Why Is Africa Urbanized But Poor? Evidence from Resource Booms in Ghana and Ivory Coast

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Abstract

Africa is highly urbanized for its level of economic development. I argue that this paradox results from African countries exporting natural resources: resource windfalls drive urbanization, but not necessarily long-term economic growth. I develop a structural transformation model where the Engel curve implies that windfalls are disproportionately spent on urban goods and services. This drives urbanization through a rise of consumer cities. I illustrate the model by studying cocoa booms and urbanization at the district level in Ghana and Ivory Coast over one century. As an identification strategy, I use the fact that cocoa is produced by consuming the forest: (a) for agronomic reasons, farmers have to deforest a new region every 25 years, and (b) for historical reasons, the cocoa frontier has shifted westward in each country. I find that cities boom in newly producing regions, but persist in old ones despite the fact those regions are poor. I discuss possible explanations for both urban irreversibility and the lack of long-term 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."

Houphouët-Boigny's Presidential Address, 25 March 1974.

1 Introduction

In 1950, Sub-Saharan Africa and Asia were poor and relatively unurbanized: their per capita GDP was less than 1,000 $1990 and their urbanization rate was around 10-15%. Interestingly, development experts were more optimistic about economic prospects in Africa than in Asia.[1] Sixty years later, Asia is three times wealthier than Sub-Saharan Africa, but the urbanization rate is around 40% for both (see Figure 1). Africa has thus urbanized without any concomitant increase in income. This is at odds with historical and cross-country evidence on urbanization and economic development (Acemoglu, Johnson and Robinson, 2002; Henderson, 2010).

What accounts for this paradox? The structural transformation literature sees urbanization 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. Standard models distinguish labor push and labor pull factors as the main drivers of this 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). 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, 1970; Hansen and Prescott, 2002).[2] Similarly, a

[1] I alternatively use the expressions "Sub-Saharan Africa" and "Africa" in the rest of the paper (41 countries)."Asia" includes Eastern Asia, South-Eastern Asia and South Asia (22 countries).

[2] A rise in manufacturing productivity also helps 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).

country with a comparative advantage in manufacturing or services can open up to trade and use imports to solve its food problem (Matsuyama, 1992; Yi and Zhang, 2011). If these two approaches describe well the historical experience of developed countries (Bairoch, 1988; Voigtländer and Voth, 2006; Allen, 2009) and successful developing economies in Asia (Young, 2003; Bosworth and Collins, 2008; Brandt, Hsieh and Zhu, 2008), they do not account for Africa's urbanization.

Agricultural yields have remained low in Sub-Saharan Africa (Evenson and Gollin, 2003; Caselli, 2005; Restuccia, Yang and Zhu, 2008). In 2009, cereal yields were 2.8 and 5.0 times lower than in Asia and the U.S., while yields were 2.1 and 5.1 times lower for starchy roots. The African manufacturing and service sectors are relatively small and unproductive (McMillan and Rodrik, 2011). In 2007, employment shares in industry and services were 9.6% and 25.7% for Africa, 23.9% and 34.9% for Asia and 20.6% and 78.0% in the U.S.. Labor productivity in industry was respectively 1.7 and 15.1 times lower than in Asia and the U.S., while labor productivity in services was respectively 3.5 and 26.0 times lower. What has driven African urbanization? Figure 2 plots the urbanization rate and GDP shares of "manufacturing and services" and "primary exports" (fuels, minerals and cash crops) for Asia and Africa in 2000. While manufacturing and services drive Asian urbanization, African urbanization is correlated with primary exports.[3] If natural resource booms spur urbanization, but produce short-lived economic growth or even economic decline due to the "resource curse" (Sachs and Warner, 2001; Robinson, Torvik and Verdier, 2006), this can solve the puzzle.[4]

I explore this hypothesis by developing a new structural transformation model where resource booms lead to urbanization, through a relaxation of the "food problem". The Engel curve implies that resource windfalls are disproportionately spent on urban goods and services and this leads to an expansion of consumer cities. This model is in line with the labor pull approach, except that primary exports are the main driver of the whole process. It also shows how primary exports result in

[3] 27 out of 41 Sub-Saharan African countries and 4 out of 22 Asian countries have more than 10% of their GDP originating from primary exports.

[4] This African paradox has been attributed to urban bias (Bates, 1981; Bairoch, 1988; Fay and Opal, 2000) or rural poverty (Barrios, Bertinelli and Strobl, 2006; Poelhekke, 2010; de Janvry and Sadoulet, 2010). Without discarding those analyzes, I wish to provide evidence for another channel, natural resources. At the continental level, resource rich countries are wealthier and more urbanized. They are also more likely to experience urbanization without growth.

a different type of structural change than manufacturing exports, as it produces the following sectoral composition of cities: relatively more (non-tradable) services and relatively less (tradable) manufacturing. I discuss how factors such as capital accumulation (e.g., durable housing and infrastructure) and the demographic transition can result in urban irreversibility. I then discuss how limited production linkages and rent-seeking can explain the retardation of economic growth.

I provide reduced form evidence consistent with the model by studying the impact of cocoa production booms on urbanization in 20th century Ghana and Ivory Coast. Figure 1 confirms that they have also experienced dramatic urbanization while remaining poor. I combine decadal district-level panel data on cocoa production and cities from 1891 to 2000 for Ghana, and 1948 to 1998 in Ivory Coast. As an identification strategy, I use the fact that cocoa is produced by consuming the forest: (i) only forested areas are suitable to cocoa cultivation, i.e. the South in each country, (ii) for agronomic reasons, each cocoa farmer moves to a new forest every 25 years, thus causing regional cycles, and (iii) for historical reasons, the cocoa front has started in the East of each country. This resulted in the cocoa front moving across the South of each country from East to West. I can thus instrument district production with a westward wave that I model using the 25-year agronomic cycles at the cocoa plantation level. Results suggest that local cocoa production explains at least three-fourths of local urbanization (excluding capital cities). Cities boom in newly producing regions, but persist in old ones despite the fact they become poor. I provide some evidence for factors of urban irreversibility and constraints on long-term economic growth.

In addition to the structural transformation literature, this paper is related to a large body of work on the relationship between urbanization and growth. It could be argued that cities promote growth in developing countries (Duranton, 2008; Venables, 2010; McKinsey, 2011).[5] Those works are based on previous studies showing there are agglomeration economies in developed countries (Rosenthal and Strange, 2004; Henderson, 2005; Combes et al., 2011) and developing countries (see

[5]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."

Overman and Venables (2005) and Henderson (2010) for references). Yet, empirical evidence on the positive impact of urbanization on growth is scarce (Henderson, 2003). I show that economic growth from natural resources produces a specific type of urbanization, consisting mostly of consumer cities producing non-tradable services. In the long run, urbanization can coexist with poverty, which casts doubt on the ability of cities that arise due to resource booms to generate growth.

My focus on cocoa means this paper also contributes to the resource curse literature (Sachs and Warner, 2001; 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). Although the cash crop sector is also taxed by the state, a large share of profits go to producing areas. If urbanization can be used as a proxy for development, my study informs on the local benefits of cash crops. Whether such effects hold in the long run is an important issue. African countries appeared to have benefited from primary exports till the early 1980s, but the subsequent period was characterized by macroeconomic disequilibria, social unrest and general impoverishment. Growth has 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 producing areas are more urbanized and have better infrastructure, but I do not find any long-term effect on per capita income. Dercon and Zeitlin (2009) and Collier and Dercon (2009) also argue that linkages observed in African agriculture are small.

Finally, my research is related to the literature on the respective roles of geography and history in the spatial distribution of economic activity. 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; Nunn and Qian, 2011). The increasing returns theory explains that there is path dependence in the location of economic activity (e.g. Krugman, 1991; Rosenthal and Strange, 2004; Henderson, 2005; Combes et al., 2011; Redding, Sturm and Wolf, 2011). In my context, the Southern forests of each country were relatively uninhabited until they provided a natural advantage for cocoa cultivation. Booming production then launched a self-reinforcing urbanization process. Yet, former producing regions are not wealthier today, casting doubt on the existence of cumulative agglomeration effects.

The paper is organized as follows. The next section presents the background of cocoa and cities in Ghana and Ivory Coast and the data used. 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

I discuss some essential features of the Ghanaian and Ivorian economies, and the data I have collected to analyze how cash crops have contributed to urbanization. Data Appendix A 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 to 2000, and 50 Ivorian districts, which I track decadally from 1948 to 1998.[6] As described below, I have collected data on cocoa production and urbanization.

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

I then construct a GIS database of cities using census reports and administrative counts. My analysis is thus limited to those years for which I have urban data: 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. Historical studies on urbanization define as a city any locality with more than 5,000 inhabitants

[6]Ghanaian data is available using *cocoa district* boundaries in 1960, while Ivorian data uses administrative district boundaries in 1998. 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.

(e.g. Bairoch, 1988; Acemoglu, Johnson and Robinson, 2002).[7] Using the same approach, Ghana and Ivory Coast had respectively 9 and 0 cities in 1901 and 324 cities in 2000 and 376 cities in 1998. Since I only have cash crop production data for 79 *cocoa districts* in Ghana and 50 administrative districts in Ivory Coast, I use GIS to construct district urban population for the above-mentioned years.[8]

I also add district total and rural populations to the Ivorian panel. This is not possible for Ghana, as cocoa districts differ from administrative districts. Additionally, I complement the panel data set with various statistics at the country, regional or district levels, such as income, migration and sectoral composition. This data was obtained from household surveys, census microdata or reports, country-level databases and agronomic studies.

2.2 Agronomic Background on Cocoa

Cocoa is produced by consuming tropical forests (Ruf, 1991, 1995*a*,*b*; Petithughenin, 1995). Cocoa farmers go to a patch of virgin forest and replace forest trees with cocoa trees. Pod production starts after 5 years, peaks after 20 and continues up to 50 years. After 25 years, pod production has already been declining for a few years, which farmers use as the sign to start a new cycle in a new forest.

Why is that? The forest initially provides agronomic benefits (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." After 25 years, cocoa trees are too old and the farmer can either establish a new plantation in a virgin forest or replant new trees. But the agronomic benefits of the forest are also extinguished after 25 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). Furthermore, it is twice more expensive to opt for a replanting strategy as intermediate inputs (fertilizers, pesticides) are needed to compensate

[7] Urbanization rates displayed in Figure 1 use official urban definitions, which are consistent with the 5,000 population threshold for most census years.

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

for tree mortality and low yields (Ruf, 1995*a*, p.240). These agronomic cycles at the plantation level, and the availability of forested land, explain why African cocoa farmers have always privileged an extensive production strategy.

