coast in 1948-2000, while cocoa has amounted to 56.9% of exports and 12.1% of GDP in Ghana over this period.

The South of each country was covered with tropical forest, while the North is savanna. In the Southern forest, some areas were more suitable for cocoa and coffee cultivation due to richer soil nutrients. Figure 4 shows *highly suitable* and *poorly suitable* districts for cocoa and coffee.[23] Figure 5 displays the total value of cash crop production in 1891-2000 for each Ghanaian district and in 1948-1998 for each Ivorian district. The comparison of Figures 4 and 5 confirms that cash crop production has been concentrated in highly suitable districts.

Cocoa was introduced to Ghana by missionaries in 1859, but production did not develop before 1900 (Hill, 1963; Austin, 2008). Production first spread out in the South-East of Ghana, in the vicinity of Aburi Botanical Gardens which were opened in 1890 (Figure 4 shows the location of Aburi). British Governor W.B. Griffith wrote in 1888 (Hill, 1963, p.174): "It was mainly with the view of teaching the natives to cultivate economic plants in a systematic manner for purposes of export that I have contemplated for some time the establishment of an

[22]Yet coffee production has never exceeded 300,000 tons per year. The cocoa boom was therefore three times more important than the coffee boom.

[23]The cocoa soil type is obtained in GIS from digitized historical soil classification maps. I also verify that these maps are consistent with contemporary maps of the forest. The soil type is not affected by initial deforestation, but the nutrient content of the soil decreases as the forest is exploited. A district is *suitable* if more than 25% of its area consists of cocoa soils, i.e. the tropical forest. A district is *highly suitable* if more than 50% of district area consists of forest ochrosols, the best cocoa soils. A district is *poorly suitable* if it is suitable but not highly suitable.

agricultural and botanical farm and garden where valuable plants could be raised and distributed in large numbers to the people." Cocoa seedlings were imported from São Tomé and distributed to local farmers. Since cocoa cultivation was very profitable, many farmers adopted the crop and production boomed. It peaked in the Eastern province in 1931 (see Figures 6 and 7), before plummeting due to the Cocoa Swollen Shoot Disease and World War II which reduced international demand. A second cycle started in the Ashanti province (see Figures 8, 9 and 10). But low producer prices after 1958, restrictive migratory policies after 1969, and droughts in the early 1980s precipitated the end of this cycle (see Figure 11).[24] High producer prices from 1983 pushed farmers to launch a third cycle in the Western province, the last tropical forest of Ghana (see Figures 12 and 13).

It was not till the 1910s that the French authorities promoted cocoa and coffee in Ivory Coast (Ruf, 1995*a*,*b*). Ivorians were originally reluctant to grow these crops, except in "Indénié" in the East (Centre-East, see Fig. 4) where farmers heard of the wealth of Ghanaian cocoa farmers (Ruf, 1995*b*, p.29). Production did not boom until the 1960s.[25] Cocoa (and coffee) again moved from the East to the West (see Figures 7-13). The production of both crops is now concentrated in the South-West region, the last tropical forest of Ivory Coast.

To conclude, in both countries, cocoa production was confined to the South and started in the South-East, for exogenous reasons. Due to the 25-year agronomic patterns at the plantation level, it moved westward (as it could not do otherwise).[26] As population growth was high and cocoa was profitable, many people specialized in it and participated in the expansion of productive land. Yet, this process has

[24] Ghana (from 1948) and Ivory Coast (from 1960) have fixed the producer price to protect farmers against fluctuating international prices. The *Ghana Cocoa Marketing Board* (COCOBOD) and the Ivorian *Caisse de stabilisation et de soutien des prix des productions agricoles* (CSSPPA) were responsible for organizing the cocoa system. Since the producer price was below the international price, this served as a taxation mechanism of the sector (Bates, 1981).

[25] Three factors explain this Ivorian "lateness". First, cocoa did not reach the Ghanaian border before 1920. Second, the French forced the Ivorians to grow cocoa and coffee through a system of mandatory labour (the *corvée*) and Ivorians only saw them as European crops. Third, production increased in the 1920s but the boom was stopped by the Great Depression and World War II.

[26] Data on regional cocoa yields for post-1948 census years also displays a westward movement in yields. The largest producing region always has the highest yields. For Ghana, this was Ashanti in the 1960s, Brong-Ahafo in the 1970s and Western in the 1990s. For Ivory Coast, this was Centre in the 1960s, Centre-West in the 1970s and early 1980s, and South-West in the late 1980s and 1990s. Data on regional cocoa production per rural capita confirms this analysis.

not been as linear in Ghana as in Ivory Coast, due to natural events and economic and political factors. Both countries have extracted almost the same quantity of cocoa in total: 24 million tons in Ghana versus 22 in Ivory Coast. But Ivory Coast did so in a much shorter time period. As the forest is about to disappear, so will cocoa production, unless farmers switch to intensive production strategies.[27]

2.4 The Urban Revolution in Ghana and Ivory Coast

While neither country was at all urbanized at the turn of the 20th century, their respective urbanization rates (using the 5,000 threshold) were 43.8% and 55.2% in 2000, making them two of the most urbanized African countries. Ghana started its urban transition earlier than Ivory Coast, but both experienced rapid urbanization after 1948. This is all the more impressive considering that the populations of Ghana and Ivory Coast have increased by 9.7 and 15.7 times respectively between 1900 and 2000. Ghana had 324 cities in 2000, while Ivory Coast had 376 in 1998, when 53.4% of urban inhabitants in Ghana and 54.8% Ivory Coast lived in small cities in the population range 5,000-20,000.

Defining as national cities the capital city and the second most important city, I calculate that they explain 45.7% of urban growth in 1901-2000 Ghana and 46.1% in 1948-1998 Ivory Coast.[28] Of the remaining urban growth, 66.3% in Ghana and 80.0% in Ivory Coast was in areas suitable for cocoa. This strong correlation between historical cash crop production and the emergence of cities is documented in Figures 3 and 4. This correlation is also spatio-temporal, as cities have followed the cash crop front (see Figures 6-12). As production moved westward, new cities appeared in the West, but cities in the East did not collapse. Our analysis must thus account for both city formation and city persistence.

[27]The forested surface of Ivory Coast has decreased from 15 million hectares in 1900 to 2.5 million in 2000, while it has decreased from 9 million in 1900 to 1.6 million in 2001 in Ghana.

[28]The capital cities are Accra in Ghana, and Abidjan and Yamoussoukro in Ivory Coast, since Houphouët-Boigny made his village of birth Yamoussoukro the new capital in 1983. The second most important cities are Kumasi in Ghana and Bouaké in Ivory Coast. The growth of these cities is disconnected from the local context and depends on the national context.

3 Model of Natural Resources and Urbanization

In this section I develop a model where resource exports drive urbanization. There are three channels through which this could happen. Resource production could be urban-based. Resource production could have production linkages with the urban-based sectors. Resource production could have consumption linkages with the urban-based sectors. Since the magnitude of the first two channels seems small in the African context, I focus on the third channel: The Engel curve implies that resource windfalls are disproportionately spent on urban goods and services. This leads to greater urban employment as a proportion of the total workforce. The model is in line with the literature that sees structural change as a consequence of income effects (Matsuyama, 1992; Caselli and Coleman II, 2001; Gollin, Parente and Rogerson, 2002, 2007). Non-homothetic preferences and rising incomes mean a reallocation of expenditure shares towards urban goods and services.[29] The model also builds on models of trade and structural change (Corden and Neary, 1982; Matsuyama, 1992; Echevarria, 2008; Galor and Mountford, 2008; Teigner, 2011; Yi and Zhang, 2011). To highlight the role of resource exports in urbanization as clearly as possible, the model assumes a small open economy, one production factor - labor - and four sectors: food, natural resources, urban tradables and urban non-tradables. It delivers four results that guide the empirical analysis.

3.1 Set-Up

3.1.1 Technologies

The economy has four sectors i: food (f), natural resources (r), urban tradables (ut) and urban non-tradables (un). Food and natural resources are tradable. Urban tradables are tradable manufactured goods and services. Urban non-tradables

[29] Other articles using this approach are Echevarria (1997), Laitner (2000), Kongsamut, Rebelo and Xie (2001), Matsuyama (2002), Voigtländer and Voth (2006), Galor and Mountford (2008), Restuccia, Yang and Zhu (2008), Yang and Zhu (2010), Duarte and Restuccia (2010) and Alvarez-Cuadrado and Poschke (2011). Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008) see structural change as a consequence of price effects: assuming a low elasticity of substitution across consumption goods, any relative increase in the productivity of one sector leads to a relative decrease in its employment share. Michaels, Rauch and Redding (2008), Buera and Kaboski (2009) and Yi and Zhang (2011) adopt or compare both approaches.

are non-tradable manufactured goods and services.[30] There is one representative agent endowed with one unit of labor. The production technologies are given by:

$$(1) \qquad Y_i = A_i L_i$$

where Y_i, A_i and L_i are the output, productivity and labor share of sector i.[31] Productivity is exogenous. I assume that food and natural resources are produced in the rural sector.[32] As I assume that the production of manufactured goods and services is located in urban areas, the urbanization rate is $L_{urban} = L_{ut} + L_{un}$.[33]

3.1.2 Preferences

The representative agent has the following non-homothetic preferences:

$$(2) \qquad U(C_f, C_r, C_{ut}, C_{un}) = (C_f - \bar{C_f})^{\alpha_f}(C_r)^{\alpha_r}(C_{ut})^{\alpha_{ut}}(C_{un})^{\alpha_{un}}$$

where C_f, C_r, C_{ut} and C_{un} denote the consumption of food, natural resources, urban tradables and urban non-tradables. Natural resources cannot be used as intermediary goods in other sectors. The sum of consumption weights is equal to one ($\Sigma_i \alpha_i = 1$). $\bar{C_f}$ is a food subsistence requirement. With $\bar{C_f} > 0$, the income elasticity of the demand for food is below one. The representative agent maximizes utility (2) subject to the budget constraint:

$$(3) \qquad w = p_f C_f + p_r C_r + p_{ut} C_{ut} + p_{un} C_{un}$$

where w, p_f, p_r, p_{ut} and p_{un} are the wage rate, and the prices of food, natural resources, urban tradable and urban non-tradables.

[30] This sector addresses the local demand for local manufactured goods, such as wearing apparel, processed food products and beverages, and furniture.

[31] Considering decreasing returns to scale should not change the results of the model.

[32] Mining production being capital-intensive and cash crops being produced by farmers, the numerical contribution of resource production to urban employment is small. Yet in Ghana and Ivory Coast, many wealthy cocoa and non-cocoa farmers settle in town and commute to their land whenever it is needed. I abstract from this issue by assuming their preference for urban living is directly included in their consumption of urban non-tradables.

[33] This assumption is supported by the fact that the primary sector represents 93.9% and 87.0% of rural employment in Ivory Coast (1985-88) and Ghana (1987-88). Conversely, the secondary and tertiary sectors account for 76.9% and 66.8% of urban employment in Ghana and Ivory Coast. The model could be enriched by distinguishing urban and rural versions of each sector.

3.2 A Closed Subsistence Economy

3.2.1 Solving for Equilibrium

I first consider a closed economy. The consumer maximizes utility subject to the budget constraint. This yields the following demands:

(4) $$C_f = \bar{C}_f + \frac{\alpha_f}{p_f}(w - p_f\bar{C}_f) \quad \text{and} \quad C_j = \frac{\alpha_j}{p_j}(w - p_f\bar{C}_f) \ \text{ for } j = \{r, ut, un\}$$

The consumption of i is increasing in the wage rate w and i's utility weight α_i, and decreasing in i's price p_i. The food subsistence requirement $\bar{C}_f$ increases food consumption C_f but decreases the consumption of other goods. Perfect competition for labor implies that:

(5) $$w = p_f A_f = p_r A_r = p_{ut} A_{ut} = p_{un} A_{un}$$

Goods and labor markets clearing conditions are:

(6) $$C_i = Y_i = A_i L_i \quad \text{and} \quad \Sigma_i L_i = 1$$

Combining (4)-(6), we find the following demands and labor shares:

(7) $$C_f = \alpha_f A_f + (1 - \alpha_f)\bar{C}_f \quad \text{and} \quad C_j = \alpha_j A_j - \alpha_j \frac{A_j}{A_f}\bar{C}_f \ \text{ for } j = \{r, ut, un\}$$

(8) $$L_f = \alpha_f + (1 - \alpha_f)\frac{\bar{C}_f}{A_f} \quad \text{and} \quad L_j = \alpha_j - \alpha_j \frac{\bar{C}_f}{A_f} \ \text{ for } j = \{r, ut, un\}$$

The food labor share is always greater than α_f but converges to it as food productivity increases. Conversely, the labor share of other sectors is lower than the consumption weight, but converges to it as the food constraint is relaxed.

3.2.2 A Subsistence Economy

The representative agent lives at the subsistence level if food productivity is low enough. Assuming $A_f = \bar{C}_f$, market clearing in the food sector gives:

(9) $$C_f = Y_f = A_f L_f = \bar{C}_f L_f$$

Consumption C_f is below the subsistence requirement $\bar{C}_f$ (and $U < 0$) unless $L_f = 1$. In other words, when food productivity is sufficiently low, the agent only consumes food and only works in the food sector:

$$(10) \qquad C_f = \bar{C}_f \quad \text{and} \quad C_j = 0 \;\; \text{for}\, j = \{r, ut, un\}$$

$$(11) \qquad L_f = 1 \quad \text{and} \quad L_j = 0 \;\; \text{for}\, j = \{r, ut, un\}$$

This is a simple illustration of the food problem (Gollin, Parente and Rogerson, 2002, 2007): the movement of labor out of the food sector into other sectors is constrained by the need to satisfy food requirements. The urbanization rate $L_{urban} = L_{ut} + L_{un}$ is nil. There cannot be urbanization without a food surplus.

3.3 Natural Resource Exports in a Small Open Economy

3.3.1 Solving for Equilibrium

I now study the pattern of structural transformation considering a *small open economy.* The country takes international prices p_f^*, p_r^* and p_{ut}^* as given. Assuming that the economy has a comparative advantage in natural resources, the autarky relative price of natural resources is lower than the international relative price:[34]

$$(12) \qquad \frac{p_r}{p_f} < \frac{p_r^*}{p_f^*} \quad \text{and} \quad \frac{p_r}{p_{ut}} < \frac{p_r^*}{p_{ut}^*}$$

The comparative advantage in natural resources implies that the country exports natural resources (X_r) and imports its consumption of food (M_f) and urban tradables (M_{ut}). While demands (4) are not modified, the country has two producing sectors and perfect competition for labor means that:[35]

$$(13) \qquad w = p_r^* A_r = p_{un} A_{un}$$

Goods and labor markets clearing conditions are:

$$(14) \qquad X_r + C_r = Y_r = A_r L_r \quad \text{and} \quad C_{un} = Y_{un} = A_{un} L_{un}$$

$$(15) \qquad C_f = M_f \quad \text{and} \quad C_{ut} = M_{ut}$$

$$(16) \qquad \Sigma_i L_i = 1$$

[34] There are a few reasons why the economy could have been closed before. If the country did not know how to produce natural resources ($A_r = 0$) and urban tradables ($A_{ut} = 0$), and given that food productivity was only covering the food requirement ($A_f = \bar{C}_f$), there was no opportunity for trade. Alternatively, one could assume that trade costs were high.

[35] The basic Ricardian trade model implies full specialization. The current model is overly simplistic as it predicts that the food and urban tradable sectors disappear. The model could be enriched by modeling imperfect substitutability between domestic and foreign goods.

The balanced trade assumption stipulates that imports equal exports:

$$(17) \qquad p_r^* X_r = p_f^* M_f + p_{ut}^* M_{ut}$$

Using (4) and (13), we find the following demands:

$$(18) \qquad C_f = \bar{C_f} + \alpha_f \frac{p_r^* A_r - p_f^* \bar{C_f}}{p_f^*} \quad \text{and} \quad C_j = \alpha_j \frac{p_r^* A_r - p_f^* \bar{C_f}}{p_j^*} \quad \text{for } j = \{r, ut, un\}$$

Since $\bar{C_f} = A_f$ and $\frac{p_r}{p_f} < \frac{p_r^*}{p_f^*}$, $p_r^* A_r - p_f^* \bar{C_f} > 0$ and $C_f > \bar{C_f}$. The country gains from trade as it now exploits its comparative advantage in natural resources. Once the food requirement is satisfied, the share of available income $p_r^* A_r - p_f^* \bar{C_f}$ allocated to sector i increases with i's consumption weight α_i and decreases with i's price p_i. Combining (14)-(17) and (18), the labor shares are:

$$(19) \qquad L_s = \alpha_s \left(1 - \frac{p_f^* \bar{C_f}}{p_r^* A_r}\right) \quad \text{and} \quad L_r = (1 - \alpha_s)\left(1 - \frac{p_f^* \bar{C_f}}{p_r^* A_r}\right) + \frac{p_f^* \bar{C_f}}{p_r^* A_r}$$

Resource exports ($p_r^* A_r$) increase the labor share of urban non-tradables, which converges to the consumption weight α_{un}. There are two contradictory effects on the labor share of natural resources. First, the country gets richer thanks to resource exports and increases its consumption of each good. Second, the country also increases its consumption of urban non-tradables, which means a reallocation of workers to the latter sector. The second effect dominates the first and the country urbanizes, but its cities take the form of consumption cities producing urban non-tradables only.[36] By comparison, a country with a comparative advantage in urban tradables is urbanized because it produces both urban tradables and non-tradables and imports its consumption of food and natural resources.[37]

[36] As discussed above, the "no tradable manufacturing" result comes from the assumption that home and foreign tradable manufactured goods are perfectly substitutable. In 2000, 64.1% and 55.1% of manufacturing consumption was coming from imports in Ivory Coast and Ghana respectively . These high shares explain why the labor share of industry has remained small in each country (8.4% and 15.7% respectively). For food, import shares were 33.8% and 12.1%. Imperfect substitutability and larger trade costs for foodstuffs could account for this result.

[37] A comparative advantage in food also generates a surplus and leads to urbanization. Yet the food sector creates a much smaller rent as it is much more competitive than the resource sector.

3.3.2 Government and Urban Bias

How would government taxation and spending affect the result? If τ is the *net* tax rate of the natural resource sector, perfect competition for labor means that:

$$(20) \qquad w = (1-\tau)p_r^* A_r = p_{un} A_{un}$$

The government has the following urban-biased preferences:

$$(21) \qquad U(C_{ut}^g, C_{un}^g) = (C_{ut}^g)^{\alpha_{ut}^g}(C_{un}^g)^{\alpha_{un}^g}, \text{ with } \quad \alpha_{ut}^g + \alpha_{un}^g = 1$$

where C_{ut}^g and C_{un}^g denote the government consumption of urban tradables and non-tradables. I assume that it has a strong preference for the latter (e.g., civil servants, infrastructure, etc.): $\alpha_{un}^g > \alpha_{un}$.[38] It maximizes (21) subject to:

$$(22) \qquad \tau p_r^* A_r L_r = p_{ut} C_{ut}^g + p_{un} C_{un}^g$$

where $\tau p_r^* A_r L_r$ is the rent extracted from the resource sector. The labor share of urban non-tradables increases compared to (19) and consists of urban non-tradables for farmers (L_{un}^f) and urban non-tradables for the government (L_{un}^g):

$$(23)\ L_{un} = L_{un}^f + L_{un}^g = \frac{C_{un}}{A_{un}} + \frac{C_{un}^g}{A_{un}} = \frac{\alpha_{un}(1-\frac{p_f^*\bar{C}_f}{p_r^* A_r}) + \tau(\alpha_{un}^g - \alpha_{un})}{1+\tau(\alpha_{un}^g - 1)} > \alpha_{un}(1-\frac{p_f^*\bar{C}_f}{p_r^* A_r})$$

Since $\frac{\delta L_{un}}{\delta \tau} > 0$, the labor share of urban non-tradables increases with the tax rate. If τ is freely fixed by the government, it will chose the highest τ that guarantees that the farmer remains in the resource sector. For $\tau = 1 - \frac{p_f^*\bar{C}_f}{p_r^* A_r}$, the farmer is indifferent between being in the food or resource sectors. Assuming the farmer then arbitrates in favor of the latter, the labor share of urban non-tradables is:

$$(24) \qquad L_s = \frac{1}{1+\frac{1}{\alpha_{un}^g(\frac{p_r^* A_r}{p_f^* \bar{C}_f} - 1)}}$$

The labor share of urban non-tradables and urbanization increase with the urban bias α_{un}^g and resource exports $p_r^* A_r$. What happens if there are two regions - *production* and *government* - and the government concentrates a share ϕ of its

[38] The government does not consume food or resources. Manufactured goods could be consumption goods for government officials or equipment goods for prestige projects ("white elephants").

urban non-tradables L^g_{un} in its own region? Defining urban primacy as the share of the government city in the urban population ($\phi \frac{L^g_{un}}{L_{un}}$), this increases with state capture (τ and ϕ).[39] In the extreme case where $\tau = 1$ and $\phi = 1$, there is one large government city. If there is some taxation and redistribution ($\tau > 0$, $\phi > 0$), urbanization in *production* stems from urban consumption by both farmers and the government. If there is taxation without redistribution ($\tau > 0$, $\phi = 0$), urbanization in *production* is driven by the urban consumption of farmers.[40]

3.4 Four Results

In this section I state explicitly four of the model's results, which structure my empirical analysis on cash crops and urbanization in Ghana and Ivory Coast.

<u>Result 1: There cannot be urbanization without a surplus:</u>
Given the "food problem", low food productivity implies everyone has to work in the food sector to meet the subsistence requirement. Without a green revolution, there cannot be urbanization unless the country can exchange goods for foodstuffs.

<u>Result 2: Natural resources drive urbanization:</u>
The Engel curve implies that the surplus generated by resource exports is mainly spent on urban goods and services. Because new opportunities in the urban sector attract people to cities, the model is in line with the labor pull hypothesis. Contrary to previous models of trade and structural change, it considers that resource exports, and not manufacturing exports, drive this transformation. These models predict that a comparative advantage in agriculture causes deurbanization, as trade leads to deindustrialization. But if the economy is at the subsistence level, the income effect dominates the trade effect and the country urbanizes.[41]

<u>Result 3: Natural resources create consumption cities:</u>
Under the assumption that home and foreign tradable manufactured goods are

[39] The growth of the capital city could also be fostered by its function as a "port of exit" for exported goods and a "port of entry" for imported goods.

[40] The model abstracts from endogenizing τ and ϕ although we could expect natural resources to lead to rent-seeking (i.e., an increase in both τ and ϕ).

[41] In Dutch disease models, resource booms shift labor away from the manufacturing sector into the non-tradable service sector and the net effect on urbanization is ambiguous. Here, resource booms unambiguously increase urbanization as there was no manufacturing sector before.

perfectly substitutable, urbanization happens only through an expansion of the non-tradable manufacturing and service sector. Because wealth is created in the rural sector and spent in the cities, this creates consumption cities. Their sectoral compositions differ from those of production cities where wealth originates from urban-based production activities, such as tradable manufacturing and services.[42]

Result 4: State capture affects the composition and spatial distribution of cities: Government taxation and redistribution augment the effect of natural resources on urbanization if government preferences indicate a strong urban bias. This affects the composition of cities in favor of government non-tradables (e.g., civil servants). It also reinforces the concentration of urban population in government cities. As the growth of these cities is driven by the consumption of urban non-tradables by the government, they are also consumption cities.

4 Method and Results

In the first step of my empirical analysis I estimate the extent to which cash crop production drives urbanization in 1891-2000 Ghana and 1948-1998 Ivory Coast.

4.1 Panel Estimation

Result 1 suggests that both countries were little urbanized before the cash crop boom. The urbanization rate of Ghana was only 3.7% in 1911 and it was 5.7% for Ivory Coast in 1948. I also verify that highly suitable districts were not differently urbanized and populated from other districts in these years.[43] I now investigate

[42]Consumption cities arise because they are surrounded by profitable fields or mines, while production cities are organized around manufacturing plants or tradable services (e.g., call centres, technological parks, etc.). Given that wealth in production cities is also spent on urban non-tradables, production cities are also consumption cities. But consumption cities are not necessarily production cities since they can exist without producing any surplus.

[43]I regress district urban population in 1911 for Ghana and 1948 for Ivory Coast on a dummy equal to one if the district is highly suitable, without and with controls. I do not find any significant difference between the two sets of districts in each country. I also use as an alternative dependent variable district urban growth between 1891 and 1911 in Ghana, and 1921 and 1948 in Ivory Coast. Using population data for Ivory Coast in 1948, I test that highly suitable districts are not different in terms of rural population. I perform the same test for Ghana on a sample of 36 Southern districts in 1901 (as the census was exhaustive only in the South).

Result 2 according to which districts producing cash crops urbanize over time. I run panel data regressions for districts d and years t of the following form:

$$\triangle \text{Urban}_{d,t} = \beta_d + \gamma_t + \delta \, \text{CashCrop}_{d,t} + \theta_t S_d + \mu_{d,t} \quad (20)$$

where β_d and γ_t are district and year fixed effects, and my dependent variable $\triangle \text{Urban}_{d,t}$ is the annual number of new urban inhabitants of district d between each pair of years. My variable of interest $\text{CashCrop}_{d,t}$ is the annual value of cash crop production (in million dollars) during the same period.[44] $\mu_{d,t}$ are individual disturbances clustered at the regional level (N = 10) to account for spatial autocorrelation.[45] I have 50 districts and 6 time periods in Ivory Coast, hence 300 observations. I have 79 districts and 10 time periods in Ghana, hence 790 observations. Since I look at the number of new urban inhabitants, I drop one round and obtain 250 and 711 observations respectively.

S_d is the set of baseline controls I interact with a time trend to account for potentially contaminating factors. The basic regression includes a district dummy for containing a national city and district area. National cities (Abidjan, Bouaké and Yamoussoukro in Ivory Coast, Accra and Kumasi in Ghana) may grow for reasons unrelated to local production. Other controls are: (i) political economy: a dummy for containing a regional capital is included for the same reason as for national cities;[46] (ii) economic geography: dummies for having an international port, and for being connected to the railway network or the paved road network, all measured at independence (1958 in Ghana, 1960 in Ivory Coast), and Euclidean distance to the coast and Euclidean distance to the largest city, as these factors could drive both production and urban growth; (iii) physical geography and demography: a dummy for being a coastal district, 1900-1945 average annual precipitation, mean altitude, and initial population (for 1931 in Ghana, 1948 in Ivory Coast), to control for pre-existing settlement patterns.[47]

[44] As there are many zero observations for district urbanization, I cannot use logarithms or growth rates. This differs from cross-country regressions where urbanization is always non-zero.

[45] The cluster covariance matrix approach is to cluster observations so that group-level averages are independent. Clustering observations using few groups (e.g., regions) can thus ensure spatial independence (Bester, Conley and Hansen, 2011).

[46] Regional capitals at independence were also regional capitals during colonization. I thus capture any effect that would stem from the colonial urban organization.

[47] The first year for which I have district population for the whole territory is 1931. I have

My identification strategy exploits the fact that cocoa cultivation was confined to the (forested) South and had to move westward in both countries, for agronomic and historical reasons. I instrument production by a measure of the distance to the predicted cocoa frontier, using the 25-year agronomic patterns at the plantation level. First, using the GIS map of suitable areas, I find that Ghana and Ivory Coast had endowments of 896,919 and 1,462,578 plantations of 10 ha in 1900.[48] Second, I use the agronomic literature to posit that each producing household owns 10 ha and uses it in 25 years (Ruf 1995*a*, p.281-283). Third, knowing the national number of producing households for each census year and the starting point of production in each country, I reconstruct the predicted cocoa frontier for each year (e.g., the Ivorian predicted cocoa frontier is at longitude -3.34° in 1955, -3.57° in 1965, -4.25° in 1975, -5.36° in 1988 and -6.68° in 1998).[49] I create *Predicted Cocoa Frontier District Dummy*, a dummy equal to one if the longitude of the centroid of district d is less than 1° ($\approx$ 110 km) from the predicted frontier. This is equivalent to including first-order and sometimes second-order contiguous neighboring districts of the frontier. Fourth, I expect a much smaller effect of being on the predicted frontier for non-suitable and poorly suitable districts, and so I instrument cash crop production with the interaction of *Predicted Cocoa Frontier District Dummy* and *Highly Suitable District Dummy* (see Figure 14 for an example in 1984-88). As a placebo test of my instrumentation strategy, I verify that there is no significant positive effect of *Predicted Cocoa Frontier District Dummy.*

4.2 Econometric Concerns

The causality is unlikely to run from cities to cash crops. First, there are few cities in areas that have not boomed yet (see Fig. 6-12). Settlement is limited in tropical forests due to tall trees, thick vegetation, high humidity and disease incidence. Farmers overcome these constraints when they achieve an income high enough to

data for Southern districts only in 1901. I do not make use of this data set here.