The aggregation of plantation cycles gives regional cycles that last several decades (Ruf, 1995*a*, p.190-203). Regional production at 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". First, land is cheap to buy.[9] Second, farmers do not need much capital to start their own plantation (Ruf, 1995*b*, p.22). Indeed, they only use land, axes, machetes, hoes, cocoa beans and labor to produce cocoa. Lastly, yields are originally high.

A few decades later, trees are old, yields have decreased and regional production declines. But production stagnates for a while if formerly protected forests are open to cultivation. Cocoa cultivation is less profitable than before 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 produce whose price has fallen, 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, a few members of producing households move to a new forest, participating into a new regional cycle. Here is an interesting quote of a cocoa farmer in Ruf (1991, p.107): "An old plantation is like an old dying wife. Medicine would be too expensive to keep her alive. It's better to keep the money for a younger woman [a new plantation]".

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*,

[9] 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 then encouraged by the state. Ivorian President Houphouët-Boigny liked to say that "land belongs to him who cultivates it."

p.63-70). Economic and political factors can accelerate or decelerate regional cycles (Ruf, 1995*a*, p.300-359): a change 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 main motor of their economic 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. 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.

The South of each country is covered with dense tropical forest, while the North is mostly savanna. In the Southern forest, some areas are more suitable to cocoa cultivation due to richer soil nutrients. Figure 4 shows the provinces of Ghana and Ivory Coast, districts suitable to cocoa, highlighting *highly suitable* and *poorly suitable*, and the two capitals, Accra and Abidjan.[10] Figure 5 displays the total value of cocoa 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 cocoa 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 agricultural and botanical farm and garden where valuable plants could be raised and distributed in large numbers to the people." Cocoa seedlings were imported

[10] 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.

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 then started in the *Ashanti* province (see Figures 7, 8 and 9). 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 10).[11] High producer prices from 1983 pushed farmers to launch a third cycle in the *Western* province, the last tropical forest of Ghana (see Figure 11).

It was not till the early 1910s that the French authorities promoted cocoa in Ivory Coast (Ruf, 1995*a*,*b*). Ivorians were originally reluctant to grow cocoa, except in Indénié (*Centre-East*, see Fig. 4) where farmers heard of the wealth of Ghanaian farmers (Ruf, 1995*b*, p.29). However, production did not boom until the 1960s.[12] Cocoa also moved from the East to the West (see Figures 6-11). Due to mounting government deficits, the producer price was halved in 1989 and it remained low thereafter, but this did not stop land colonization. Production 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 cycles at the plantation level, it moved westward (as it could not do otherwise).[13] As population growth was high and cocoa was profitable, many people specialized in it and participated to land expansion. Yet, the colonization process has not

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

[12] Three factors explain this Ivorian "lateness". First, cocoa did not reach the Ghanaian border before the 1910s. Second, the French forced the Ivorians to grow cocoa through a system of mandatory labour (the *corvée*) and Ivorians only saw it as an European crop. Third, production increased in the 1920s but the boom was stopped by the Great Depression and World War II.

[13] Data on regional cocoa yields for post-1948 census years also displays a westward movement in yields. The largest producing region has always the highest yields. For Ghana, it was *Ashanti* in the 1960s (22% higher than the national average), *Brong-Ahafo* in the 1970s (27%) and *Western* in the 1990s (40%). For Ivory Coast, it was *Centre* in the 1960s (32%), *Centre-West* in the 1970s (19%) and early 1980s (45%), and *South-West* in the late 1980s (107%) and 1990s (28%). Data on regional cocoa production per rural capita confirms this analysis.

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 tropical forest is about to disappear, so will cocoa production, unless farmers switch to intensive production strategies.[14]

2.4 The Urban Revolution in Ghana and Ivory Coast

While both countries were unurbanized at the turn of the 20th century, their respective urbanization rate (using the 5,000 threshold) is 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 population of Ghana and Ivory Coast have respectively increased by 9.7 and 15.7 times between 1900 and 2000. Ghana had 324 cities in 2000, while Ivory Coast had 376 in 1998. Then, respectively 53.4% and 54.8% of urban inhabitants in Ghana and Ivory Coast lived in small cities in the population range 5,000-20,000.

I calculate that national cities explain respectively 45.7% and 46.1% of urban growth in 1901-2000 Ghana and 1948-1998 Ivory Coast.[15] Respectively 66.3% and 80.0% of remaining urban growth was in areas suitable to cocoa. This strong correlation between historical cash crop production and the emergence of cities is documented in Figures 4 and 5. This correlation is also spatio-temporal as cities have followed the cash crop front (see Figures 6-11). As production moves westward, new cities appear in the West. But cities in the East do not collapse. If anything, our analysis must account for both city formation and city persistence.

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

[15] I define as *national cities* the capital city (Accra in Ghana, Abidjan and Yamoussoukro in Ivory Coast, since Houphouët-Boigny made his village of birth the new capital in 1983) and the second most important city (Kumasi in Ghana, Bouaké in Ivory Coast). The growth of those cities is disconnected from the local context and entirely depends on the national context.

3 Model of Natural Resources and Urbanization

I now develop a model where natural resource exports generate a surplus, which is mainly spent on urban goods and services due to the Engel curve. Urbanization is driven by consumption linkages and takes the form of consumer cities. The model is in line with the literature that sees the structural transformation 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.[16] A few models consider an open economy and look at the effects of trade on structural transformation (Matsuyama, 1992; Echevarria, 2008; Galor and Mountford, 2008; Matsuyama, 2009; Teigner, 2011; Yi and Zhang, 2011). Yet, in such models, manufacturing exports drive urbanization. Besides, these models predict that a rise in agricultural productivity leads to deurbanization, as the country specializes in agricultural exports and deindustrializes. My model predicts the contrary. To highlight the role of resource booms in urbanization as clearly as possible, the model assumes a small open economy, only one production factor – labor –, and four sectors: food, natural resources, manufacturing and services. Only services are not tradable. The country has a comparative advantage in natural resources, which it exports in exchange for food and manufactured goods. Resource booms and non-homothetic preferences imply an expansion of the service sector and urbanization. I then discuss under which conditions natural resources can drive urbanization while income stagnates, advancing possible explanations for urban irreversibility and the lack of long-term economic growth.

[16] Other articles privileging this approach are Echevarria (1997), Laitner (2000), Piyabha Kongsamut, Sergio Rebelo and Danyang Xie (2001), Voigtländer and Voth (2006), Matsuyama (2002, 2009), Galor and Mountford (2008), Diego Restuccia, Dennis Tao Yang and Xiaodong 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 the two approaches.

3.1 Set-Up

3.1.1 Technologies

The economy consists of four sectors i: food (f), natural resources (c), manufacturing (m) and services (s). Food, primaries and manufactured goods are tradable, but services are not. 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.[17] Productivity is exogenous. Then, assuming the production of manufactured goods and services is located in urban areas, the urbanization rate is $L_{urban} = L_m + L_s$.[18]

3.1.2 Preferences

The representative agent has the following non-homothetic preferences:

$$(2) \qquad U(C_f, C_c, C_m, C_s) = (C_f - \bar{C_f})^{\alpha_f}(C_c)^{\alpha_c}(C_m)^{\alpha_m}(C_s)^{\alpha_s}$$

where C_f, C_c, C_m and C_s denote the consumption of food, natural resources, manufactured goods and services. For the sake of simplicity, natural resources cannot be used as intermediary goods in other sectors and only serve as consumption goods. 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, in line with the Engel's law. The representative agent maximizes her utility (2) subject to the budget constraint:

$$(3) \qquad w = p_f C_f + p_c C_c + p_m C_m + p_s C_s$$

where w, p_f, p_c, p_m and p_s are the wage rate, and the prices of food, natural resources, manufactured goods and services.

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

[18] This assumption is supported by the fact that the primary sector represents 87.0% and 93.9% of rural employment in Ghana (1987-88) and Ivory Coast (1985-88). Conversely, the secondary and tertiary sectors account for 66.8% and 76.9% 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 that the economy is closed. The consumer maximizes utility subject to the budget constraint. This yields the following demands:

(4) $$C_f = \alpha_f \frac{w}{p_f} + (1-\alpha_f)\bar{C_f} \quad \text{and} \quad C_j = \alpha_j \frac{w}{p_j} - \alpha_j \frac{p_f}{p_j}\bar{C_f} \quad \text{for } j = \{c, m, s\}$$

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) $$w = p_f A_f = p_c A_c = p_m A_m = p_s A_s$$

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) $$C_f = \alpha_f A_f + (1-\alpha_f)\bar{C_f} \quad \text{and} \quad C_j = \alpha_j A_j - \alpha_j \frac{A_j}{A_f}\bar{C_f} \quad \text{for } j = \{c, m, s\}$$

(8) $$L_f = \alpha_f + (1-\alpha_f)\frac{\bar{C_f}}{A_f} \quad \text{and} \quad L_j = \alpha_j - \alpha_j \frac{\bar{C_f}}{A_f} \quad \text{for } j = \{c, m, s\}$$

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

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:

$$(10) \qquad C_f = \bar{C}_f \quad \text{and} \quad C_j = 0 \ \text{ for } j = \{c, m, s\}$$

$$(11) \qquad L_f = 1 \quad \text{and} \quad L_j = 0 \ \text{ for } j = \{c, m, s\}$$

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 $L_{urban} = L_m + L_s$ is nil. Thus, there cannot be urbanization without 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_c^* and p_m^* as given. Assuming that the economy has a comparative advantage in natural resources (and a comparative disadvantage in food and manufacturing), the autarky relative price of natural resources is lower than the international relative price:[19]

$$(12) \qquad \frac{p_c}{p_f} < \frac{p_c^*}{p_f^*} \quad \text{and} \quad \frac{p_c}{p_m} < \frac{p_m^*}{p_m^*}$$

The comparative advantage in natural resources implies that the country specializes in the export of natural resources and imports its consumption of food and manufactured goods. While demands (4) are not modified, the country has two producing sectors and perfect competition for labor means that:[20]

$$(13) \qquad w = p_c^* A_c = p_s A_s$$

Goods and labor markets clearing conditions are:

$$(14) \qquad X_c + C_c = Y_c = A_c L_c \quad \text{and} \quad C_s = Y_s = A_s L_s$$

[19] There are a few reasons why the country could be "closed" before. If the economy did not know how to produce natural resources ($A_c = 0$) and manufactured goods ($A_m = 0$), and given that food productivity was only covering the food requirement ($A_f = \bar{C}_f$), there was no trade opportunity. Then, one could assume that trade costs were too high.