[48]Those figures are very close to historical approximations of the forest area in 1900: 9 million hectares in Ghana, 15 million in Ivory Coast.

[49]As argued in section 2.2, each producing household sends selected members to establish a new farm in the West every 25 years. New producing households, which I identify by looking at the difference between the numbers of producing households at times t and t-1, are directly allocated to the cocoa frontier, as land east of the frontier has already been used.

pay the fixed costs of deforestation, which is the case with cash crops. Second, cocoa cultivation does not depend on cities for the provision of capital and inputs, as it only requires forested land, axes, machetes, hoes, cocoa beans and labor, and farmers use small amounts of fertilizers and insecticides. This traditional mode of production is not conducive to a role for cities in the diffusion of technological innovations in this context. Third, the ability of farmers to find labor did not depend on urban proximity. West African labor markets are highly integrated, with many laborers originating from northern regions or other countries.

There could be omitted factors. First, one could argue that logging enables cash crop production and urbanization, yet cocoa farmers deforest land themselves. Furthermore, if logging opens forest tracks, this might influence the location of production *in* a district, but it is unlikely to account for the westward wave (the land colonization of new districts). Also, the export of forest products has only amounted to 10.1% and 16.1% of exports in Ghana and Ivory Coast in 1948-2000. Logging has been dominated by a few parastatal companies, and profits have been repatriated to the capital rather than spent locally. Lastly, even if there were such local channels, this would not alter the message of the paper that resource exports drive urbanization, as forestry exports belong to this category. My coefficients would then capture the effects of cocoa, coffee and forestry.

Second, transport networks could drive both production and urbanization. Again, while roads could influence the location of production *within* districts, it cannot explain the westward wave. Transportation networks have historically followed a south-north orientation, rather than an east-west one. Besides, all the Southern districts were already connected to the primary road network in 1948. Finally, cocoa beans have a high value per ton and are easily storable. That makes cocoa "a product relatively easy to transport, which contributes to explain the remoteness of production from roads. [...] Very often, production precedes in time the infrastructure supposed to facilitate the evacuation of cocoa. [...] Migrants establish their own network of forest tracks. As production expands, farmers widens their tracks, transform them into motor tracks, maintain them. The State later invests to transform those tracks into motor roads." (Ruf, 1995*b*, p.334-335). I nonetheless directly control for infrastructure at independence.[50]

[50]The role of transportation networks was more important one century ago. I argue here that

Third, district demographic growth could foster district rural-urban migration and provide cheap labor for district cocoa cultivation. As argued above, settlement was limited in forested areas and most migrants were coming from other regions. Since we mechanically expect more population growth in areas that were already populated, controlling for pre-existing settlement patterns should limit the influence of this channel. I later use data on district rural population to look at the growth of villages in producing districts. Also, demographic growth at the country level should not mechanically lead to more urbanization (people could found new villages or villages could grow without passing the 5,000 threshold), and does not explain why cities are concentrated in some districts within countries.[51]

Lastly, the westward movement has been spatially linear, as no spatial jumps are observed (see Fig. 6-13). Some farmers could have initiated another front from the Western border rather than being on the frontier. This did not occur for a few reasons (Hill, 1963; Ruf, 1995*b*): First, farmers cluster as they often belong to cooperatives, which helps them to buy and deforest land at a lower cost. Second, most cocoa landowners are from Eastern ethnic groups, since this is where production first began. As they still own land and have family members (including wives and children) in the East, they often commute between their two regions of residence. This gives them a strong incentive to remain as close as possible to their village of origin while looking for new plots in the West. Even if the westward movement had not been linear, I would instrument it with a linear one, which is exogenous to unobservable local factors determining spatial jumps.[52]

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production shifted westward for agronomic and historical reasons. In Jedwab and Moradi (2011), we show that railway construction influenced the movement of production *within* each newly colonized district in 1911-1931 Ghana. In other words, railroads do not explain the westward wave at the district level (the instrument), but can explain the location of production at a finer spatial level. I verify that my results are robust if I restrict my sample to the post-1948 period.

[51] Several African countries have experienced the same demographic growth as Ghana and Ivory Coast while their urbanization rate has remained quite low (e.g. Kenya, Uganda and Chad).

[52] The linearity of the westward movement also raises the issue of what prevented farmers to exploit the forest "at once", rather than doing it over more than 50 years. First, land was initially abundant compared to labor in African countries (Austin, 2008). It was not until recently that there were enough farmers in these countries to cultivate available land. Second, there are some fixed costs of establishing a cocoa farm in a tropical forest and of learning the technology to produce cocoa, which prevented many from starting their own farm.

4.3 Results

Table 1 presents the results for 1948-1998 Ivory Coast (columns (1)-(4)) and 1891-2000 Ghana (columns (5)-(8)). OLS and 2SLS estimates without and with controls are not significantly different for each country.[53] Focusing on 2SLS estimates with controls (see col. (4) and (8)), and accounting for the fact that the 2SLS estimate for Ivory Coast might be upward biased, I find that one million additional dollars of production leads to around 74 additional urban inhabitants in both countries.[54] There is no independent effect of being on the predicted cocoa frontier on either cash crop production or urbanization for districts that are not highly suitable.

I run a few robustness checks, whose results are presented in Table 2. Column (1) reproduces the main results from Table 1. First, the results are robust to using production in volume (see col. (2)). Second, I modify the definition of the *Predicted Cocoa Frontier District Dummy*. Instead of considering districts less than 1° ($\approx$ 110 km) in longitude from the predicted frontier, I consider the 100 km and 50 km thresholds. Results are robust to both (see col. (3) and (4)). Third, estimates are lower and less significant when using other urban thresholds: 10,000 (see col. (5)) and 20,000 (not reported but available upon request). A large share of urban growth is coming from local cities in the 5,000-20,000 population range. Fourth, we mechanically expect more population growth in areas that were already populated. Each regression already includes initial district population interacted with a time trend. I verify that the results are robust to the inclusion of district population at time t-1 for Ivory Coast (results not reported but available upon request). I also find that the cash crop effect on total population is driven mostly by urban growth for Ivory Coast (see col. (6) and (7)). The effect for rural population is four times lower than for urban growth, which makes the urbanization rate increase (result not shown but available upon request).[55] This does not mean there was no rural growth

[53] Reverse causality and omission biases were likely to bias the coefficient upward. I do not find much evidence for this. The fact that the OLS estimate is smaller than the 2SLS estimate for Ghana is probably due to measurement errors. As discussed in the Data Appendix, the quality of production data is lower for Ghana than for Ivory Coast. District boundaries have changed many times over time and I had to make some assumptions to recreate a consistent data set.

[54] The Kleibergen-Paap rk Wald F Stat is 9.0 for Ivory Coast, and the critical value for 15% maximal IV size is 9.0. If we assume conservatively that the IV estimate is upward biased by 20%, this gives a coefficient of 71.8 in Ivory Coast compared to 74.2 in Ghana.

[55] If cash crop production increases the number of inhabitants of district d by 10,000, this could

in producing districts. The rural population of Ivorian suitable districts has been multiplied by 4.7 between 1948 and 1998. Yet rural growth was high too in non-suitable districts, especially in the north. Moreover, production booms between t-1 and t if some farmers have also established cocoa farms before t-1. Due to the inclusion of district fixed effects, the short-term relationship between production and village growth is attenuated by what is happening in the previous period. Besides, many farmers settle in towns and commute to their land whenever it is needed, and this preference for urban living certainly contributes to the differential growth of cities. Fifth, I verify that the results are robust to specification checks. I regress district urban population at time t on the value of cash crop production between t-1 and t, simultaneously controlling for urban population at time t-1. Lastly, I perform additional robustness checks whose results are not reported but available upon request. Results are robust to: (i) interacting controls with a non-linear trend, (ii) including the squares of controls interacted with a linear trend, (iii) adding district trends (although here the coefficients of interest are no longer significant at 10%), (iv) accounting for spatial autocorrelation using other spatial techniques,[56] and (v) introducing spatial lags of production or urbanization.

I calculate the magnitude of the cash crop effect, i.e. how much of national urban growth over the period is attributed to this single effect. Excluding national cities, I find that cash crop production explains 73.5% of urban growth in Ivory Coast between 1948 and 1998 and 43.5% in Ghana between 1891 and 2000. I investigate why this magnitude is lower in Ghana. First, I calculate that Ivorian and Ghanaian farmers have respectively received 1.65 $ and 1.16 $ (2000) per ton of cash crop production in the last century. This difference comes from Ivory Coast taxing its export of cocoa and coffee relatively less, thus allowing producing areas to receive higher profits for the same output.[57] If Ghanaian production had been as profitable as Ivorian production, the magnitude in Ghana would have risen to 52.5%. Second, mining (gold, bauxite, manganese and diamonds) has represented

give one city of 10,000 or 10 villages of 1,000. This increases urban population by 10,000 in the first case and rural population by 10,000 in the second case.

[56]The plug-in HAC covariance matrix approach is to plug-in a covariance matrix estimator that is consistent under heteroskedasticity and autocorrelation of unknown form (Conley, 1999).

[57]The 1948-2000 average tax rate has been 40.5% for cocoa and coffee in Ivory Coast, and 49.9% for cocoa in Ghana.

24.6% of Ghanaian exports since 1948. If I run the same regression model as before but include the district annual value of mining, I find that one million dollar of mineral production gives 12.6 urban inhabitants (significant at 1%), while the cash crop effect is unchanged. As this effect accounts for 7.0% of local urbanization, the magnitude due to resource exports rises to 59.5%.[58] Finally, assuming one million dollars of resource exports gives 74 urban inhabitants, I find that resource exports have contributed to 71% of urban growth in 1960-2010 Sub-Saharan Africa. This calculation supposes that fuel, mining and cash exports have the same urbanizing effect. It also abstracts from distributional issues, as it assumes 74 additional urban inhabitants whether the rent goes to producers or the government.

4.4 Long-Difference Estimation

As a robustness check, I run the following long-difference model for districts d:

$$\triangle \text{Urban}_d = \alpha + \delta' \,\text{CashCrop}_d + \eta S_d + \epsilon_d \tag{21}$$

where my dependent variable $\triangle\text{Urban}_d$ is the annual number of new urban inhabitants of district d between the first and last years of the country sample (e.g., 1891 and 2000 in Ghana). My variable of interest CashCrop_d is the annual value of cash crop production (cocoa and coffee, in million dollars) during the same period. I instrument the value of cash crop production with *High Suitability Dummy*, a dummy equal to one if more than 50% of district area is highly suitable for cocoa cultivation. This instrumentation exploits the discontinuity in soil suitability (see Figure 4) and echoes the strategy used by Nunn and Qian (2011) when studying the impact of potatoes on Old World population and urbanization. I have already demonstrated in section 4.1 that highly suitable districts were not different from other districts before production boomed. As I relate urban change to cash crop production over a very long period, δ' captures the long-term effect of the latter on the former, while δ from the panel estimation (20) captures the short-term effect.

Table 3 presents the results for 1948-1998 Ivory Coast (columns (1)-(4)) and 1891-2000 Ghana (columns (5)-(8)). Focusing on 2SLS estimates with controls (see col. (4) and (8)), I find that one million dollars of cash crop production results in

[58] The local urbanizing effect is relatively much lower for mining. This is logical if a high share of mining profits goes to the government, which spends them in non-mining districts.

around 95 to 105 additional urban inhabitants in both countries.[59] This coefficient should be compared with estimates from the panel estimation. One million dollars leads to 74 additional urban inhabitants in the short term and 95 to 105 new inhabitants in the long term, although I cannot reject the hypothesis that these estimates are not significantly different. This might be because a booming city is more attractive for migrants and grows further in latter periods, or because a booming city experiences a demographic transition, making it grow further. This result confirms that cities persist in the long run in this context, notwithstanding the decline of cash crop production. I then run the same robustness checks as before and report their results in Table 4. As I instrument cash crop production with the high suitability district dummy, I attempt to restrict the sample to districts less than 100 km or 50 km from the forest-savannah border (see col. (3) and (4)), in the spirit of a spatial regression discontinuity design (e.g., Dell, 2010). Results are rather robust. I obtain a significant effect for rural population growth (see col. (7)), but the urban growth effect remains twice as high (see col. (1)).

5 Discussion

I now discuss the type of cities produced by natural resources and their long-term effects. Due to the scarcity of data in both countries, I do not have repeated measurements of income and other relevant dimensions at the district level and cannot carry out the same type of estimation as for the main results. Instead, I rely on historical data at a more aggregate spatial level and rough cross-sectional correlations on contemporary data. The sources I use are household survey and census data (the 1985-88 LSMS, 1998 and 2002 ENV in Ivory Coast; the 1987-88, 1997-98 and 2005-06 GLSS, the 2000 *Population Census* and *Facility Census* in Ghana), administrative reports, cross-country databases and agronomic studies.

[59]The Kleibergen-Paap rk Wald F Stat is 13.1 for Ivory Coast. This indicates that the IV estimate could be biased by 15%, which gives a coefficient of 105.5.

5.1 Evidence on Consumption Cities

5.1.1 Who Lives in These Cities?

Result 3 of the model suggests that natural resources create consumption cities. What does this imply in terms of urban employment? I compare the sectoral composition of cities in Ghana and Ivory Coast with that of cities in non-African countries with the same urbanization rate of 45-50% (using a similar urban threshold of 5,000). I use U.S. cities in 1920 and Chinese cities in 2008.[60] Interestingly, Ivorian and Ghanaian cities have a relatively larger agricultural sector (17-22% against 1-3% for the U.S. and China) and a more limited industrial sector (11-24% against 43-44% in the U.S. and China). When investigating the composition of each sector, I find that they have a much smaller manufacturing sector: 7% for Ivory Coast and 16% for Ghana, against 35% in the U.S. and 28% in China. Their manufacturing exports being small, manufacturing production must address the demand for local manufactured goods. 75% of Ghanaian and Ivorian manufacturing employment consists of textile and clothing, food products, beverages and tobacco, and furniture. The same sectors account for only 30% of manufacturing employment in the U.S. and 25% in China. They also have a smaller financial and business services sector, which we could interpret as tradable services: 3% in Ivory Coast, 2% in Ghana, 6% in the U.S. and 11% in China. Given that Ghana and Ivory Coast do not export such services, this sector only supplies the local demand. I more generally argue that these cities are consumption cities because they arise as a result of increased demand (and not from productivity gains in the urban sector). I now investigate what gives rise to this composition, distinguishing production and consumption linkages arising from cocoa production. I abstract from including coffee to my analysis, as it is not different from cocoa.

[60] I obtain historical U.S. census data from IPUMS USA. Using the 5,000 urban threshold, I estimate that the U.S. urbanization rate was 47% in 1920. The National Bureau of Statistics of China reports the urban sectoral composition on its website. It defines as a city any independent settlement of more than 3,000 inhabitants, which is quite comparable and gives an urbanization rate of 45%. I verify that my results can be generalized by extending the analysis to countries for which the urbanization is around 40-50%, the urban definition is close to the 5,000 threshold and census microdata is available. The list of these countries is available in the Data Appendix.

5.1.2 Production Linkages

Backward production linkages were unlikely in this context, given the small level of urban inputs used in cocoa production. First, cocoa yields have doubled between 1960 and 2009, yet this increase has been permitted by the diffusion of high-yielding trees from the 1960s (Ruf 1995*a*, p.75-79). Aside from this innovation, production has remained traditional. Cocoa cultivation only requires forested land, axes, machetes, hoes, cocoa beans and labor. Farmers can use fertilizers and pesticides to increase yields. Yet only 6.9% of Ivorian cocoa farmers were using fertilizers in 1985-88; this share was 0.4% in Ghana in 1987-88. Meanwhile, 23.5% of Ivorian farmers were using insecticides in 1985-88 (11.6% in Ghana in 1987-88). From Ghanaian data reported by Teal, Zeitlin and Maamah (2006), I find that cocoa farmers used 3.6 kg of fertilizer and 0.14 liter of insecticide per hectare in 2002. By comparison, FAO data shows that Indonesian cocoa farmers used 95 kg of fertilizer and 0.80 liter of insecticide per hectare. The world used 94 kg of fertilizer and 3 liters of insecticide per hectare considering all crops. The data also reveals that both countries import their consumption of chemical fertilizers and insecticides.

Forward production linkages were also very unlikely in this context. First, there is no local processing of the crop. Cocoa farmers harvest cocoa pods during the peak season, which are opened to collect fresh cocoa beans. These are fermented between banana leaves, and dried by being spread in the sun on mats. The cocoa beans are later bagged and transported to the international port for export. The whole process provides no incentive for capital investments. Ruf (1995*a*, p.296) writes: "Unlike rubber or palm oil, no factory is needed to export cocoa beans. This relative absence of capital and technology contributes to slow down the development of agro-industries." Chocolate manufacturing is highly capital-intensive and requires refrigerated factories and ships for transport in high temperature environments. These constraints and the failure of African countries to boost manufacturing due to rent-seeking could explain why cocoa processing did not develop. I find that Ghana and Ivory Coast were responsible for 49.9% of cocoa exports in 2008, but only 0.9% of chocolate exports (FAO, 2010). Second, the agronomic literature has shown how the proceeds of cocoa farming were reinvested in buying new land, building houses and sending children to school, rather than starting new sectors (Hill, 1963; Ruf, 1995*a*). The cocoa sector is dominated by a myriad of smallholders, who are reluctant to deposit their savings in the formal bank system (Ruf, 1995*a*, p.379). Profits were thus unlikely to fund industrial projects. Third, the logistics of cocoa exports involves local and regional depots and transportation companies. Since their activity is urban-based, this could translate into more urbanization. But I find that people working in this subsector only represent 0.8% of the tertiary sector in the forest cities of Ivory Coast (1985-88).

5.1.3 Consumption Linkages

I argue that cocoa farmers spend their rising income on urban goods and services. Ruf (1995*a*) writes (p.379): "The possibility to enter the cocoa sector without much capital contributes to limit investments and fuels consumption fever." First, the influx of cocoa-producing households usually account for two thirds of population change in booming regions.[61] Second, cocoa farmers are wealthier than the non-cocoa farmers of the same region. Using household survey data, I regress household expenditure on a dummy equal to one if the household produces cocoa and I include village fixed effects to compare cocoa and non-cocoa farmers *within* the same locality. Cocoa (and coffee) farmers are 33.4% wealthier than other farmers in the forested areas of Ivory Coast in 1985-88. In the forest regions of Ghana, they are 22.1% wealthier in 1987-88.[62] Third, I find that cocoa farmers allocate around 30% of total consumption to home food production (mostly starchy roots, vegetables and cereals), 30% to food expenses (mostly "tasty" food such as seafood, cereals, sweets and meat) and 40% to other goods and services (mostly clothing, transfers and events, education, health and housing). Although I cannot identify which good is *urban* per se, I assume that food and non-food expenses imply the growth of the urban sector.[63] To summarize, cocoa farmers account for around 2/3

[61]They respectively account for 79.7% and 62.9% of population change in the Ivorian Centre-West region between 1988 and 1998 and the Ghanaian Western province between 1984 and 2000.

[62]In Jedwab and Moradi (2011), we describe a very similar story for the Eastern province in 1931. As production boomed there, there was a massive influx of migrants who were getting rich by working on cocoa farms. Cardinall (1931) writes (p.84): "An influx of strangers drawn here as it were to El Dorado has opened up the country to an extent that no man could have foreseen as possible within so short a period."

[63]Dercon and Hoddinott (2005) show on Ethiopian data that rural households go to the nearest market town to: (i) buy 47% of crop inputs, (ii) sell a large share of crop production, (iii) get non-

of population change in a booming region, are around 30% wealthier than other farmers, and spend around 70% of their income on urbanizing goods. If production had not boomed and if cocoa farmers had been *counter-factually* replaced by a number 50% lower of non-cocoa farmers, back-of-the-envelope calculations suggest that the aggregate income spent on urban goods and services would have been 2.9 times lower.[64] How this can be related to urban employment growth is difficult to say, but the evidence generally suggests large consumption linkages.[65]

5.1.4 Government Taxation and Redistribution

I now investigate whether state capture affects the composition and spatial distribution of urbanization effects (Result 4). As explained before, the government has respectively captured 40.5% and 49.9% of cocoa (and coffee) exports in Ivory Coast. The cocoa tax accounted for around 20% of government spending in 1961-2000. Also, around two thirds of government spending corresponds to government consumption (public employment), while the rest consists of government investments (infrastructure). In cities of producing districts, I find that public employment represented around 10% of total employment in the 1980s, in line with the national average. These cities thus did not grow as administrative centres. But I find that villages and cities of the old producing districts have better infrastructure. This could make these villages grow and pass the 5,000 threshold, or this could contribute to the growth of existing cities. I first create district measures of infrastructure provision for Ghana in 2000. I then create district dummies if cocoa production has boomed in the 1980s or 1990s (the newly producing districts) or before the 1980s (the old producing districts).[66] Finally, I regress the various

agricultural income by selling artisanal products, and (iv) purchase 55% of their consumables.

[64] Assuming that cocoa farmers would have been replaced by half less non-cocoa farmers without any cocoa boom is a more than reasonable hypothesis, given the high fixed costs of deforestation. As argued earlier, farmers were willing to overcome those costs only when agricultural production was profitable, which was the case with cocoa and coffee.

[65] Another issue is why so many cocoa (and non-cocoa) farmers live in town. As argued earlier, living in the forest can be difficult and the prevailing production technologies may allow farmers to commute to their land only when necessary. Cities also offer better consumption amenities, such as leisure and recreational activities, durable housing and infrastructure.

[66] I use infrastructure data from the 2000 *Facility Census* and *Population Census*. As they adopt the administrative district decomposition in 2000 (N = 110), which differs from the one I have used before, I identify new and old producing districts by studying regional patterns of

measures of infrastructure on these district dummies, including the same baseline controls as before. Results from Table 5 confirm that rural and urban inhabitants of old producing districts are more likely to have access to health facilities (col. (1)-(4)), schools (col. (5)-(10)), communications (col. (11)-(14)), utilities (col. (15)-(18)) and roads (col. (19)), while newly producing districts do not seem to have relatively better infrastructure. Results for Ivory Coast are similar (not reported but available upon request). Public employment accounts for around 20% of total employment in national cities (Abidjan, Bouaké and Yamoussoukro in Ivory Coast, Accra and Kumasi in Ghana), which indicates their role as administrative centres. Besides, around two thirds of the total civil servant wage bill is concentrated in these cities. As we know the total amount of the cocoa tax, its spatial allocation rule (based on the wage bill), and assuming one million dollars leads to 74 additional urban inhabitants (see section 4.3), I find that state capture respectively explains 29.5% and 48.4% of the urban growth of national cities in Ghana and Ivory Coast. Indeed, Abidjan is the fifth largest city in Sub-Saharan Africa, despite the fact that Ivory Coast is only the thirteenth largest country.

5.2 Why Is Africa Urbanized But Poor?

This section summarizes potential future research on the relationship between resource exports, urbanization and economic growth. While both regions were poor and unurbanized in 1950, Asia is now three times wealthier than Sub-Saharan Africa, but the urbanization rate is around 40% for both (see Figure 1). Africa has thus urbanized with only modest economic growth. This is at odds with historical and cross-country evidence on urbanization and development (Acemoglu, Johnson and Robinson, 2002; Henderson, 2010). If resource exports drive urbanization, but produce short-lived economic growth or even economic decline in the long run due to the resource curse, this can explain why African countries are urbanized but poor, though this also supposes that cities persist as income declines.[67]

Using contemporary cross-sectional data on Ghana and Ivory Coast, I compare

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production. Production boomed in the districts of the *Western* province in the 1980s or 1990s.

[67] In 2010, the top 20 resource-rich African countries have an urbanization rate of 47% and a per capita GDP of 1,820 U.S. dollars (1990). England, the U.S., Argentina, Malaysia and China reached the same urbanization rate at much higher levels of per capita GDP: 3,190 (1870), 5,550 (1920), 4,180 (1943), 4,160 (1980) and 6,720 (2010) U.S. dollars respectively.

new, old and non-producing districts along various dimensions. I regress the district urbanization rate, per capita income and employment share of manufacturing around 2000 on dummies if the district has boomed in the 1980s or 1990s, or before the 1980s. Given that old producing districts have accumulated a surplus for a few decades, we expect them to be relatively more developed today. Preliminary results suggest that old producing districts are more urbanized today (with an urbanization rate equal to 150-170% of the national average). Second, old producing districts are not wealthier than the rest of the country. Average per capita consumption is around 700 year 1990 U.S. dollars. As consumption is around 70% of income, this is consistent with a per capita GDP of 1,000 dollars in 2000 (the country's level of economic development in 1950). Third, old producing districts have the same employment share of manufacturing as the rest of the country. To conclude, old producing districts are "urbanized but poor".

There are a few reasons why income might have stagnated in both countries. First, if income rises in booming regions but stagnates or declines in old ones, aggregate income only slightly increases. Second, aggregate income only increases if the surplus of the cocoa sector has been invested to transform the economy. Yet the composition of these cities has shown that this did not happen in this context. This (lack of) production linkages is interesting, given historical examples where resource production had spillover effects on industry. Wright (1981) describes how the cotton-producing South of the U.S. developed its own textile industry from 1880, catching-up with the New England industry. Campante and Glaeser (2009) explain that Buenos Aires and Chicago originally grew as "conduits for moving meat and grain from fertile hinterland to eastern markets", and later became transformers of raw commodities and industrial producers. Michaels (2011) shows that oil-abundant counties in the Southern U.S. have more manufacturing today. This lack of resource-led industrialization could be specific to cocoa, as no producing countries process it in significant quantities. It could stem from comparative advantages that make manufacturing (and chocolate) production relatively cheaper in developed countries. Or it could result from the resource curse. As in Sachs and Warner (2001), their governments may have adopted the "wrong" economic policies; or, as in Robinson, Torvik and Verdier (2006) and Caselli and Michaels (2009), part of the windfall may have been appropriated by the political elite.

There are also several reasons why cities might persist, even when income declines (Glaeser, Kolko and Saiz, 2001). First, capital accumulation makes cities better places to live than villages. Preliminary evidence suggests that cities have advantages in production, such as skills and infrastructure. But there is no direct evidence for the existence or lack of agglomeration effects. Cities also have advantages in consumption, such as leisure and recreational activities, durable housing and infrastructure. I also find that cities of the old producing regions are better places to live than other cities along these dimensions. Second, I observe that the demographic transition has been urban first in Ghana and Ivory Coast. Natural increase - the difference between fertility and mortality - peaked in the early 1970s for cities and the late 1980s for rural areas. African cities are thus very different from cities of the Industrial Revolution, where mortality was higher than in the countryside (Clark and Cummins, 2009). Using a simple model of demographic growth, I find that natural increase has become a significant factor of urban growth. For instance, it accounted for 45% of urban growth in the 1990s.

To conclude, in this context, resource exports have driven urbanization without raising long-run income. Assuming two initially poor countries, the country with a comparative advantage in natural resources experiences both economic growth and urbanization in the short term. But some theories suggest that it will grow less in the long run than a country with a comparative advantage in manufacturing, where skill accumulation, linkages and agglomeration effects are supposedly larger (Young, 1991; Matsuyama, 1992; Galor and Mountford, 2008; McMillan and Rodrik, 2011). Despite this, the resource rich country remains as urbanized as the other country. That there could be a "right" and a "wrong" kind of structural change is purely speculative and a topic left for future research. But it is clearly a promising avenue to understand the role of cities in economic development.

6 Conclusion

This paper analyzes the causal effect of cash crop production on urbanization using a natural experiment in two African countries, Ghana and Ivory Coast, during the 20th century. It makes three contributions to our understanding of the relationship between natural resources, urbanization and economic development.

The first contribution is to establish that Sub-Saharan Africa has followed a different pattern of urbanization from elsewhere. In contrast to standard theories of structural transformation, Africa did not urbanize following a green revolution or an industrial revolution, but as a result of natural resource exports.

The second contribution is to show that economic growth in the rural sector can lead to urbanization. Whether urbanization in turn promotes growth might depend on the type of cities created. I argue that resource exports create consumption cities, with small manufacturing and tradable service sectors. If these "missing" sectors are more likely to exhibit agglomeration effects and provide incentives for skill accumulation, consumption cities have a relatively small impact on growth.

The third contribution of my paper is to confirm that resource exports have positive economic effects in the short term, as producing regions accumulate cities. However, this may not have been enough to increase per capita income in the long term in the African context, probably due to limited production linkages and weak state institutions. This may in part explain the apparent paradox that Sub-Saharan Africa is "urbanized but poor".