[20] The basic Ricardian trade model implies full specialization. The current model is overly simplistic as it predicts that the domestic food and manufacturing sectors disappear. The model could be enriched by modeling imperfect substitutability between domestic and foreign goods of a same sector (e.g., using Armington aggregators).

$$(15) \qquad C_f = M_f \quad \text{and} \quad C_m = M_m$$

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

The balanced trade assumption stipulates that imports equal exports:

$$(17) \qquad p_c^* X_c = p_f^* X_f + p_m^* X_m$$

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

$$(18) \qquad C_f = \bar{C}_f + \alpha_f \frac{p_c^* A_c - p_f^* \bar{C}_f}{p_f^*} \quad \text{and} \quad C_j = \alpha_j \frac{p_c^* A_c - p_f^* \bar{C}_f}{p_j^*} \quad \text{for } j = \{c, m, s\}$$

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

$$(19) \qquad L_s = \alpha_s \left(1 - \frac{p_f^* \bar{C}_f}{p_c^* A_c}\right) \quad \text{and} \quad L_c = \underbrace{(1 - \alpha_s)\left(1 - \frac{p_f^* \bar{C}_f}{p_c^* A_c}\right)}_{\text{Effect A}} + \underbrace{\frac{p_f^* \bar{C}_f}{p_c^* A_c}}_{\text{Effect B}}$$

If $p_f^* \bar{C}_f = 0$ or $p_c^* A_c = \infty$, there is no "food problem". A rise in natural resource exports increases the labor share of services, which converges to the consumption weight α_s. There are then two contradictory effects on the labor share of the natural resource sector. First, the country gets richer thanks to natural resource exports and increases its consumption of food, natural resources and manufacturing. The representative agent has then a strong incentive to work in the natural resource sector (effect A). Second, as the country gets richer, it also increases its consumption of services, which means a necessary reallocation of workers to the latter sector (effect B). The second effect dominates the first, and the service sector expands with natural resource exports. The country urbanizes, but it takes the form of consumer cities, that consist of consumer services.[21]

[21] The model is purposely simplistic. As discussed above, the "no manufacturing" result comes from the assumption that home and foreign manufactured goods are perfectly substitutable. In 2000, respectively 55.1% and 64.1% of manufacturing consumption was coming from imports in Ghana and Ivory Coast. For food, those shares were 12.1% and 33.8%.

3.3.2 Discussion

The model explains how the surplus generated by natural resource exports drives urbanization as a result of non-homothetic preferences. But it does not tell us why the country gets more urbanized while income stagnates. I now discuss possible explanations for urban irreversibility and the lack of long-term economic growth. I especially focus on the case of cocoa in Ghana and Ivory Coast.

If cities arise in new producing regions and persist in old ones, aggregate urbanization rises over time. Natural resources pay the fixed cost of building cities. As production shifts westward, new cities also arise following a westward pattern. Then, a few factors can account for urban persistence. First, if people show preference for urban living due to higher consumption amenities ("city lights"), and if people are mobile enough to maximize utility across space, they accept a lower income to live in town (Glaeser, Kolko and Saiz, 2001). Second, the model is blind to capital accumulation, whether private or public. Cities are places where people accumulate human capital and obtain higher wages (Glaeser and Mare, 2001; Lucas, 2004). Cities also have durable housing and durable infrastructure: negative shocks reduce housing prices more than they decrease population, which explains why urban decline is not frequent (Glaeser and Gyourko, 2005). Third, the demographic transition can boost urban growth. If human capital accumulation and health infrastructure decrease more urban mortality than they decrease urban fertility, natural increase will multiply the effect of natural resources.

There are a few reasons why aggregate income might stagnate. First, if income rises in booming regions but stagnates or declines in old ones, aggregate income only slightly increases. Second, income only increases if the surplus is invested to transform the economy. If it is consumed, if there are no production linkages from the cocoa sector or agglomeration effects from being more urbanized, a positive productivity shock related to cocoa only has temporary effects. Thus, a country with a comparative advantage in natural resources experiences economic growth in the short run. But it grows 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). Third, there may be negative political implications of resource booms such as weak institutions, which then impacts policies and growth (Sachs and Warner, 2001). Rent-seeking could also produce inequality and conflict, as the political elites compete for the surplus (Robinson, Torvik and Verdier, 2006; Angrist and Kugler, 2008; Caselli and Michaels, 2009).[22]

4 Method and Results

I test the hypothesis that cash crop production drives urbanization, focusing on 1891-2000 Ghana and 1948-1998 Ivory Coast. I now describe my empirical strategy and display the results.

4.1 Panel Estimation

I run panel data regressions for districts d and years t of the following form:

$$\triangle \text{Urban}_{d,t} = \beta_d + \gamma_t + \delta \, \text{Cocoa}_{d,t} + \theta_t S_d + \mu_{d,t} \tag{20}$$

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 $\text{Cocoa}_{d,t}$ is the annual value of cash crop production (in million 2000$) during the same period. $\mu_{d,t}$ are individual disturbances clustered at the district level. 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 respectively 250 and 711 observations.

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) grow without it being related to local production. Other controls are: (i) Political economy: dummy for containing a regional capital, for the same reason as for national cities; (ii) Economic geography: dummies for having an international port, being connected

[22] In Web Appendix C, I discuss an extension of the model where the government taxes the cocoa sector to pay civil servants in the capital city. This leads to primacy. I also discuss the role of the capital city as a "port of entry" for traders.

to the railway network or the paved road network, all measured at independence (1958 in Ghana, 1960 in Ivory Coast), as this could drive both urban growth and production; (iii) Physical geography: dummy for being a coastal district and 1900-2000 average annual precipitations to control for pre-existing settlement patterns.

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 25-year agronomic cycles at the plantation level. I describe at length how I construct my instrument in Web Appendix D. First, using the GIS map of suitable area, I find that Ghana and Ivory Coast respectively had an endowment of 896,919 and 1,462,578 plantations of 10 ha in 1900.[23] 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 can 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). 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. That is why I instrument cash crop production with the interaction of *Predicted Cocoa Frontier District Dummy* and *Highly Suitable District Dummy* (see Figure 12 for an example in 1960-65). As a placebo check of my instrumentation strategy, I verify 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, settlement is limited in tropical forests due to high humidity and disease incidence, and there are few cities in regions that have not boomed yet (see Fig. 6-11). Farmers overcome

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

these constraints when they get a high income, 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. Third, West African labor markets are highly integrated, with many laborers originating from Northern regions or other countries. The ability of farmers to find labor thus did not depend on urban proximity.

There could be omitted factors. First, one could argue that logging enables cash crop production and urbanization, but farmers do not need logging companies to cut trees. Furthermore, if logging companies open forest tracks, this might influence the location of production within districts, but it is unlikely to account for the westward wave. Then, the export of forest products has only amounted to 10.1% and 16.1% of exports in Ghana and Ivory Coast. Logging has been dominated by a few parastatal companies, and profits were repatriated to national cities rather than spent locally. Even if there were such local channels, this would not alter the message of the paper that primary exports drives urbanization, as forestry exports also belong to this category. My coefficients 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. 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 also control for infrastructure.[24] Third, local demographic growth could foster rural-urban migration and provide cheap labor for cocoa cultivation. As argued above, settlement was limited in forested

[24]In Jedwab and Moradi (2011), we argue that railway construction at the beginning of the 20th century has allowed cocoa farmers to start colonizing the *Ashanti* province (see Fig. 4). Production had to shift westward for agronomic and historical reasons, but railroads explain why production shifted northwestward, instead of westward or southwestward. As I instrument production with a westward wave, my estimates are not contaminated by this channel.

areas and most migrants were coming from other regions. Integrated labor markets imply that cocoa did not exclusively depend on local labor supply.

Lastly, the westward movement has been spatially "linear", as no spatial jumps are observed (see Fig. 6-11). Indeed, some farmers could have initiated another front from the Western border rather than being on the cocoa frontier. First, farmers spatially cluster as they 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 it all began. As they still own land and have family members (including wives and children) in the East, they commute quite often between their two regions of residence (Hill, 1963; Ruf, 1995*b*). 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. Then, even if the westward movement had not been linear, the instrument would instrument it with a linear movement, which is exogenous to unobservable local factors determining spatial jumps.

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 *within* and *across* each country. 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 1 million \$2000 gives around 69 urban inhabitants in both countries.[25]

I then run a few robustness checks. Results for Ivory Coast are presented in Table 2, while results for Ghana are presented in Table 3. Columns (1) reproduce the main results from Table 1 (see col. (4) and (8)). First, 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. If results are robust to the former (see col. (3)),

[25]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. This indicates that the IV estimate could be biased by 15-20%. If we assume conservatively that it is upward biased by 20%, this gives a coefficient of 71.2 in Ivory Coast compared to 66.8 in Ghana. The average between the two is 69.

estimates are 30-40% lower and only significant at 15% using the latter (see col. (4)). 50 km is a small threshold given the average district size, and only a few districts are selected as "treated", which limits comparisons. Third, results are robust to correcting for spatial autocorrelation, whether clustering at the regional level (see col. (5)) or directly accounting for it using standard spatial techniques.[26] Fourth, estimates are lower and less significant when using other urban thresholds: 10,000 (see col. (6)) and 20,000 (see col. (7)). A large share of urban growth is coming from cities in the 5,000-20,000 population range. This also means that local production has a large (but heterogenous) effect on cities in the 20,000-+ population range. Fifth, production has a strong impact on city formation (see col. (8)). Lastly, I find that the cash crop effect is 4 times lower when considering rural population in Ivory Coast as an outcome (see col. (9)), which makes the urbanization rate increase.[27]

I calculate the magnitude of the cash crop effect, i.e. how much of national urban growth over the period is attributed to this sole effect.[28] Excluding national cities, I find that cash crop production explains 73.5% of urban growth in Ivory Coast between 1948 and 1998 and 39.4% in Ghana between 1891 and 2000. I then investigate why magnitude is lower in Ghana. First, if I run the same regression model with production in volume, I find that 1,000 tons of cocoa-coffee respectively gives 118.4 and 83.6 urban inhabitants in Ivory Coast and Ghana. Given one million $2000 of cash crop production has the same urbanization return in both countries (69 inhabitants), the difference comes from production in volume being relatively less profitable for Ghanaian producing areas. I calculate that Ivorian and

[26] I test two different approaches of spatial clustering. 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). 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). My results are robust to those various forms of clustering (results not reported but available upon request).

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

[28] If δ is the impact of cocoa production on urban growth and if the total changes in urban population and cash crop production over the study period are respectively ϕ and τ, an approximation of the magnitude of this effect is $\frac{\tau \times \delta}{\phi} * 100$.