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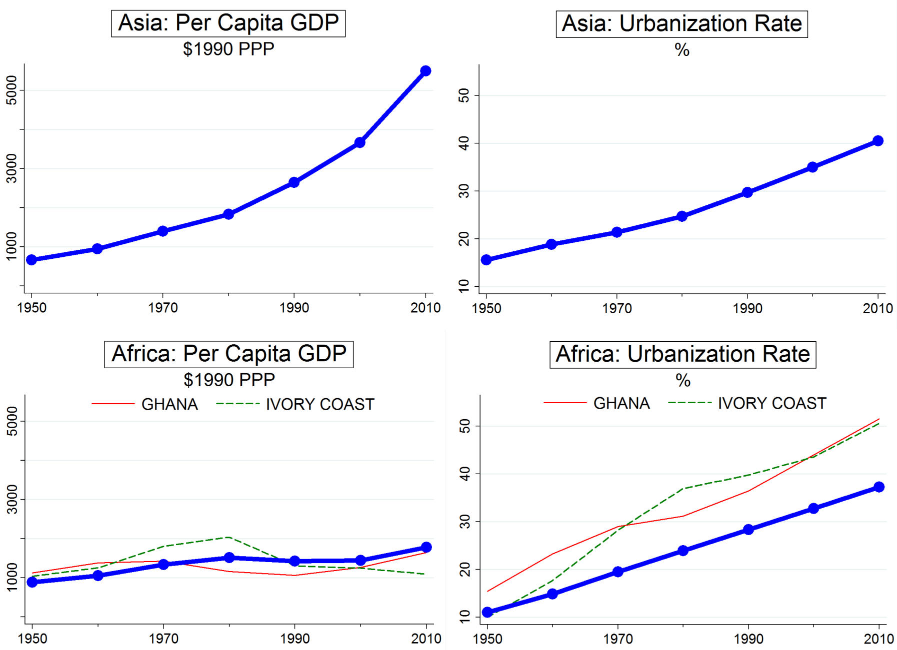
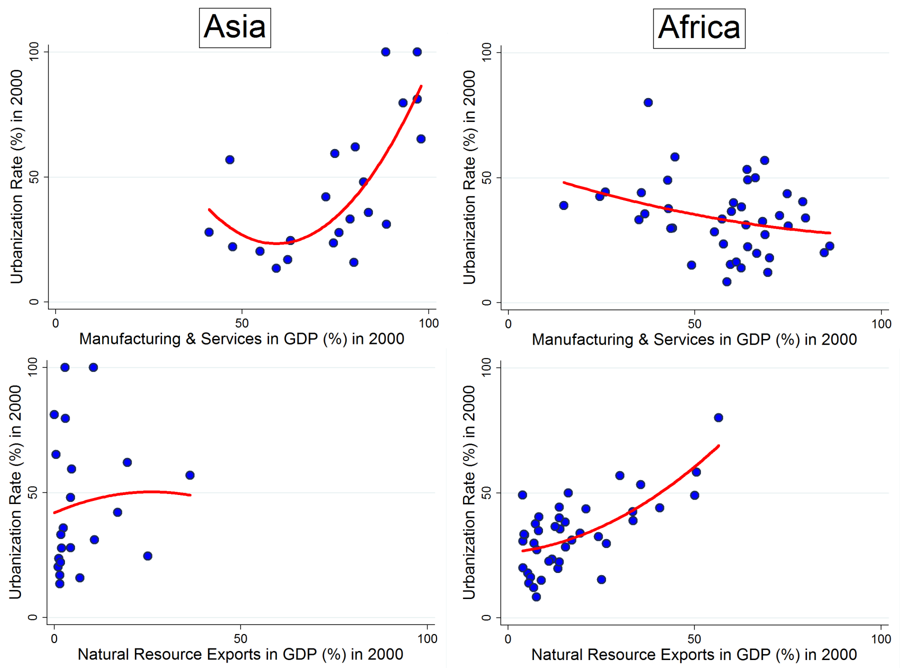
Figure 1: Income and Urbanization, Asia versus Africa, 1950-2010.



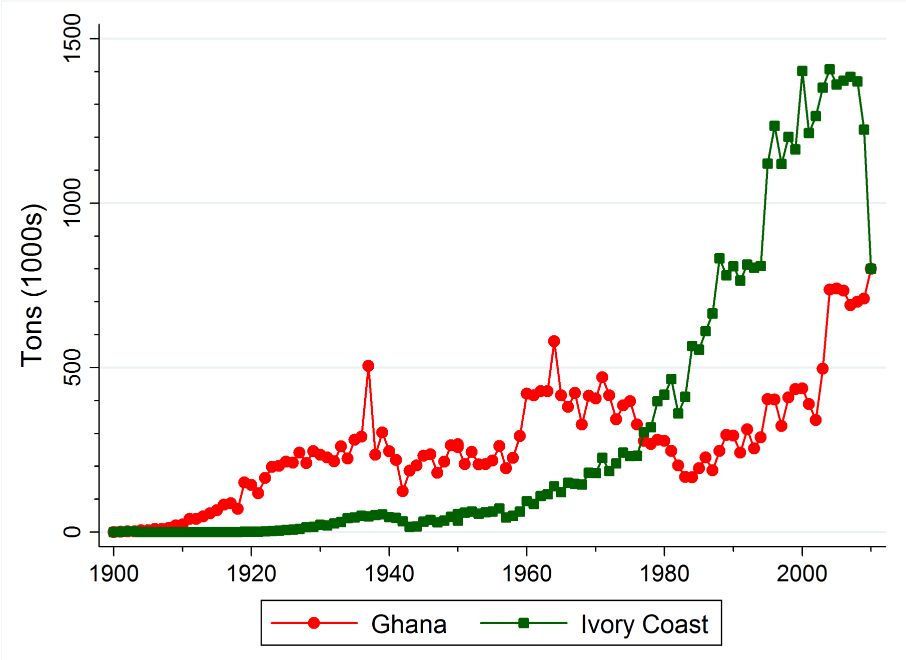
Sources: Maddison 2008, UN 2009, WDI 2010, author's calculations. Per capita GDP data is reported in 1990 Geary-Khamis dollars (constant, PPP). The urbanization rate is reported using national urban definitions. This figure shows the weighted averages of per capita GDP and urbanization rate for 22 Asian countries (Eastern Asia, South-Eastern Asia and South Asia) and 41 Sub-Saharan Africa countries, and separately for Ghana and Ivory Coast.

Figure 2: Urbanization and Composition of GDP, Asia versus Africa, 2000.



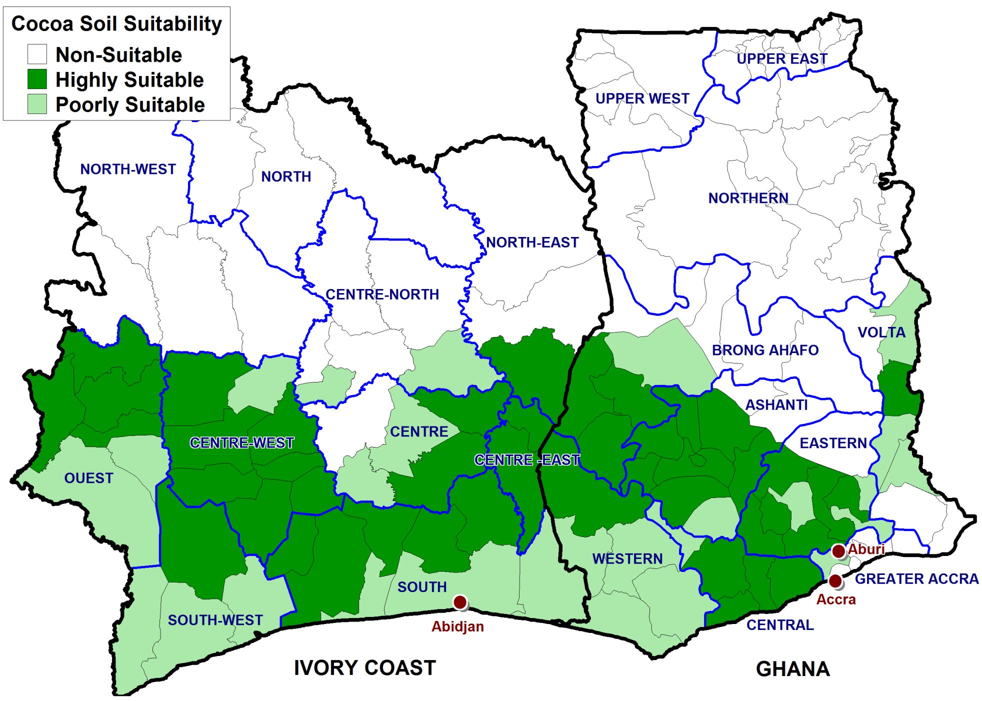
Sources: UN 2009, WDI 2010, USGS 2010, FAO 2010, author's calculations. The urbanization rate is reported using national urban definitions. GDP is decomposed into manufacturing and services, natural resource exports (fuel, mining and cash crop exports) and agriculture (for domestic consumption). The share of agriculture in GDP is not reported. The data includes 22 Asian countries (Eastern Asia, South-Eastern Asia and South Asia) and 41 Sub-Saharan African countries. I display in red the quadratic prediction plots.

Figure 3: Cocoa Production, Ghana and Ivory Coast, 1900-2010.



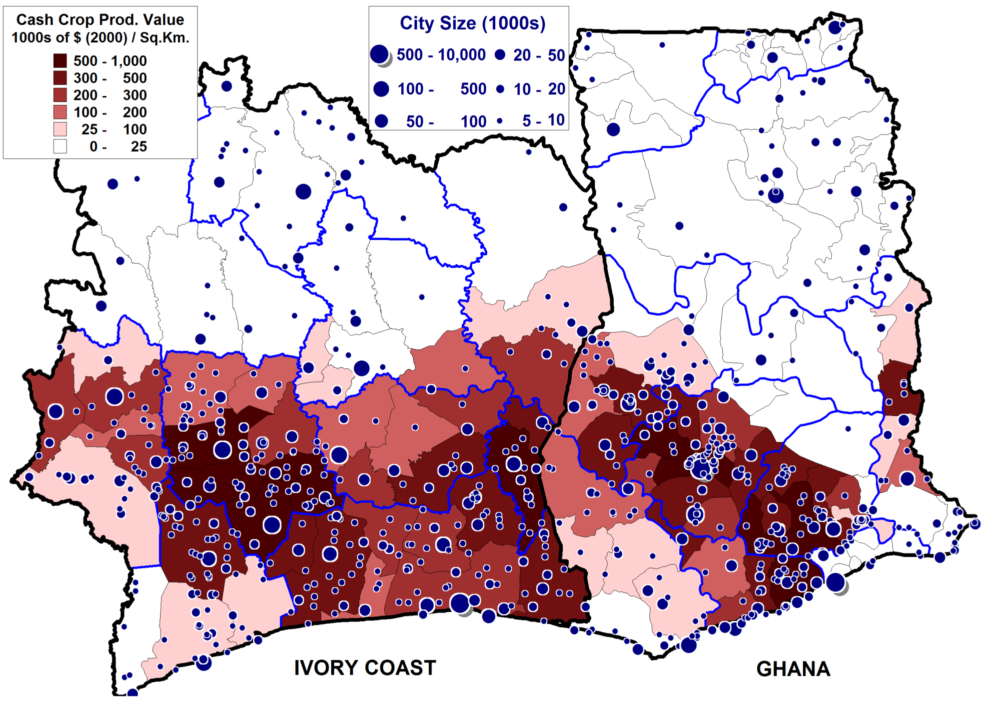
Sources: See Data Appendix for more details. Both countries have extracted almost the same quantity of cocoa beans throughout the 20th century: 24 and 22.1 million tons in Ghana and Ivory Coast, respectively. Cocoa production boomed in the 1920s in Ghana and the 1960s in Ivory Coast. Ivorian coffee boomed in the 1960s, but annual production was limited to 300,000 tons.

Figure 4: Cocoa Soil Suitability and Regional and District Boundaries.



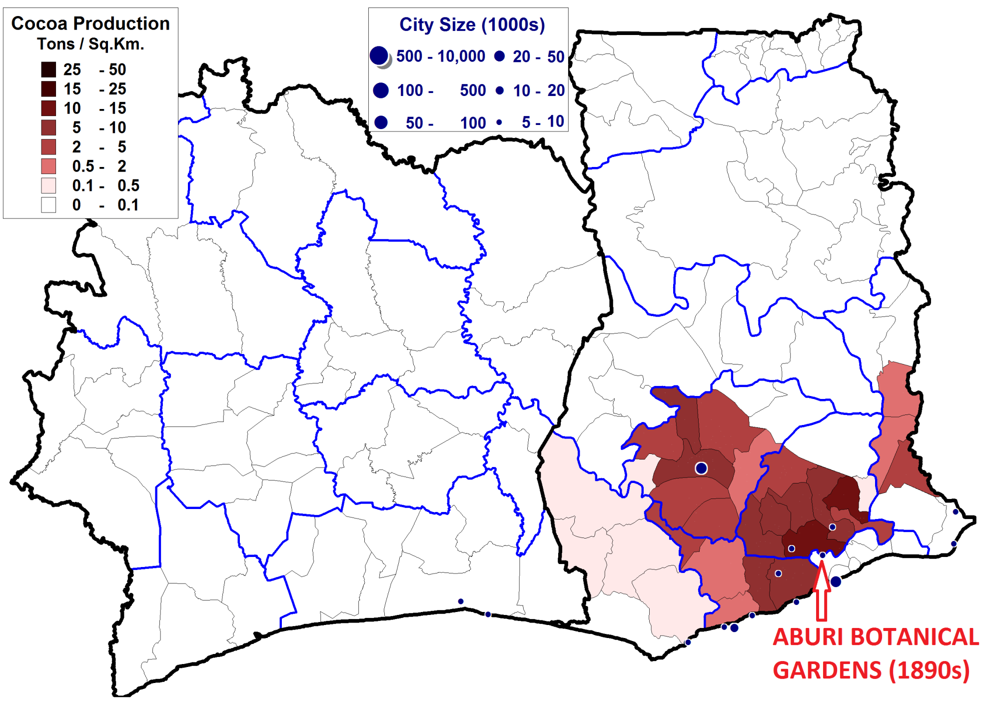
Sources: Historical soil classification maps, Globcover 2009 (see Data Appendix for more details). The South of each country was historically covered with dense tropical forest. A district is defined as *suitable* if more than 25% of its area consists of cocoa soils (the tropical forest). A district is defined as *highly suitable* if more than 50% of its area consists of forest ochrosols, the best cocoa soils. It is defined as *poorly suitable* if it is suitable, but not highly suitable.

Figure 5: Value of Cash Crop Production (1900-2000) and Cities (2000).