Ghanaian farmers have respectively received 1.65 \$2000 and 1.16 \$2000 per ton in the last century. This difference comes from Ivory Coast taxing relatively less its export of cocoa and coffee, thus allowing producing areas to receive more profits for the same output [29] If Ghanaian production had been as profitable as Ivorian production, the magnitude would have risen to 46.5%. Second, mining (gold, bauxite, manganese and diamonds) has represented 24.6% of Ghanaian exports since 1948. If I run the same regression model as before but include the district value of mining, I find that one million 2000\$ of mineral production gives 15.0 urban inhabitants (significant at 1%), while the cash crop effect is unchanged. As this effect accounts for 8.0% of local urbanization, the magnitude due to primary exports rises to 54.4%.[30]

4.4 Long-Difference Estimation

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

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

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 Cocoa_d is the annual value of cash crop production (cocoa and coffee, in million 2000\$) during the same period. I have 79 districts in Ghana and 50 districts in Ivory Coast. Controls are unchanged. I also 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 to cocoa cultivation. This instrumentation exploits the spatial discontinuity in land suitability (see Figure 4) and echoes the strategy used by Nunn and Qian (2011) when studying the impact of potatoes on population and urbanization. As I relate urban change over a very long period to the total cash crop production over the same period, δ' captures the long-term effect of the latter on the former, while δ from the panel estimation captures the short-term effect.

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

[30] The local urbanizing effect is much lower for mining than for cash crop production. This is logical if a high share of mining profits goes to the government, which then spends them in non-mining districts. Mining production is also much less labor-intensive than cocoa production.

Table 4 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 *within* and *across* each country. Focusing on 2SLS estimates with controls (see col. (4) and (8)), I find that 1 million $2000 of cash crop production gives around 87 urban inhabitants in both countries. This coefficient must be compared with estimates from the panel estimation. One million $2000 gives 69 urban inhabitants in the short term and 87 inhabitants in the long term, the difference coming from increasing returns. A booming city is more attractive for migrants and grows further in latter periods. Or a booming city can experience a demographic transition, making it grow further.[31]

I run a few robustness checks, whose results are describe in Web Appendix E. I first test that highly suitable and other districts are similar at the beginning of the period. I consider 1948 for Ivory Coast and 1921 Ghana, before the cocoa boom in each country. I also verify that highly suitable districts do not experience relatively more urban and rural growths before (I consider 1921-1948 for Ivory Coast and 1901-1921 for Ghana). Second, I restrict the sample to districts less than 100 km and 50 km from the Forest-Savannah border, in the spirit of a spatial regression discontinuity design (e.g., Dell, 2010). Lastly, I show that results are robust to: (i) using production in volume; (ii) correcting for spatial autocorrelation; (iii) using other urban thresholds; (iv) considering the number of cities. I also use district data on rural population for Ivory Coast. As one million 2000$ of production increases district population by 86.6 urban inhabitants but only 49.0 rural inhabitants, the urbanization rate of producing districts increases. When calculating the magnitude of the long-term effect, I find that it explains 89.5% and 53.2% of urban growth (excluding national cities) in Ivory Coast and Ghana respectively. Correcting for taxation and mining, the magnitude rises to 75.9% in Ghana.

[31]The short term effect is respectively 28.2% and 17.9% lower than the long-term effect in Ghana and Ivory Coast. It is relatively lower in Ghana because land colonization has been more gradual there. I also study Ghana over more than one century, where cumulative agglomeration effects might create a clear disconnection between the short and long terms.

5 Discussion

I now discuss rural-urban linkages in newly producing regions and the long-term effects of cash crop production, focusing on old producing regions. Due to the poverty 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 estimations 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 full analysis, including econometric results, is available in Appendix B, while the next sections only summarize its content.

5.1 Rural-Urban Linkages in New Producing Regions

The effect of rural-based cocoa production on urban growth could be explained either by "consumption linkages" or "production linkages". I emphasize the former in the model. The Engel curve implies that a disproportionate share of the cocoa windfall is spent on urban goods and services, which gives rise to consumer cities. If manufacturing goods are imported, the expansion of the urban sector takes the form of non-tradable services. A related channel which is not discussed in the model is that farmers could choose to live in town and commute to their farm when needed. Cocoa production could then have backward production linkages, through a higher demand for intermediate inputs, and forward production linkages, through the development of an agro-processing sector. Urbanization then happens through agriculture-led industrialization. I now contrast the two sets of channels.

Using as an example two regions that have recently boomed in each country, I find that more than 1/3 of urban employment growth comes from the primary sector (in particular cocoa farmers) and around 50% from the service sector (in particular traders and personal service workers), while the contribution of industry is small.[32] This argues in favor of consumption linkages. I provide some evidence that new producing regions experience a massive in-migration of cocoa farmers. As those spend a large share of their wealth on *urbanizing* goods and services ("tasty

[32] Wholesale and retail trade and personal services account for two thirds of employment growth in the service sector. Transport, communications, education and health explain around 25%, while the contribution of business and banking services and administration is small.

food", clothing, education, health, transfers and events, etc.), this is likely to drive local urbanization. Since they spend more on services than on manufacturing and a large share of manufactured goods are imported (around 60%), this can potentially account for the growth of services. The fact that many cocoa farmers live in town may also indicate a preference for urban living.

Cocoa cultivation has few backward production linkages and its production technology has remained largely unchanged for the last century. Cultivation requires only forested land, axes, machetes, hoes, cocoa beans and labor, and cocoa farmers have made limited use of fertilizers and insecticides. Cocoa also has few forward production linkages. Cocoa beans are not processed locally as chocolate manufacturing is highly capital-intensive and require refrigerated factories and ships. Profits from the cocoa sector were consumed or reinvested in land accumulation, rather than used to start new sectors.

5.2 The Long-Term Effects of Cash Crop Production

Using contemporary cross-sectional data, I compare new, old and non-producing districts along various dimensions. Interestingly, old producing districts are relatively more urbanized today, despite the fact they have remained as "poor" as the rest of the country (see Appendix B.2.1 and Appendix Tables B.1 and B.2). Their urbanization rate is around 40-70% although their per capita income has remained around 1,000 1990 $ (the country's level of economic development in 1950). How can this shed light on Figure 1, which shows that both countries have urbanized while aggregate income has almost stagnated over half a century?

There are a few reasons why aggregate income might have stagnated. First, if income rises in booming regions but stagnates or declines in old ones, aggregate income only slightly increases. I document that old cocoa farms in old producing regions have probably been reconverted to grow food crops for urban markets, thus providing cocoa farmers with another, less profitable, source of income. Second, aggregate income only increases if the surplus of the cocoa sector has been invested to transform the economy. In particular, we could expect production linkages arising from the cocoa sector. But the previous analysis of rural-urban linkages, and the fact that the sectoral composition of old producing districts is not that different from other districts (see Appendix Tables B.1 and B.2), cast doubt on the economic significance of such linkages in this context. The employment share of industry was still below 10% in 2000. This (lack of) new linkages is interesting, given historical examples where natural resources had spillover effects on industrialization. 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". It 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. But my result is in line with Dercon and Zeitlin (2009) and Collier and Dercon (2009) who argue that current linkages observed in African agriculture are small, probably due to the production structure and poor institutions. The fact that old producing districts have urbanized without any permanent rise of standards of living could indicate that agglomeration economies are limited in this context. This is contrast with Bleakley and Lin (2010) and Michaels (2011) who show that natural advantages (portage sites or oil endowments) have led to rising population densities and/or infrastructure investments, with positive effects on industrialization. Third, there have been macro-institutional factors behind the inability of the two countries to use the windfalls to transform their economy. I describe how their institutions have remained weak. As in Sachs and Warner (2001), their governments have sometimes adopted the "wrong" economic policies. Then, as in Robinson, Torvik and Verdier (2006) or Caselli and Michaels (2009), part of the windfall has been directly appropriated by the political elite.

There are then several reasons why cities persist. First, capital accumulation make cities better places to live than villages (Glaeser, Kolko and Saiz, 2001; Lucas, 2004). I find that cities are correlated with advantages in production, such as skill accumulation and infrastructure. But there is no direct evidence for the existence or lack of agglomeration effects. Cities also have with 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. Second, I document how 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 in urban growth. For instance, it accounted for 45% of urban growth in the 1990s (excluding the capital city). This means that any district sees its urban population double in 20 years as a result of internal growth, making urban decline very unlikely.

To conclude, in this context, resource booms have driven urbanization and infrastructure development, but this was maybe not enough to compensate for non-industrialization and weak institutions. 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 it grows 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, it remains as urbanized. That there could be a "right" and a "wrong" structural transformations is purely speculative and left for future research. But it is clearly a promising avenue to understand the role of cities on economic development.

6 Conclusion

I look at the effect of cash crop production on urbanization in two African countries, Ghana and Ivory Coast, during the 20th century. In line with the theoretical model, I show that consumer cities arise in booming regions. Cities persist in old producing regions although they become poor. I discuss possible explanations for both urban irreversibility and the lack of long-term economic growth. In terms of public policy, this means that: (i) Africa has followed a different urbanization pattern, as its structural transformation was driven by natural resource exports; (ii) the ability of cities to promote economic growth might depend on the type of structural transformation. If the sectors behind the urbanization process display small production linkages and agglomeration effects, a country can urbanize without long-term growth; (iii) resource booms have positive economic effects in the short term, as producing regions accumulate cities and infrastructure. But this might not be enough to increase per capita income, probably due to missing production linkages and weak state institutions; and (iv) natural advantages interact with path dependence to explain the spatial distribution of economic activity.

Both countries are consuming their last tropical forest and cocoa production will end in 20 years, unless they adopt intensive production strategies. In the meantime, the 2002-2011 Ivorian civil conflict was linked to the scramble for forested land. Since independence, Baoules from the *Centre* region were encouraged to colonize the West, Northern migrants worked on Baoule farms and western Betes were getting rich by selling land rights. This ethnic division of labor was working well till the 1980s, when the economic crisis and land pressure fueled ethnic tensions. Baoules and Betes complained about Northerners "stealing" their jobs, and Betes resented the wealth of Baoules. The catalyst to the conflict was the refusal by the government to recognize the Northern presidential candidate as "Ivorian" enough. Ghana has not experienced any conflict, but instead has discovered offshore oil and gas reserves. The Financial Times writes (see December 15th 2010): "Ghana expects Jubilee's oil and gas to help double its growth rate to more than 12 per cent next year, funding projects to boost infrastructure and laying the foundation for new industrial sectors." Whether the country will experience another resource curse is impossible to say, but the paper sheds some light on its first.

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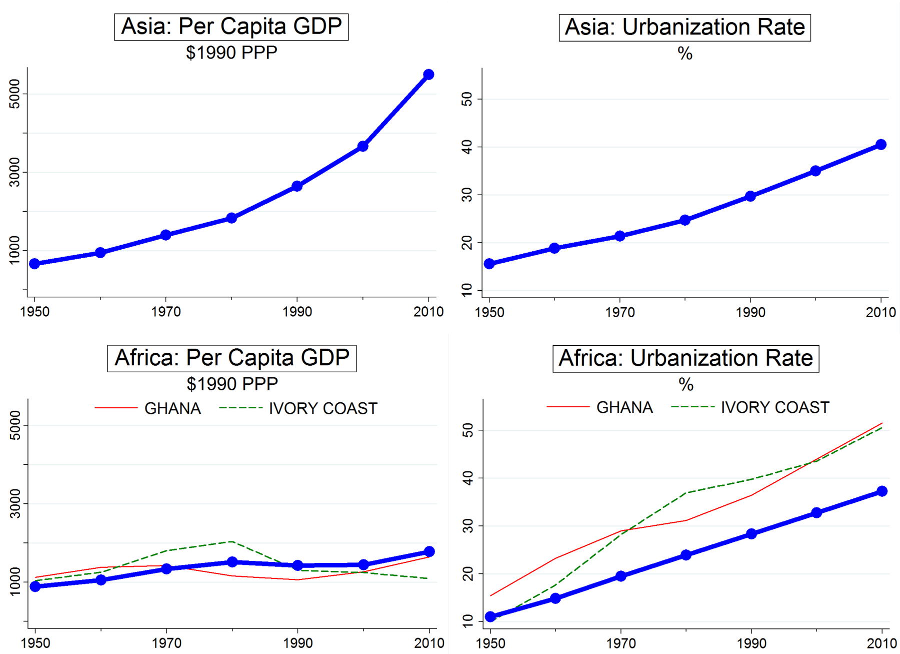
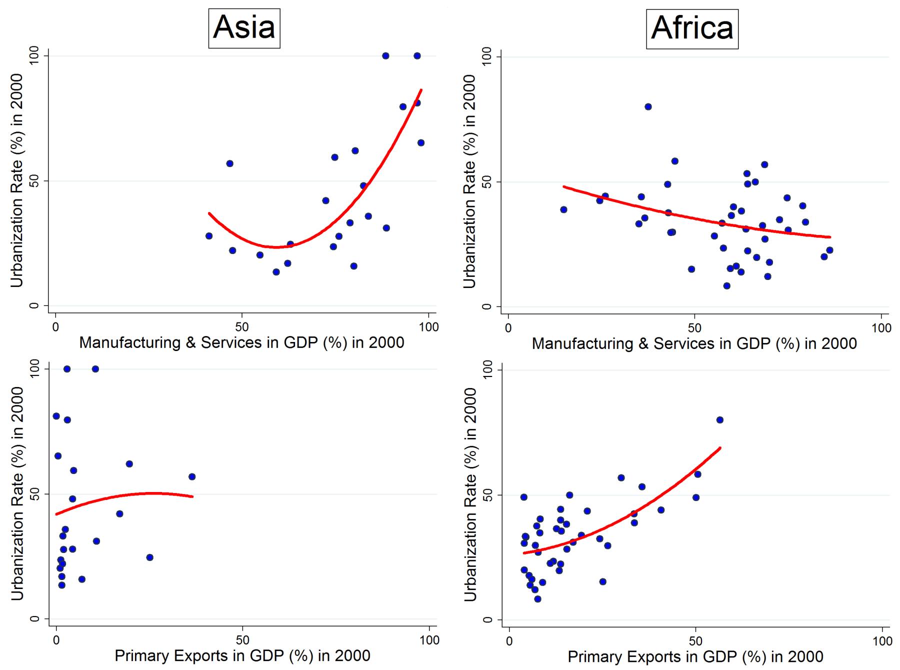
Figure 1: Urbanization and Economic Development, Asia versus Africa, 1950-2010.



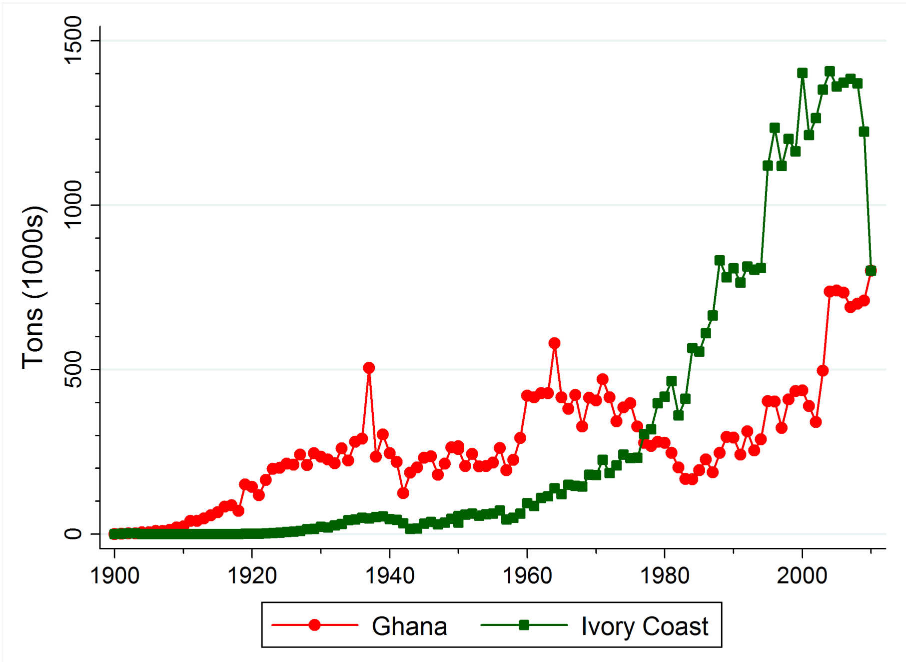
Sources: Maddison 2008, WUP 2009, WDI 2010, Author's calculations. Per capita GDP data is reported in 1990 Geary-Khamis dollars (constant, PPP). The urbanization rate is reported using national urban definitions. This figure shows the weighted average of per capita GDP and urbanization rate for 22 Asian 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.



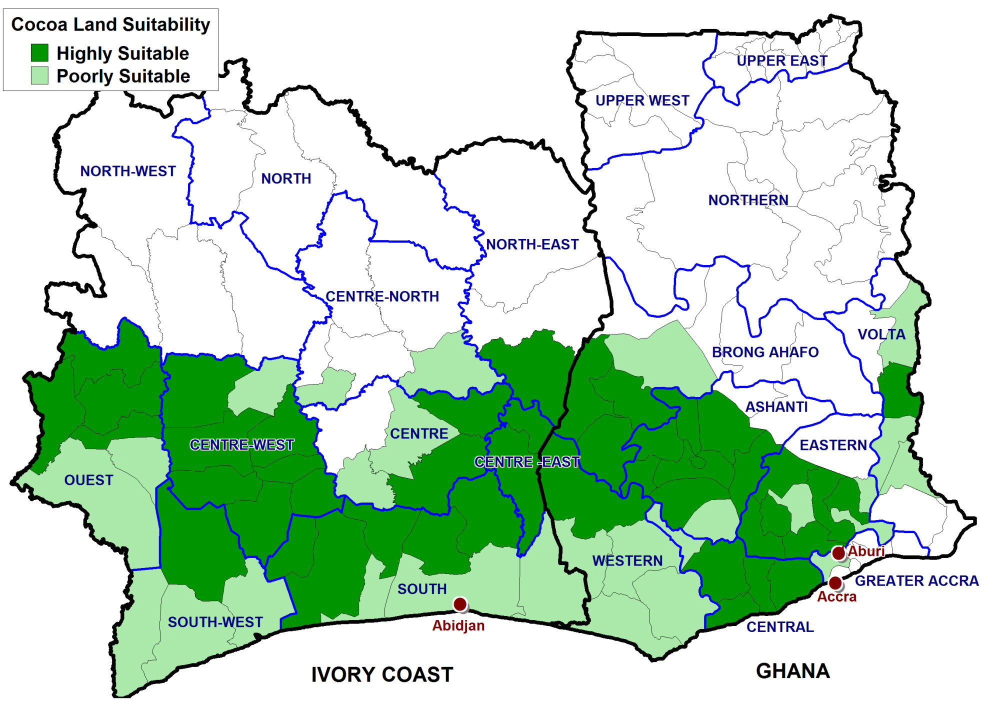
Sources: WUP 2009, WDI 2010, USGS 2010, FAO 2010, Author's calculations. The urbanization rate is reported using national urban definitions. The GDP is decomposed between manufacturing and services, primary exports (fuel, mining and cash crop exports) and agriculture (for domestic consumption). The share of agriculture in GDP is not reported. The figure distinguishes 22 Asian countries (Eastern Asia, South-Eastern Asia and South Asia) and 41 Sub-Saharan Africa countries. I display in red the quadratic prediction plots.

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



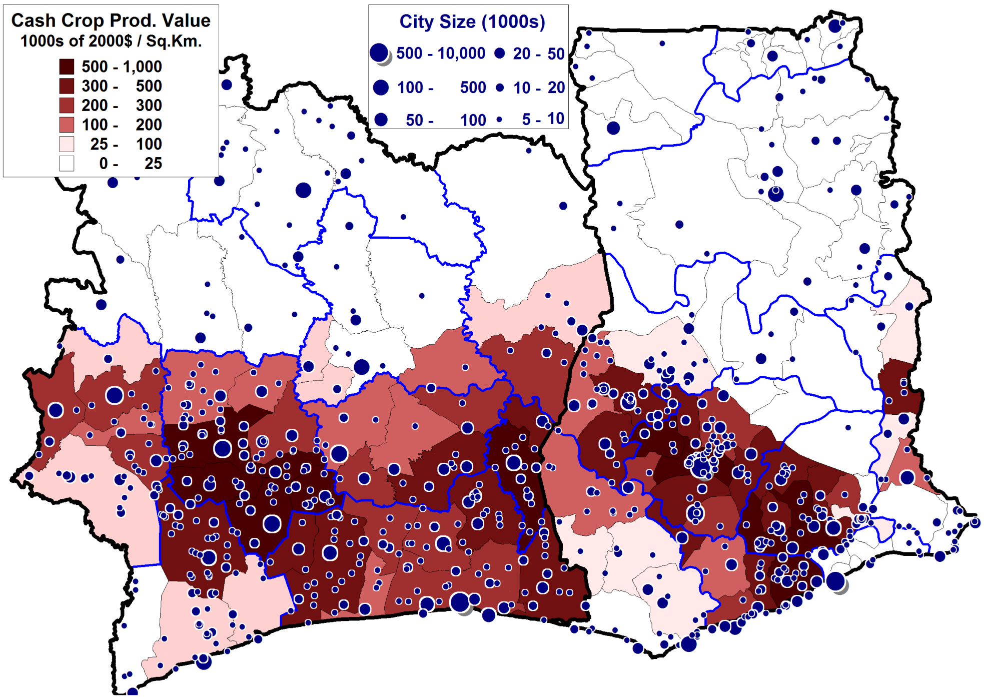
Sources: See Data Appendix A for more details. Both countries have extracted almost the same quantity of cocoa beans throughout the 20th century: 24 million tons in Ghana, 22.1 million tons in Ivory Coast. Production first boomed in the 1920s in Ghana, 1960s in Ivory Coast.