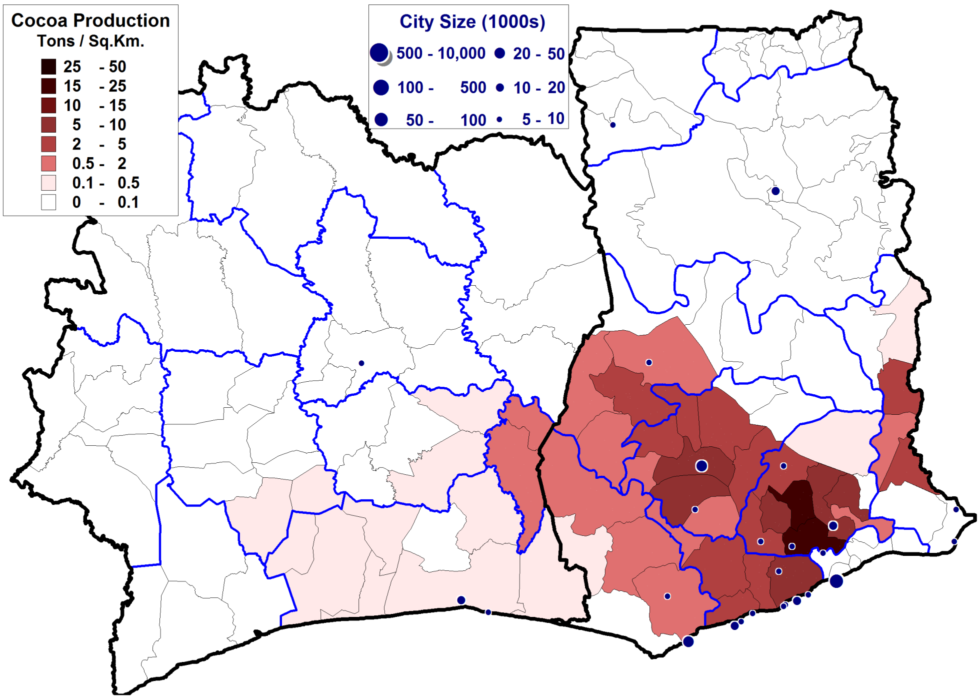
Note: The value of cash crop production includes the district total value (in thousands of year 2000 U.S. dollars per sq.km.) of cocoa production in Ghana from 1891 to 2000, and cocoa and coffee production in Ivory Coast from 1948 to 2000. As there were very few cities one century ago, cities in 2000 (1998 for Ivory Coast) represent the change in urbanization over one century.

Figure 6: District Density of Cocoa Production and Cities in 1921.



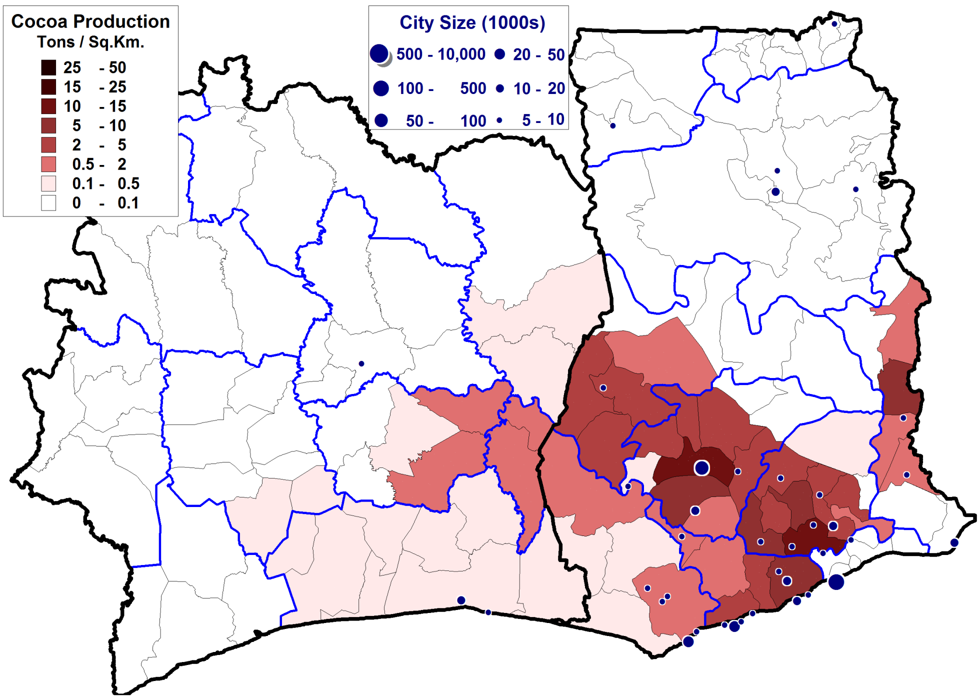
Note: See Data Appendix for more details. Production first boomed around Aburi Botanical Gardens (*Eastern* province) where the British colonizer has distributed cocoa seedlings to local farmers in the 1890s. Maps for previous years (1891, 1901, 1911) are available upon request.

Figure 7: District Density of Cocoa Production and Cities in 1931.



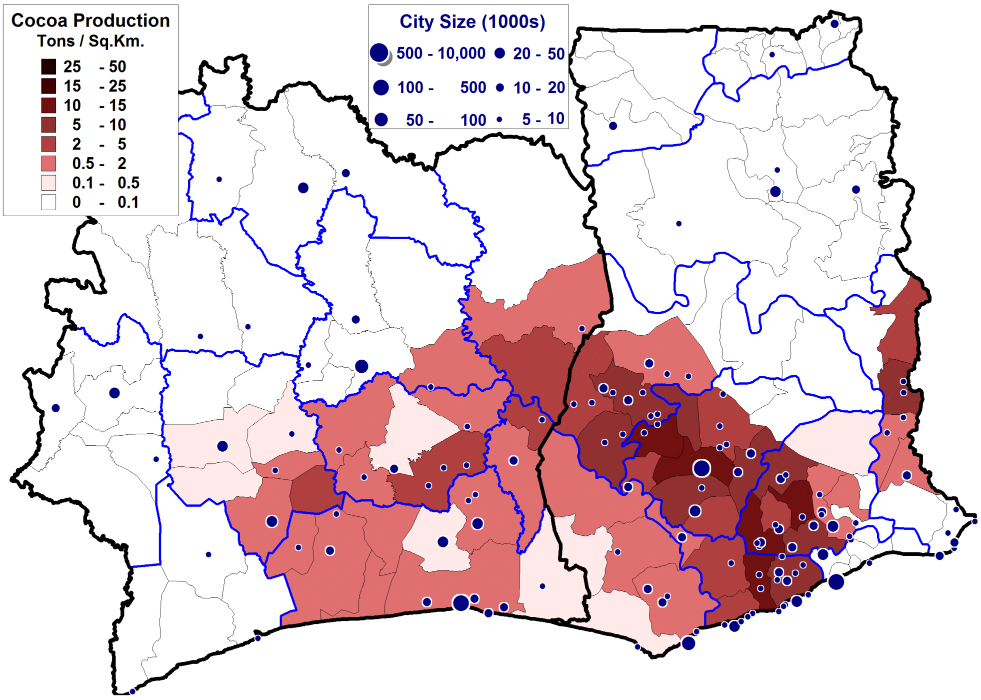
Note: See Data Appendix for more details.

Figure 8: District Density of Cocoa Production and Cities in 1948.



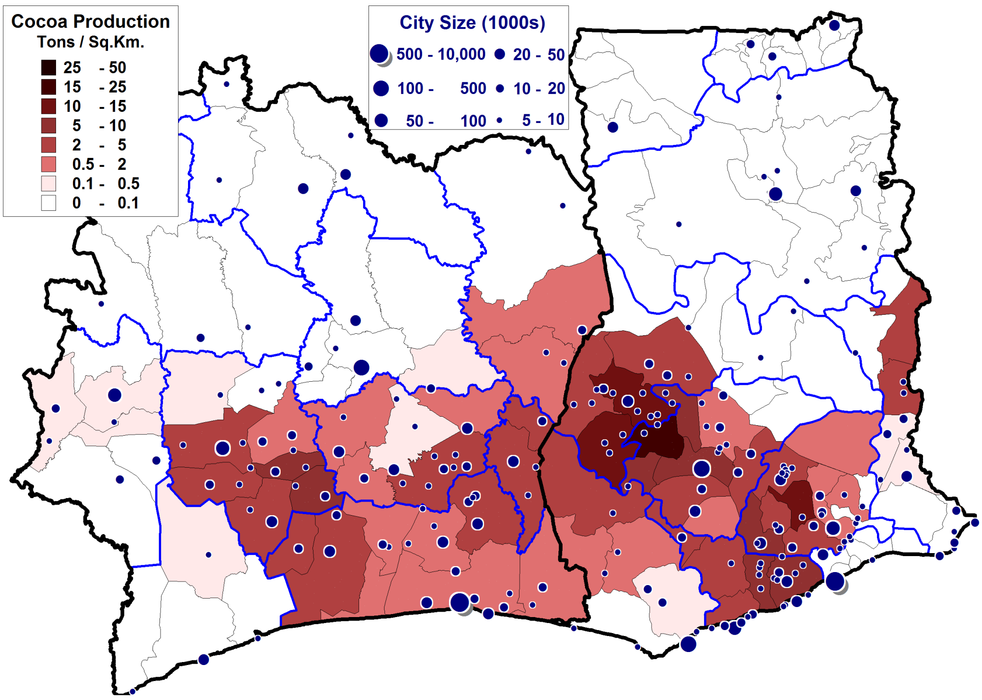
Note: See Data Appendix for more details.

Figure 9: District Density of Cocoa Production and Cities in 1960-1965.



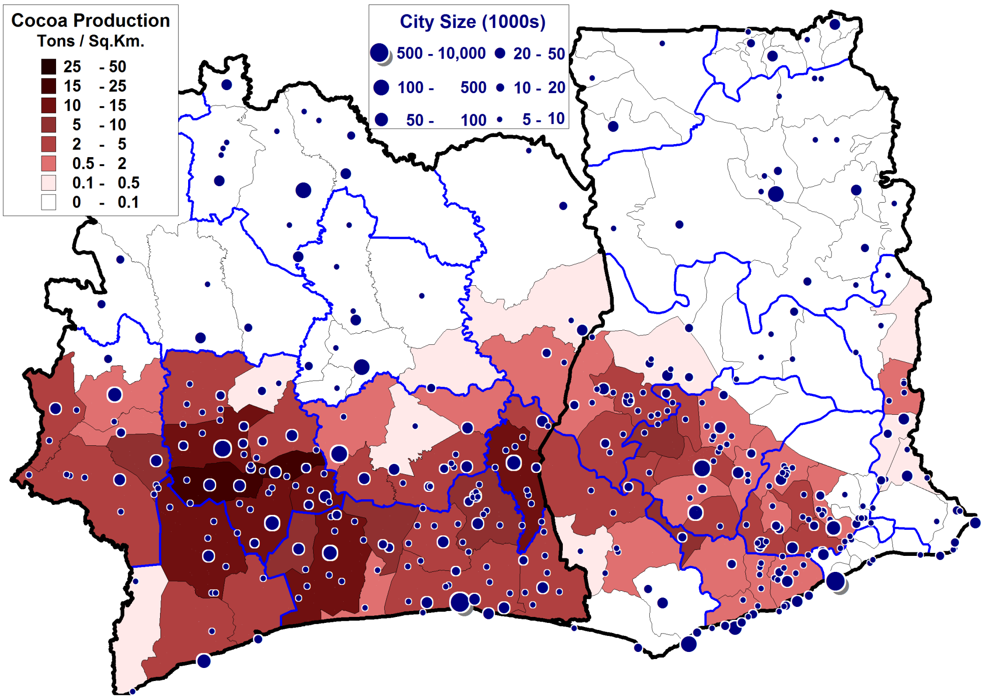
Note: See Data Appendix for more details. The map is for 1960 in Ghana and 1965 in Ivory Coast, as the population census years differ for both countries.

Figure 10: District Density of Cocoa Production and Cities in 1970-1975.



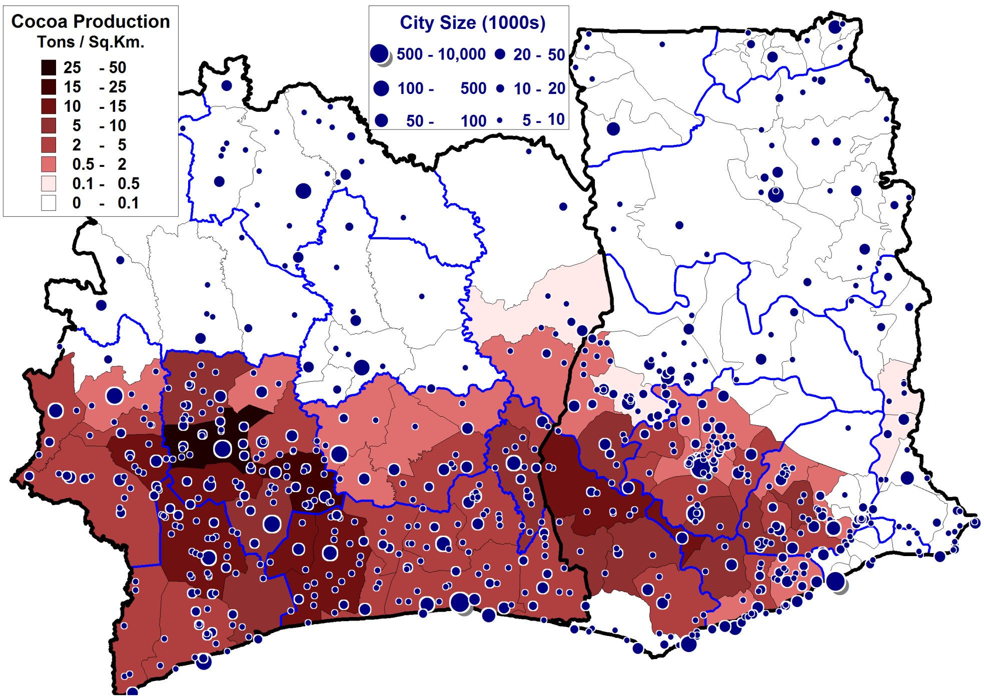
Note: See Data Appendix for more details. The map is for 1970 in Ghana and 1975 in Ivory Coast, as the population census years differ for both countries.

Figure 11: District Density of Cocoa Production and Cities in 1984-1988.