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



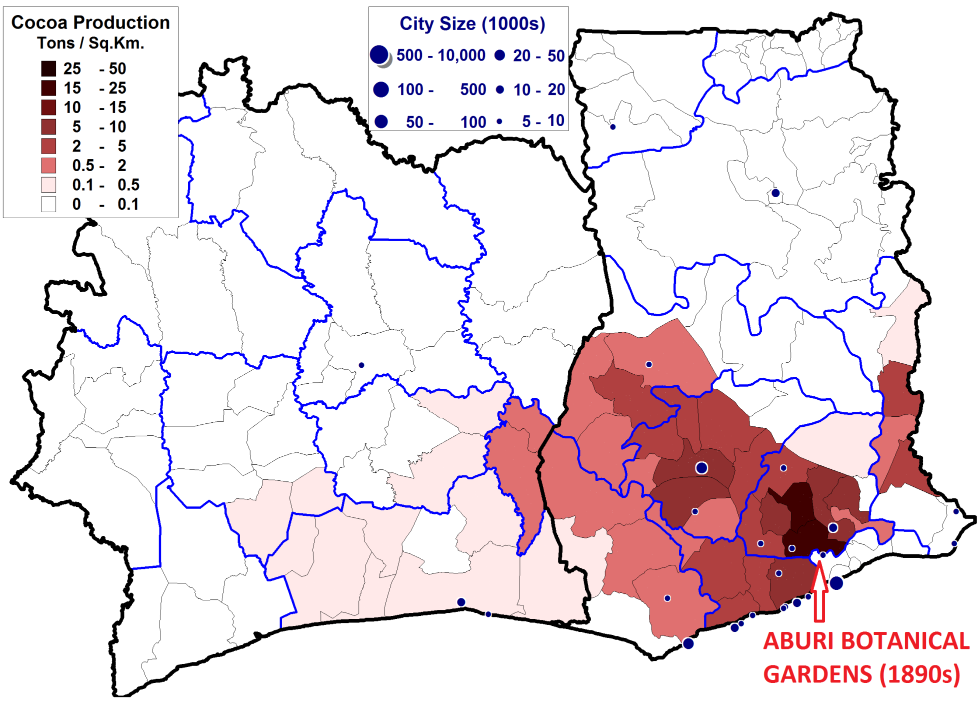
Sources: Historical soil classification maps, Globcover 2009 (see Data Appendix A for more details). The South of each country is covered with dense tropical forest. A district is defined as *suitable* if more than 25% of its area consists of cocoa soils (= tropical forest). A district is defined as *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).



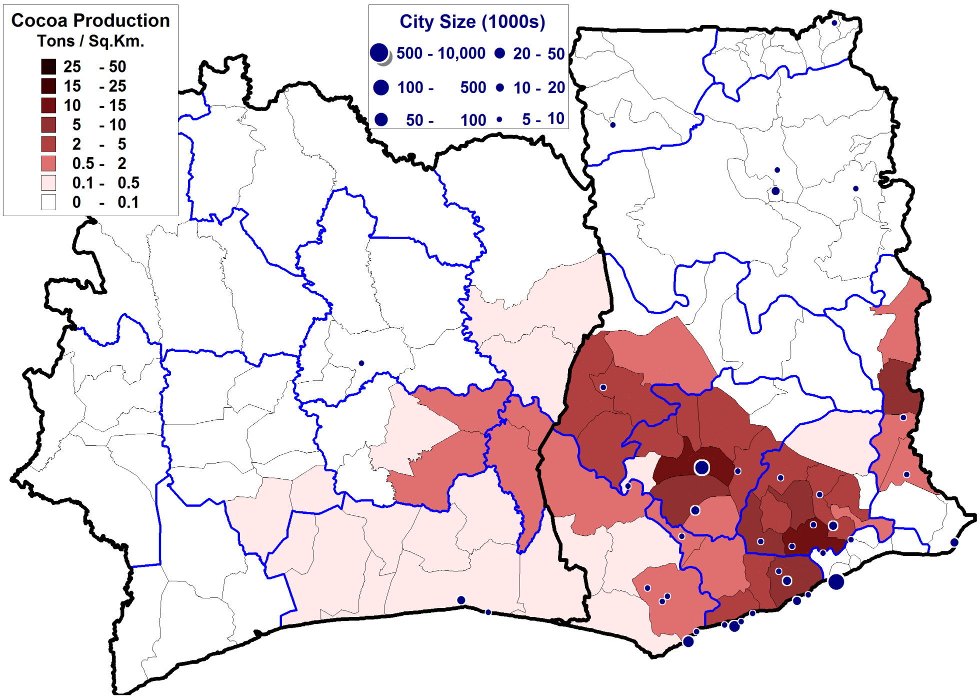
Note: The value of cash crop production includes the district total value (in thousand 2000$ per sq.km.) of cocoa production in Ghana from 1891 to 2000, and cocoa and coffee production in Ivory Coast from 1948 to 2000 (not much was produced before 1948). As there were very few cities one century ago, cities in 2000 represent the change in urbanization over one century.

Figure 6: District Density of Cocoa Production and Cities in 1931.



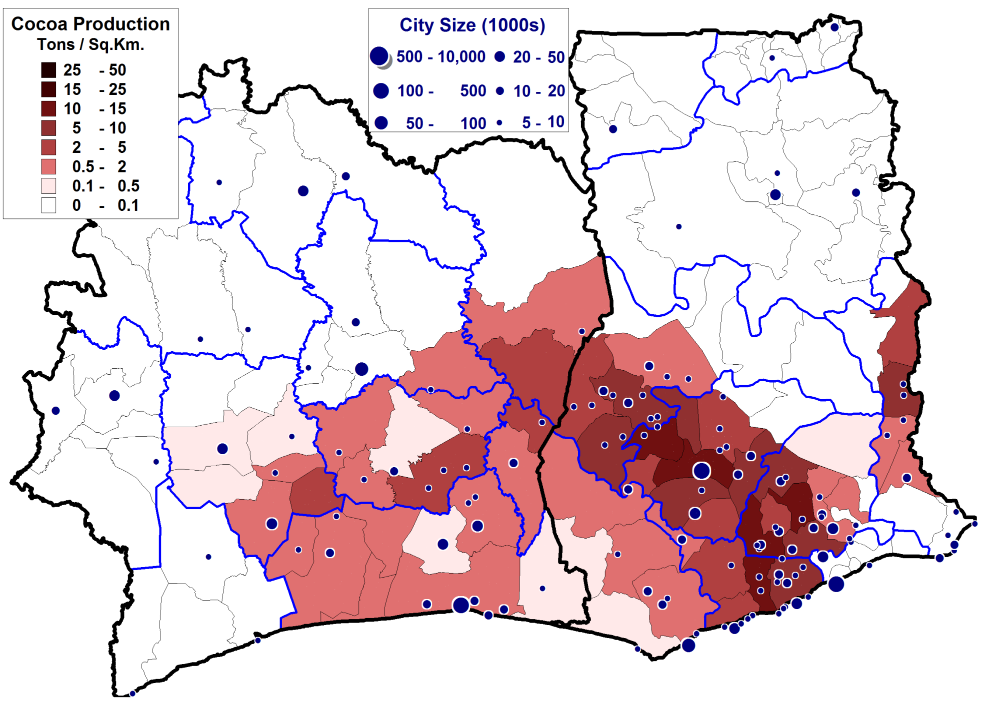
Note: See Data Appendix A for more details. Production first boomed around Aburi Botanical Gardens (*Eastern* province) where the British colonizer has distributed cocoa seedlings to local farmers in the 1890s. Maps for previous years (1891, 1901, 1911, 1921) are available upon request.

Figure 7: District Density of Cocoa Production and Cities in 1948.



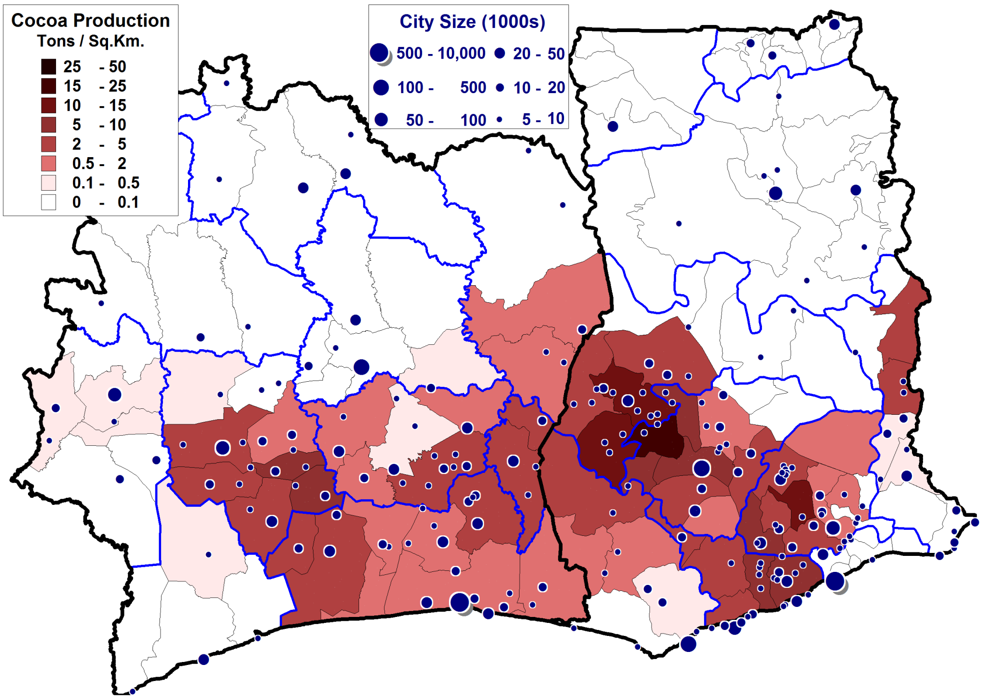
Note: See Data Appendix A for more details.

Figure 8: District Density of Cocoa Production and Cities in 1960-1965.