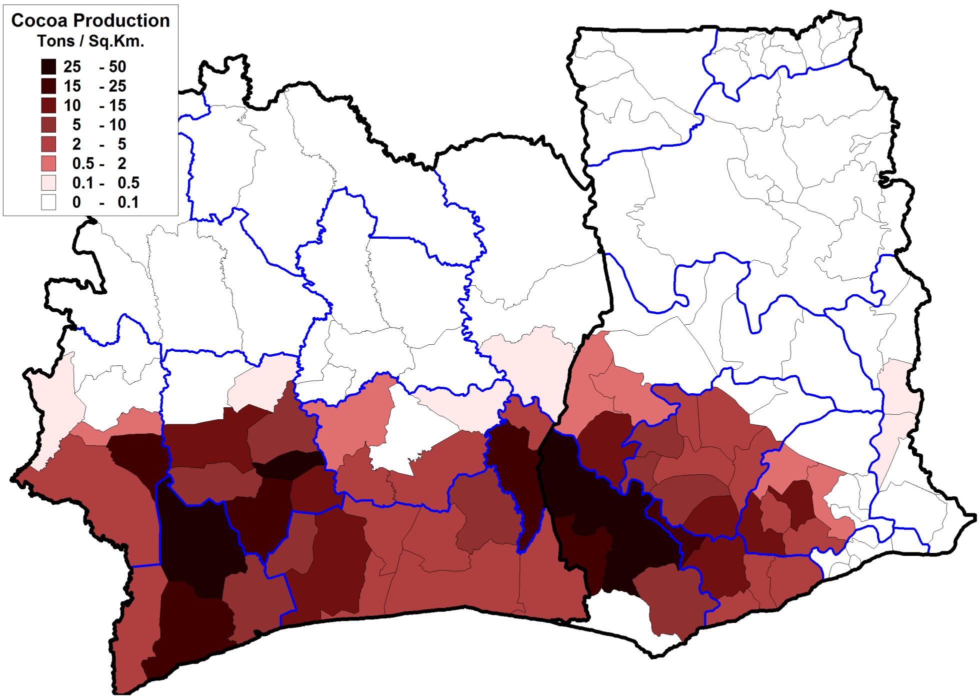
Note: See Data Appendix for more details. The map is for 1984 in Ghana and 1988 in Ivory Coast, as the population census years differ for both countries.

Figure 12: District Density of Cocoa Production and Cities in 1998-2000.



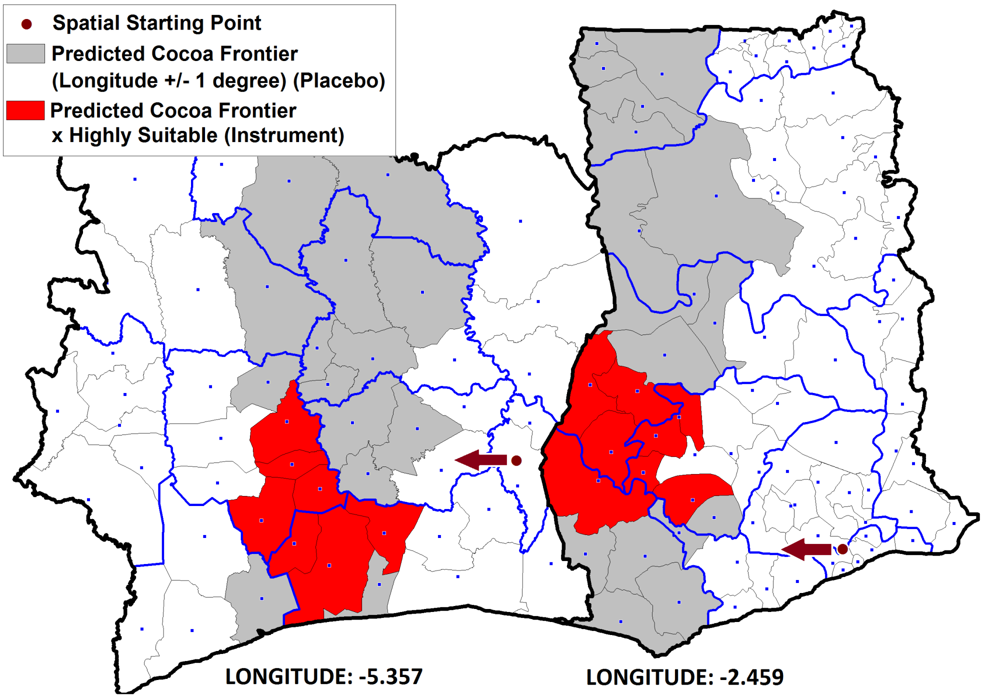
Note: See Data Appendix for more details. The map is for 2000 in Ghana and 1998 in Ivory Coast, as the population census years differ for both countries.

Figure 13: District Density of Cocoa Production 2009.



Note: See Data Appendix for more details. The census data has not been released yet for 2009.

Figure 14: Instrumentation for Cash Crop Production, 1984-88.



Note: The map shows the instrument (*Predicted Cocoa Frontier* × *Highly Suitable*) for 1984 in Ghana, 1988 in Ivory Coast. Given the forest endowment and the spatial starting point of production at t_0, the number of producing households at times t, t-1, t-2, etc., and the fact that each household use a 10 ha plantation every 25 years, I predict the longitude of the cocoa frontier at time t. I define as *Predicted Cocoa Frontier District* any district less than 1° from this longitude. Within the longitude band, I expect a large effect for highly suitable districts (the instrument), and a much smaller effect for other districts (the placebo test).

Table 1: Cash Crops and Urbanization, Panel Estimation, Main Results

Dependent Variable:	District Annual Urban Growth (Annual Number of New Urban Inhabitants, Between $t-1$ and t)							
	Ivory Coast, 1948-1998				**Ghana, 1891-2000**			
	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)	OLS (5)	OLS (6)	2SLS (7)	2SLS (8)
Panel A: Main Equation								
District Annual Value of Cash Crop Prod.	107.5***	91.2***	166.9**	89.7***	24.9**	25.4**	65.0**	74.2**
(Millions of U.S. Dollars, Between $t-1$ and t)	(18.6)	(19.2)	(60.9)	(30.5)	(10.0)	(12.1)	(30.0)	(35.5)
Predicted Cocoa Frontier District Dummy			-1,035	614			-488	-429
(Dist. Longitude $\leq 1°$ from Predicted Cocoa Frontier)			(1,075)	(450)			(409)	(330)
Panel B: First Stage								
Predicted Cocoa Frontier Dist. × Highly Suitable Dist.			20.0***	16.1***			13.0***	12.7***
			(6.4)	(4.8)			(1.2)	(1.0)
Predicted Cocoa Frontier District Dummy			-2.8	-0.7			-0.9*	-1.3**
(Dist. Longitude $\leq 1°$ from Predicted Cocoa Frontier)			(3.5)	(3.8)			(0.6)	(0.6)
Kleibergen-Paap rk Wald F Stat	-	-	8.6	9.0	-	-	50.4	51.5
Observations	250	250	250	250	711	711	711	711
R-squared	0.53	0.87	0.51	0.87	0.65	0.68	0.65	0.68
District and Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Baseline Controls × Year	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at the regional level in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. There are 50 districts and 6 years in Ivory Coast, and 79 districts and 10 years in Ghana. Since I look at the number of new urban inhabitants, I drop one round. The value of cash crop production is expressed in year 2000 U.S. dollars. All regressions include district and year fixed effects, and a dummy equal to one if the district contains a national city and district area (sq km). *Predicted Cocoa Frontier Dist.* × *Highly Suitable Dist. Dummy* is a dummy equal to one if the district is highly suitable and its longitude (measure by its centroid) is less than 1° from the predicted cocoa frontier ($\approx$ 110 km). A district is highly suitable if more than 50% of its area consists of forest ochrosols. I include various controls. Political economy: a dummy equal to one if the district contains a regional capital. Economic geography: dummies for whether the district has a paved road, a railway or an international port at independence (1958 in Ghana, 1960 in Ivory Coast), Euclidean distances (km) to the largest city and the coast. Physical geography: a district dummy for being a coastal district, 1900-1945 average annual precipitation (mm), mean altitude (m) and initial population (1931 in Ghana, 1948 in Ivory Coast). The Data Appendix explains in details how I construct the variables.

Table 2: Cash Crops and Urbanization, Panel Estimation, IV, Robustness

Dependent Variable:	District Annual Growth (Number of Inh., Between $t-1$ and t)							Urban Pop. (t)
	Urban	Urban	Urban	Urban	Urban	Total	Rural	Ctrl for $t-1$
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
			100km	*50km*	*10,000*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Ivory Coast 1948-1998								
District Annual Value of Cash Crop Prod.	89.7**		105.5***	125.0***	50.1*	111.4**	21.8	
(Millions of U.S. Dollars, Between $t-1$ and t)	(30.5)		(18.2)	(25.1)	(30.7)	(49.0)	(49.6)	
District Annual Cash Crop Production		122.2**						
(Thousands of Tons, Between $t-1$ and t)		(30.6)						
District Value of Cash Crop Prod.								95.9***
(Millions of U.S. Dollars, Between $t-1$ and t)								(23.0)
Panel B: Ghana 1891-2000								
District Annual Value of Cash Crop Prod.	74.2**		77.5**	55.3*	64.1*	-	-	
(Millions of U.S. Dollars, Between t_0 and $t-1$)	(35.5)		(37.5)	(29.5)	(39.0)	-	-	
District Annual Cash Crop Production		95.6**						
(Thousands of Tons, Between t_0 and T)		(48.0)						
District Value of Cash Crop Prod.								51.2***
(Millions of U.S. Dollars, Between $t-1$ and t)								(14.7)

Notes: Robust standard errors clustered at the regional level in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. There are 50 districts and 6 years in Ivory Coast, and 79 districts and 10 years in Ghana. Since I look at the number of new urban inhabitants, I drop one round. The value of cash crop production is expressed in year 2000 U.S. dollars. All regressions include district and year fixed effects, a dummy equal to one if the district contains a national city, and district area (sq km). I instrument cash crop production with *Predicted Cocoa Frontier Dist.* $\times$ *Highly Suitable Dist. Dummy*, a dummy equal to one if the district is highly suitable and its longitude happens to be less than 1° from the predicted cocoa frontier. ***Col.(2):*** *District Annual Cash Crop Production* is the annual production in volume between $t-1$ and t. ***Col.(3):*** the district is on the predicted cocoa frontier if its longitude is less than 100 km from the frontier, instead of 1° ($\approx$ 110 km). ***Col.(4):*** I consider the 50 km threshold. ***Col.(5):*** The outcome is district urban growth in localities $\geq$ 10,000 inh. ***Col.(6):*** The outcome is the annual number of new residents (whether urban or rural) between $t-1$ and t. I do not have panel data on population for Ghana. ***Col.(7):*** The outcome is the annual number of new rural residents (living in localities $<$ 5,000 inh.) between $t-1$ and t. ***Col.(8):*** The outcome is the annual number of urban residents at time t, controlling for the number of urban residents at time $t-1$.

Table 3: Cash Crops and Urbanization, Long-Difference Estimation, Main Results

Dependent Variable:	District Annual Urban Growth (Annual Number of New Urban Inhabitants, Between t_0 and T)							
	Ivory Coast, 1948-1998				**Ghana, 1891-2000**			
	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)	OLS (5)	OLS (6)	2SLS (7)	2SLS (8)
Panel A: Main Equation								
District Annual Value of Cash Crop Prod.	133.6**	77.2***	71.0***	124.1***	63.9***	89.0***	74.5***	94.6**
(Millions of U.S. Dollars, Between t_0 and T)	(57.7)	(23.9)	(20.9)	(43.4)	(15.7)	(36.8)	(18.8)	(46.7)
Panel B: First Stage								
Highly Suitable District Dummy			26.1***	23.9***			8.3***	5.2***
			(5.2)	(5.6)			(0.9)	(1.1)
Kleibergen-Paap rk Wald F Stat	-	-	23.6	13.1	-	-	74.1	18.7
Observations	50	50	50	50	79	79	79	79
R-squared	0.56	0.90	0.54	0.90	0.86	0.90	0.86	0.90
Baseline Controls	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at the regional level. * significant at 10%; ** significant at 5%; *** significant at 1%. The value of cash crop production is expressed in year 2000 U.S. dollars. All regressions include a dummy equal to one if the district contains a national city, and district area (sq km). *Highly Suitable Dist. Dummy* is a dummy equal to one if more than 50% of district area consists of forest ochrosols (the best cocoa soils). I include various controls. Political economy: a dummy equal to one if the district contains a regional capital. Economic geography: dummies for whether the district has a paved road, a railway or an international port at independence (1958 in Ghana, 1960 in Ivory Coast), Euclidean distances (km) to the largest city, and the coast. Physical geography: a district dummy for being a coastal district, 1900-1945 average annual precipitation (mm), mean altitude (m) and initial population (1931 in Ghana, 1948 in Ivory Coast). The Data Appendix explains in detail how I construct the variables.

Table 4: Cash Crops and Urbanization, Long-Difference Estimation, IV, Robustness

Dependent Variable:	Annual District Growth (Number of Inh., Between t_0 and T)							Urban Pop. (T)
	Urban	Urban	Urban	Urban	Urban	Total	Rural	Ctrl for t_0
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
			100km	*50km*	*10,000*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Ivory Coast 1948-1998								
Annual District Value of Cash Crop Prod.	124.1***		73.9***	60.5***	92.4**	172.5***	48.4**	
(Millions of U.S. Dollars, Between t_0 and T)	(43.4)		(21.9)	(5.7)	(39.9)	(53.5)	(21.8)	
Annual District Cash Crop Production		198.7***						
(Thousands of Tons, Between t_0 and T)		(67.3)						
District Value of Cash Crop Prod.								90.2***
(Millions of U.S. Dollars, Between t_0 and T)								(30.3)
Panel B: Ghana 1891-2000								
Annual District Value of Cash Crop Prod.	94.6**		85.2**	103.6***	80.9*	-	-	
(Millions of U.S. Dollars, Between t_0 and T)	(46.7)		(35.5)	(31.4)	(46.2)	-	-	
Annual District Cash Crop Production		103.3**						
(Thousands of Tons, Between t_0 and T)		(51.6)						
District Value of Cash Crop Prod.								81.5**
(Millions of U.S. Dollars, Between t_0 and T)								(40.2)

Notes: Robust standard errors clustered at the regional level in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The value of cash crop production is expressed in year 2000 U.S. dollars. I instrument cash crop production with *Highly Suitable Dist. Dummy*, a dummy equal to one if the district is highly suitable to cocoa cultivation. ***Col.(2):*** *Annual District Cash Crop Production* is the annual production in volume between t_0 and T. ***Col.(3):*** I restrict the sample to districts whose centroid is less than 100 km from the forest-savannah border. ***Col.(4):*** I consider the 50 km threshold. ***Col.(5):*** The outcome is district urban growth in localities $\geq$ 10,000 inh. ***Col.(6):*** The outcome is the annual number of new residents (whether urban or rural) between t_0 and T. I do not have panel data on population for Ghana. ***Col.(7):*** The outcome is the annual number of new rural residents (living in localities $<$ 5,000 inh.) between t_0 and T. ***Col.(8):*** The outcome is the annual number of urban residents at time T, controlling for the number of urban residents at time t_0. All regressions include controls that are described in the footnote of Table 3, while the Data Appendix explains in detail how I construct the variables.