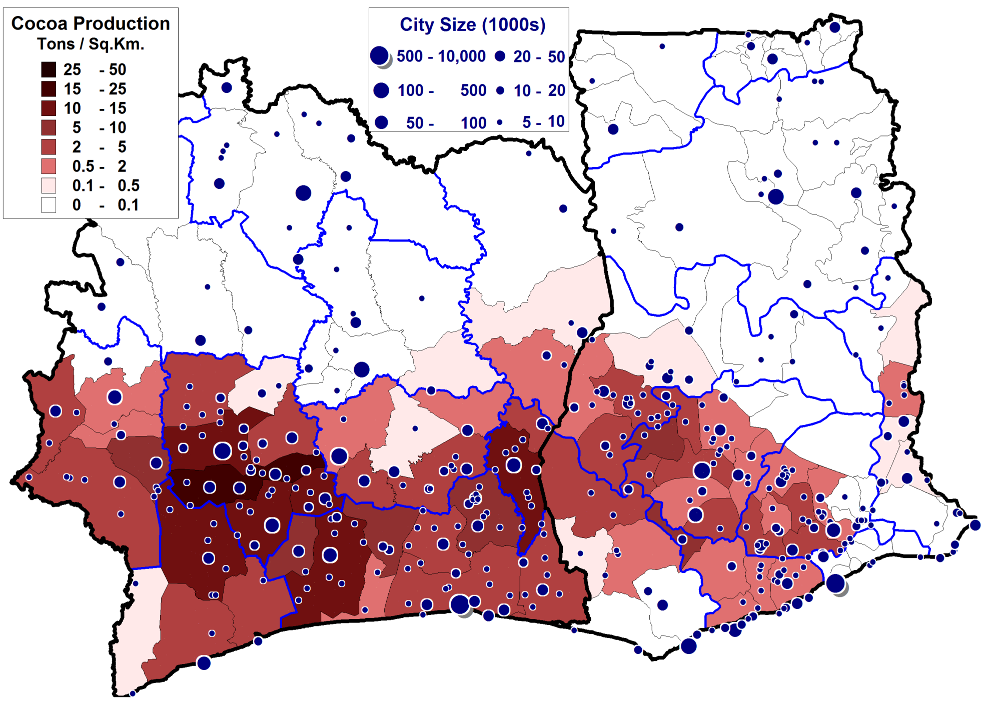
Note: See Data Appendix A for more details. The map is for 1960 in Ghana and 1965 in Ivory Coast, as the population census years differ for both countries.

Figure 9: District Density of Cocoa Production and Cities in 1970-1975.



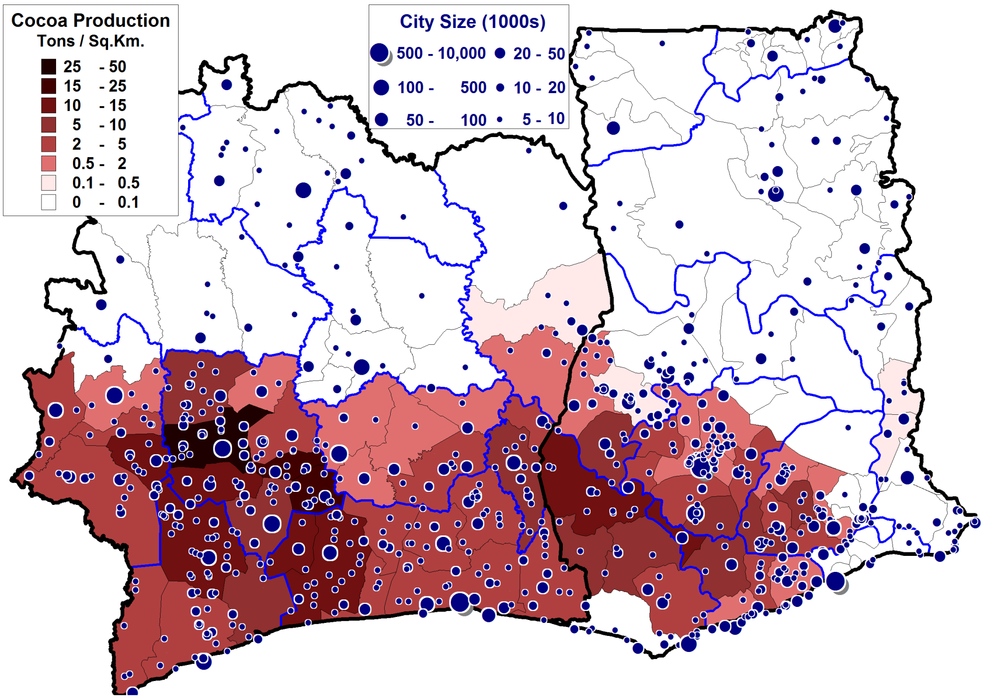
Note: See Data Appendix A for more details. The map is for 1970 in Ghana and 1975 in Ivory Coast, as the population census years differ for both countries.

Figure 10: District Density of Cocoa Production and Cities in 1984-1988.



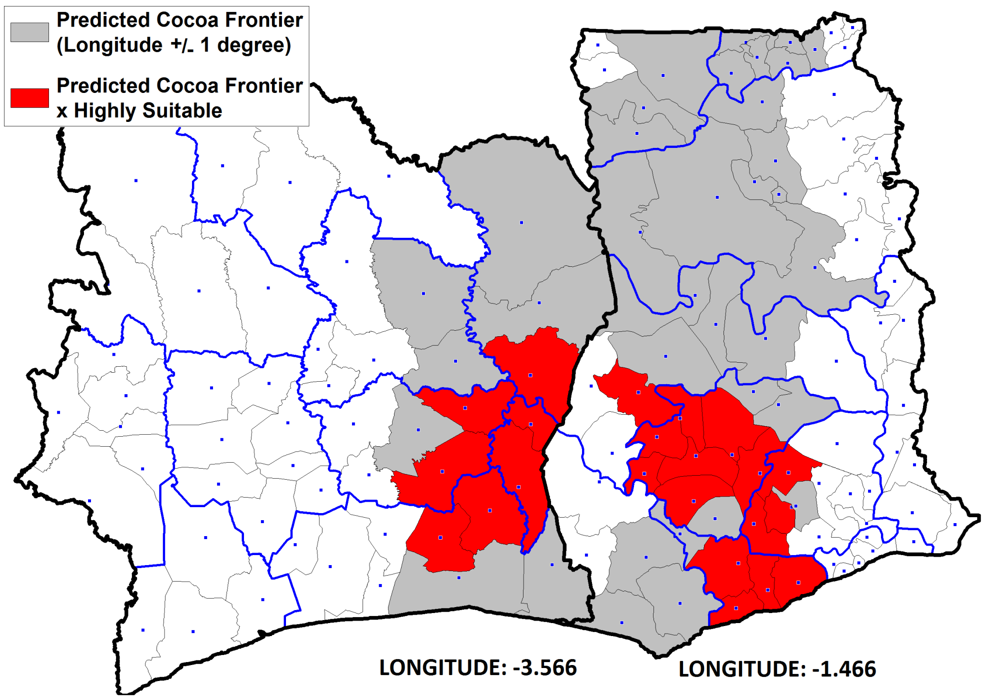
Note: See Data Appendix A for more details. The map is for 1984 in Ghana and 1988 in Ivory Coast, as the population census years differ for both countries.

Figure 11: District Density of Cocoa Production and Cities in 1998-2000.



Note: See Data Appendix A 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 12: Instrumentation for Cash Crop Production, 1960-1965.



Note: See Web Appendix D for more details how I construct the instrument. The map shows the instrument (*Predicted Cocoa Frontier* × *Highly Suitable*) for 1960 in Ghana, 1965 in Ivory Coast. Knowing the total endowment of forested land, the spatial starting point of cocoa production and the number of cocoa-producing households, and given that farmers change location every 25 years for agronomic reasons, I predict the longitude of the cocoa frontier for each census year. I then define as *Predicted Cocoa Frontier District* any district which is less than 1° in longitude from the predicted cocoa frontier. As the frontier only has a large impact for highly suitable districts, the instrument is *Predicted Cocoa Frontier* × *Highly Suitable*. I expect no independent effect of *Predicted Cocoa Frontier District*.

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	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Main Equation								
District Annual Value of Cash Crop Prod.	107.5***	73.8***	166.9**	89.0**	24.9**	24.0*	65.0*	66.8*
(Millions of 2000\$, Between $t-1$ and t)	(19.8)	(15.0)	(82.7)	(43.2)	(11.6)	(13.2)	(38.5)	(38.4)
Predicted Cocoa Frontier District Dummy			-1,035.5	-154.6			-488.2	-494.9
(District Longitude $\leq 1°$ from Predicted Cocoa Frontier)			(1,260.4)	(494.2)			(399.0)	(361.5)
Panel B: First Stage								
Predicted Cocoa Frontier Dist. $\times$ Highly Suitable Dist. Dummy			20.0***	16.6***			13.0***	12.9***
			(6.6)	(5.3)			(1.8)	(1.8)
Predicted Cocoa Frontier District Dummy			-2.8	-0.6			-0.9*	-1.2**
(District Longitude $\leq 1°$ from Predicted Cocoa Frontier)			(3.2)	(2.3)			(0.5)	(0.5)
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	0.81	0.51	0.81	0.65	0.67	0.65	0.67
District and Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Baseline Controls $\times$ Year	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at the district 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. 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). *District Annual Urban Growth* is the annual number of new urban inhabitants in the district between $t-1$ and t. *District Annual Value of Cash Crop Prod.* is the annual value of cash crop production in the district between $t-1$ and t. *Predicted Cocoa Frontier Dist.* $\times$ *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). Physical geography: district dummy for being a coastal district and 1900-2000 average annual precipitations (mm). Data Appendix A explains in details how I construct the variables.

Table 2: Cash Crops and Urbanization, Panel Estimation, Robustness, Ivory Coast 1948-1998

Dependent Variable:	Annual District Urban Growth (Annual Number of New Urban Inhabitants, Between $t-1$ and t)							Annual Dist. Growth Number Cities	Annual Dist. Growth Rural Pop.
	2SLS	2SLS	2SLS *100 km*	2SLS *50 km*	2SLS *CCE*	2SLS *10,000*	2SLS *20,000*	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Annual District Value of Cash Crop Prod.	89.0**		96.9**	65.2	89.0***	51.3	33.4	0.007**	22.3
(Millions of 2000$, Between $t-1$ and t)	(43.2)		(41.8)	(48.4)	(30.6)	(32.7)	(37.8)	(0.004)	(52.7)
Annual District Cash Crop Production		118.4**							
(Thousands of Tons, Between $t-1$ and t)		(51.3)							
Kleibergen-Paap rk Wald F Stat	9.0	6.3	10.0	9.6	5.9	9.0	9.0	9.0	0.9
Observations	250	250	250	250	250	250	250	250	250
R-squared	0.81	0.82	0.81	0.81	0.81	0.79	0.72	0.62	0.30
District and Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline Controls × Year	N	Y	N	Y	N	Y	N	Y	Y

Notes: Robust standard errors clustered at the district 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. 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). *District Annual Urban Growth* is the annual number of new urban inhabitants in the district between $t-1$ and t. *District Annual Value of Cash Crop Prod.* is the annual value of cash crop production in the district between $t-1$ and t. I instrument it with *Predicted Cocoa Frontier Dist.* $\times$ *Highly Suitable Dist. Dummy*, a dummy equal to one if the district is highly suitable and its longitude (measure by its centroid) happens to be less than 1° from the predicted cocoa frontier ($\approx$ 110 km). Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables. ***Col.(2):*** *Annual District 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):*** observations are clustered at the province level (N = 10). ***Col.(6):*** I consider district urban growth in localities $\geq$ 10,000 inh. ***Col.(7):*** I now consider the 20,000 threshold. ***Col.(8):*** *Annual Dist. Growth Number Cities* is the annual number of new cities in the district between $t-1$ and t. ***Col.(9):*** *Annual Dist. Growth Rural Pop.* is the annual number of new rural inhabitants in the district between $t-1$ and t.