Table 5: Cocoa Production and Infrastructure Investments in Ghana, 2000

Dependent Variable:	Share of Inhabitants $\leq$ 10 Kms From (%) Health Centre		Hospital		Primary School		Junior Sec. School		Senior Sec. School	
Sample:	Rural (1)	Urban (2)	Rural (3)	Urban (4)	Rural (5)	Urban (6)	Rural (7)	Urban (8)	Rural (9)	Urban (10)
New Cocoa District Boom in the 1980s-1990s	-0.06***	0.01	-0.00	-0.02	0.01***	0.00	0.05***	-0.00	-0.09**	-0.04
	(0.01)	(0.00)	(0.02)	(0.03)	(0.00)	(0.00)	(0.00)	0.00	(0.02)	(0.02)
Old Cocoa District Boom Before the 1980s	0.08***	0.01*	0.09**	0.08**	0.02**	0.00	0.06***	-0.00	0.07**	-0.05*
	(0.01)	(0.00)	(0.03)	(0.03)	(0.01)	(0.00)	(0.01)	0.00	(0.02)	(0.02)
National Average	0.77	0.98	0.42	0.80	0.98	0.99	0.93	0.99	0.55	0.92

Dependent Variable:	Share of Inh. $\leq$ 10 Kms From (%) Post Office		Telephone		Share of Inh. (%) with Electricity		Tapwater		Density (m / Sq.Km.) Paved Roads
Sample:	Rural (11)	Urban (12)	Rural (13)	Urban (14)	Rural (15)	Urban (16)	Rural (17)	Urban (18)	(19)
New Cocoa District Boom in the 1980s-1990s	-0.03**	-0.03**	-0.05**	0.03	0.06**	0.15***	-10.7*	-11.6*	-7.45
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(4.79)
Old Cocoa District Boom Before the 1980s	0.17***	0.06**	0.14*	0.10**	0.06*	0.09**	0.01	0.01	11.7*
	(0.01)	(0.02)	(0.05)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)	(5.60)
National Average	0.57	0.94	0.51	0.90	0.16	0.61	0.24	0.42	(34.8)

Notes: Robust standard errors clustered at the group level = [New Cocoa District, Old Cocoa District] in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. I use the 2000 *Facility Census* and *Population and Housing Census* to create variables at the district level in 2000, using the district decomposition of 2000 (N = 110). There are only 106 observations for urban regressions, as 4 districts have no cities. This decomposition substantially differs from the one of cocoa districts used in the main analysis (N = 79). All regressions include controls that are described in the footnote of Table 1, while the Data Appendix explains in detail how I construct the variables.

Appendices

A Data Description

This appendix describes in detail the data I use in my analysis.

Spatial Units:

I assemble data for a panel of 79 districts in Ghana, from 1891 to 2000, and a panel of 50 districts in Ivory Coast, from 1948 to 1998. Ghanaian districts correspond to *cocoa districts* in 1960, which significantly differ from administrative districts.[68] Ivorian districts correspond to administrative districts ₋ or *départements* ₋ in 1998.[69] Ghanaian and Ivorian districts belong to 10 regions in each country.

Urban and Population Data:

I collect urban population data from various decadal statistical publications.[70] Defining as a city any locality with more than 5,000 inhabitants, I obtain a geospatialized sample of 364 cities in Ghana (1891, 1901, 1911, 1921, 1931, 1948, 1960, 1970, 1984 and 2000) and 398 cities in Ivory Coast (1901, 1911, 1921, 1931, 1948, 1955, 1965, 1975, 1988, 1998). Using GIS, I can recalculate district urban population for any spatial decomposition, but I am limited by the type of cash crop production data at my disposal. In Ivory Coast, production data is reported at the administrative district level. After reaggregating data to account for administrative changes, I obtain a consistent sample of 50 districts. I only have total population and rural population data from 1948. In Ghana, production is available at the *cocoa district* level (79). As cocoa districts differ from administrative districts, I privilege the former decomposition when creating the urban data set. Besides, administrative boundaries have been considerably modified across years, this impeding any consistent reaggregation. This also means I cannot have panel data on total and rural populations for Ghanaian districts. I nevertheless obtain population data for 36 Southern districts in 1901 and all the districts in 1931.[71]

[68]Ghanaian production data is not available at the administrative district level. The number of cocoa districts has been decreasing over time, but I use various sources and GIS to reconstruct the data set using the same boundaries for the whole period. As it was not always possible to recreate data by reaggregating or disaggregating districts, I had to make some assumptions when constructing the data. The quality of Ghanaian production data is lower as a result.

[69]The number of Ivorian districts has been increasing over time, but I use various sources and GIS to reconstruct the data set using the same boundaries for the whole period.

[70]Publications for Ghana are: *Population and Housing Censuses* 1891, 1901, 1911, 1921, 1931, 1948, 1960, 1970, 1984 and 2000. Publications for Ivory Coast are: *Rapports statistiques* 1900-1920; *Rapports périodiques des gouverneurs et chefs des services* 1895-1940; *Annuaire statistique de l'A.O.F. 1949-1951 and 1950-1954*; *Population de l'A.O.F. par canton et groupe ethnique 1950-1951*; *Répertoire des villages de la Côte d'Ivoire 1955*; *Inventaire économique de la Côte d'Ivoire 1947-1958*; *Côte d'Ivoire 1965: Population*; *Recensement général de la population 1975*; *Population de la Côte d'Ivoire, Analyse des données démographiques disponibles 1984*; *Recensement général de la population et de l'habitat* 1988 and 1998. I also use Geopolis (2010), a previous attempt by geographers to collect urban data for African countries.

[71]I digitize population maps published in the census reports to obtain population at a fine spatial level in 1901 and 1931. I use GIS to reconstruct population at the district level. As the 1901 census was exhaustive in the South only, I recreate population only for Southern districts.

Cash Crop Production and Price Data:

The data on cash crop production was collected from a variety of sources.[72] For both Ghana and Ivory Coast, I am able to create a consistent dataset of cash crop production (cocoa in Ghana, cocoa and coffee in Ivory Coast) for most years. When a year is missing, it is obtained by linear interpolation, giving production data for 79 districts in Ghana for every year between 1891 and 2009, and 50 districts in Ivory Coast for every year between 1948 and 2009.[73] I also collect information on regional cocoa yields whenever it is available. I then use the same sources and additional sources to obtain the international and producer prices in year 2000 U.S. dollars.[74] By multiplying cocoa production and the deflated producer price, I get the annual deflated total value of cocoa production going to farmers. Similarly, using the difference between the international and producer prices, I get the annual deflated total value of cocoa production being captured by the state. I proceed similarly for coffee in Ivory Coast. Lastly, I estimate the total value of cash crop production between each census year for each district to match the temporal structure of the urban database.

Geographical Data:

Forest data comes from land cover GIS data compiled by Globcover (2009). The data displays those areas with virgin forest and areas with mixed virgin forest and croplands, which were areas with virgin forest before it was cleared for cash crop production. I then use historical cocoa soil map which I digitize in GIS to recalculate for each district the area share of each cocoa soil type (forest ochrosols, forest intergrades and forest oxysols).[75] A district is defined as *suitable* if more than 25% of district area consists of cocoa soils. Suitable land area in the two countries exactly corresponds to the area initially covered by tropical forest. A district is

[72] Sources for Ghana are: *1927 Yearbook of the Gold Coast*; *Ghana Population Atlas* 1960; *Annual Reports and Accounts of the Ghana Marketing Board* 1957-1962, 1965, 1970; Dickson (1968); *Reports of the Department of Botanical and Agricultural Department* 1904-1955; *Analysis of Cocoa Purchases by Societies, Districts and Regions* 1961-1975, 1989 and 1994-1999; *Ghana Cocoa Marketing Board Newsletter* 1966-1974; *Ghana Cocoa Marketing Board Monthly Progress Reports* 1972-1985; and a summary of 2001-2009 district purchases (Ghana Cocoa Marketing Board). Sources for Ivory Coast are: *Annuaire Statistique de l'A.O.F.* 1949-1951; *Inventaire Economique de la Côte d'Ivoire 1947-1958*; *Documentary Material on Cacao* 1947; *Annuaire rétrospectif de statistiques agricoles et forestières 1900-1983*; *Atlas de Côte d'Ivoire, 1971-1979*; *Caisse de stabilisation et de soutien des prix des productions agricoles*; and *Pesage systématique du café et du cacao à l'entrée des usines de conditionnement et de transformation 2009.*

[73] Ghanaian cocoa production data only corresponds to the main crop (October-July). This is not an issue as this amounts to 94.7% of total production from 1948 to 2000.

[74] Additional sources are Bateman (1965), Teal (2002), FAO (2010) and World Bank (2010*a*). I use parallel exchange rate data when the black market premium is different from zero.

[75] The documents I use for obtaining cocoa soil maps are: *Survey of Ghana: Classification Map of Cocoa Soils* 1958, *Atlas de Côte d'Ivoire: Carte pédologique 1976* and Petithuguenin (1998).

highly suitable if more than 50% of district area consists of forest ochrosols, the best cocoa soils. A district is defined as *poorly suitable* if it is suitable, but not highly suitable. I then use GIS: (i) to estimate district area (sq km), (ii) to reconstruct district average annual precipitations (mm) in 1900-1945 and district mean altitude (m),[76] (iii) to create a dummy for coastal districts, and (iv) to calculate the district Euclidean distances (km) to the coast, the largest city (Abidjan in Ivory Coast, Accra in Ghana), and the forest-savanna border.

Mining Production and Price Data:
I use annual mining production data for Ghanaian mines in 1891-2000 for four commodities: gold (ounces), bauxite (tons), manganese (tons) and diamond (carats).[77] As I have the geographical coordinates of each mine and the export price in year 2000 U.S. dollars, I reconstruct the district annual value of mining production.

Household Survey and Census Data:
I use household surveys and census microdata to calculate a range of statistics. In Ivory Coast, these are: the 1985-1988 *Living Standards and Measurement Study* (LSMS), the 1998 and 2002 *Enquêtes sur le niveau de vie des ménages* (ENV). In Ghana, these are: the 1987-1988, 1997-1998 and 2005-2006 *Ghana Living Standard Survey* (GLSS), and the 2000 *Population and Housing Census* IPUMS sample.

Agronomic Data:
I use various agronomic statistics at the national or regional levels. In addition to household surveys, I exploit Ruf (1995*a*), Ruf (1995*b*), Teal, Zeitlin and Maamah (2006) and FAO (2010). The aggregate number of cocoa farmers is obtained from census reports and household survey data.

Infrastructure Data:
I collect data from various sources on the spatial allocation of infrastructure. First, I create three control variables intended to capture transportation infrastructure at independence (1958 in Ghana, 1960 in Ivory Coast). A GIS data set of railways and roads in 2010 is obtained from *Digital Chart of the World*. I then use various sources to identify international ports and reconstruct the railway network around 1960: Dickson (1968) and *Atlas de Côte d'Ivoire, 1971-1979*. I use Michelin road maps to reconstruct in GIS the road network around 1960. Michelin road maps allow me to distinguish paved and unpaved roads. I then use GIS to create district dummies for whether a district is connected to the railway network in 1960, or the

[76] Climate data comes from *Terrestrial Air Temperature and Precipitation: 1900-2006 Gridded Monthly Time Series, Version 1.01.* Altitude data comes from *NASA/JPL SRTM30.*

[77] Mining production and price data is collected from the following documents: *The Mineral Industry of the British Empire and Foreign Countries 1913-1919*; *Reports of the Mines Department of the Gold Coast* 1931-1958; and *The Mineral Industry of Ghana* 1963-2000 (USGS 2010).

paved road network in 1960, or contains an international port in 1960. Second, I collect infrastructure data for a cross-section of districts in 2000. For Ghana, I use the 2000 *Facility Census* to calculate for each district the share of rural and urban inhabitants less than 10 km from the following facilities: primary school, junior secondary school, senior secondary school, hospital, health centre, post office and telephone. I then use the 2000 *Population and Housing Census* to calculate for each district the share of rural and urban inhabitants with access to electricity and tapwater. Lastly, I use a recent Michelin road map which I have digitized in GIS to estimate the district density of paved roads (in meters per sq km).

Demographic Data:
Using various sources, I am able to track the evolution of birth and death rates separately for urban and rural 1960-2000 Ghana and 1965-1998 Ivory Coast.[78]

Urban and Income Cross-Country Data:
I use various sources to obtain the urbanization rates and per capita GDP (in constant 1990 $, PPP) for 41 Sub-Saharan African countries and 22 Asian countries between 1950 and 2010: Maddison (2008), United Nations (2009), and World Bank (2010*b*). Each country adopts a different urban definition, but African countries do not tend to adopt relatively lower or higher population thresholds than the rest of the world. I then collect data on the composition of GDP (agricultural production for domestic consumption, natural resource exports, and manufacturing and services) between 1960 and 2010 using the following sources: World Bank (2010*b*), FAO (2010) and USGS (2010).

Urban Sectoral Composition Data:
Except for China for which I use data published on the website of its National Bureau of Statistics, I exploit census microdata made publicly available by IPUMS (IPUMS-USA and IPUMS-International) to recreate the urban sectoral composition for selected countries with an urbanization rate around 40-50%. These are Mexico (1960), Venezuela (1971), Colombia (1973), Malaysia (1980), Philippines (1990), Senegal (2002), Sudan (2004) and India (2008). To have more African countries in my sample, I also include countries whose urbanization rate is around 30-35%, such as Mali (1998), Kenya (1999) or Sierra Leone (2004). I also compare my results with England (1870), Germany (1910) and France (1950) using census reports available for these years.

[78] The main sources for Ghana are: *The Population of Ghana 1974*; *Demographic and Household Survey* 1988; and *Ghana's Development Agenda and Population Growth* 2006. The main sources for Ivory Coast are: Chaleard (2000); Tapinos, Hugon and Vimard (2003); and *Recensement général de la population et de l'habitation 1998.*