Table 3: Cash Crops and Urbanization, Panel Estimation, Robustness, Ghana 1891-2000

Dependent Variable:	Annual District Urban Growth (Annual Number of New Urban Inhabitants, Between $t-1$ and t)							Annual Dist. Growth Number Cities	Annual Dist. Growth Rural Pop.
	2SLS	2SLS	2SLS *100 km*	2SLS *50 km*	2SLS *CCE*	2SLS *10,000*	2SLS *20,000*	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Annual District Value of Cash Crop Prod.	66.8*		75.6*	40.5	66.8**	55.2	44.4	0.003*	-
(Millions of 2000$, Between $t-1$ and t)	(38.4)		(42.1)	(27.6)	(30.6)	(37.4)	(36.2)	(0.001)	-
Annual District Cash Crop Production		83.6*							
(Thousands of Tons, Between $t-1$ and t)		(48.5)							
Kleibergen-Paap rk Wald F Stat	51.5	38.5	42.0	41.0	113.1	51.5	51.5	51.5	-
Observations	711	711	711	711	711	711	711	711	-
R-squared	0.67	0.67	0.67	0.67	0.48	0.67	0.67	0.26	-
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 district 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. 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). *District Annual Urban Growth* is the annual number of new urban inhabitants in the district between $t-1$ and t. *District Annual Value of Cash Crop Prod.* is the annual value of cash crop production in the district between $t-1$ and t. I instrument it with *Predicted Cocoa Frontier Dist.* × *Highly Suitable Dist. Dummy*, a dummy equal to one if the district is highly suitable and its longitude (measure by its centroid) happens to be less than 1° from the predicted cocoa frontier (≈ 110 km). Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables. ***Col.(2):*** *Annual District 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° (≈ 110 km). ***Col.(4):*** I consider the 50 km threshold. ***Col.(5):*** observations are clustered at the province level (N = 10). ***Col.(6):*** I consider district urban growth in localities ≥ 10,000 inh. ***Col.(7):*** I now consider the 20,000 threshold. ***Col.(8):*** *Annual Dist. Growth Number Cities* is the annual number of new cities in the district between $t-1$ and t. ***Col.(9):*** *Annual Dist. Growth Rural Pop.*: this district variable is not available for Ghana.

Table 4: 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**	100.6***	71.0***	86.6***	63.9***	82.0***	74.5***	87.3***
(Millions of 2000$, Between t_0 and T)	(57.7)	(23.0)	(20.9)	(31.3)	(15.7)	(18.4)	(18.8)	(23.0)
Panel B: First Stage								
Highly Suitable District Dummy			26.1***	24.6***			9.1***	7.8***
			(5.2)	(4.5)			(1.0)	(1.1)
Kleibergen-Paap rk Wald F Stat	-	-	23.6	23.7	-	-	64.1	43.9
Observations	50	50	50	50	79	79	79	79
R-squared	0.56	0.81	0.54	0.81	0.86	0.90	0.86	0.90
Baseline Controls	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. There are 50 districts in Ivory Coast, and 79 districts in Ghana. All regressions include a dummy equal to one if the district contains a national city and district area (sq km). *District Annual Urban Growth* is the annual number of new urban inhabitants in the district between t_0 and T, the first and the last years of the data set: 1948 and 1998 for Ivory Coast, 1891 and 2000 for Ghana. *District Annual Value of Cash Crop Prod.* is the annual value of cash crop production in the district between t_0 and T. I instrument it with *Highly Suitable District Dummy*, a district dummy equal to one if more than 50% of its area consists of forest ochrosols, the best cocoa soils. Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables.

Appendices

A Data Description

This appendix describes in details 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.[33] Ivorian districts correspond to administrative districts – or *départements* – in 1998.[34] Both Ghanaian and Ivorian districts belong to 10 regions.

Urban and Population Data:
I collect urban population data from various decadal statistical publications.[35] 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, cash crop 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, cash crop 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 total population and rural population for Ghanaian districts.

Cash Crop Production and Price Data:
The data on cash crop production was collected from a variety of sources.[36]

[33]Historical production data is not available at the administrative district level. The number of Ghanaian 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.

[34]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.

[35]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.

[36]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

Whether for Ghana or 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. In the end, my data set corresponds to 79 districts in Ghana every year between 1891 and 2009, and 50 districts in Ivory Coast every year between 1948 and 2009.[37] I then use those same sources and additional sources to obtain the international and producer prices in 2000$.[38] By multiplying cocoa production and the deflated producer price, I get the annual deflated total value (also in 2000$) 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 calculate how much 2000$ of production were earned 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 or mixed virgin forest/croplands, which were areas with virgin forest before it was cleared for cash crop production. I verify that the GIS of tropical forest matches historical cocoa soil classification maps.[39] A district is defined as *suitable* if more than 25% of district area consists of cocoa soils, which perfectly correspond with the tropical forest. A district is then *highly suitable* if more than 50% of district area consists of forest ochrosols, the best cocoa soils. It is defined as *poorly suitable* if it is suitable, but not highly suitable. The Forest-Savanna border is obtained using GIS. Then, climate data comes from *Terrestrial Air Temperature and Precipitation: 1900-2006 Gridded Monthly Time Series, Version 1.01*, 2007, University of Delaware.

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).[40] As I have the geographical coordinates of each mine and the export price (2000$), I reconstruct the total value of mining production annually for each district.

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*.

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

[38] 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 significantly different from 0, which was the case for several years in Ghana.

[39] 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).

[40] 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).

Household Survey and Census Data:
I use household surveys and census microdata to calculate a range of statistics. In Ivory Coast, those 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, those 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 have used various agronomic statistics at the national or regional levels. In addition to household surveys, those are the sources which I have exploited: Ruf (1995*a*), Ruf (1995*b*), Teal, Zeitlin and Maamah (2006) and FAO (2010). The 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 controlling variables supposed to capture transportation infrastructure at independence (1958 in Ghana, 1960 in Ivory Coast). A GIS data set of railways and roads today is obtained from *Digital Chart of the World*. I then use various sources to 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. Lastly, I know from Dickson 1968 and *Atlas de Côte d'Ivoire, 1971-1979* the location of international ports around 1960. I then use GIS to create district dummies for whether a district is connected to the railway network in 1960, the paved road network in 1960 and contains an international port in 1960. Second, I collect infrastructure data for a cross-section of districts around 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 facility: 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. For Ivory Coast, I first use the official publication *Elephants d'Afrique 1995-2000* to obtain an index of the number of primary schools at the *sous-préfecture* level (N = 185) and the number of secondary schools at the district level in 1994.[41] I then use *WHO Public Health Mapping for Ivory Coast* 2003 to obtain the number of hospitals and health centres for each district in 2003. I use the 1998 EP and 2002 ENV household surveys to estimate for each district the share of rural and urban inhabitants with access to electricity, tapwater and a phone. Lastly, I use a recent Michelin road map to estimate for each district in each country the density of paved roads (in meters per sq.km.).

[41] The primary school index is categorized as follows: 0 (0-5 primary schools per *sous-préfecture*), 1 (5-10), 2 (10-20), 3 (20-50), 4 (50-100), 5 (100-150) and 6 (> 150). The secondary school index is categorized as follows: 0 (1 secondary school per district), 1 (2-5), 2 (5-10), 3 (10-15), 4 (15-30) and 5 (> 30).

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.[42]

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*). I then collect data on the structure of their GDP in 2000 using the following sources: World Bank (2010*b*), FAO (2010) and USGS (2010).

B Evidence on Linkages and Long-Term Effects

This appendix provides historical and cross-sectional evidence on rural-urban linkages in new producing regions and the long-term effects of cash crop production. The sources I use for my analysis 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.

B.1 Rural-Urban Linkages in New Producing Regions

I first use as an example two regions that have recently boomed (see Figure 4): (i) the *Centre-West* region of Ivory Coast between 1988 and 1998, where cocoa production density increased from 7.0 to 14.5 tons per sq km and urban population by 69.5%, and (ii) the *Western* province of Ghana between 1984 and 2000, where cocoa production density increased from 2.3 to 16.8 tons per sq km and urban population by 112.4%. Combining household survey and census data, I look at the sectoral decomposition of urban employment growth. More than 1/3 comes from the primary sector, and around 50% from the service sector. The contribution of industry is small, and even negative in Ivory Coast.[43] Interestingly, cocoa farmers have notably contributed to the primary sector effect, as they respectively explain 32.1% and 16.9% of urban employment growth in Ivory Coast and Ghana. The main sectors behind the tertiary sector effect are trade, personal services, transport, communications, education and health. Altogether, they account for more than 90% of this effect. This decomposition argues in favor of consumption linkages, but I now discuss the roles of consumption and production linkages.

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[42]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.*

[43]At the national level, the employment share of industry was only 6.0% in 1985-88 (6.3% in 2002) in Ivory Coast, and 9.4% (12.3% in 2005) in Ghana. The same share is less than 25% when considering Abidjan or Accra only.

B.1.1 Consumption Linkages

The main hypothesis is that urbanization is driven by consumption linkages, the fact 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." I focus on my two regional examples. First, the influx of cocoa-producing households has respectively accounted for 79.7% and 62.9% of total population change in the *Centre-West* region of Ivory Coast between 1988 and 1998 and *Western* province of Ghana between 1984 and 2000. 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 respectively 33.4% and 28.4% wealthier than other farmers in the forested areas of Ivory Coast in 1985-88 and 1998-2002. In the forest regions of Ghana, they are respectively 22.1% and 20.2% relatively wealthier in 1987-88 and 1998-2005.[44] I also find that cocoa farmers own relatively more durable goods.[45] Third, I look at the structure of household expenditure for cocoa and non-cocoa farmers in forest areas. I find that cocoa farmers allocate around 30% of total consumption to home food production (mostly starchy roots, vegetables and cereals), 30% on food expenses (mostly seafood, cereals, sweets and meat) and 40% on other goods and services (mostly clothing, transfers and events, education, health and housing). The whole structure is stable across space and time. Although I cannot identify which good is *urban* per se, I assume that expenses imply the growth of the urban sector.[46] To summarize, cocoa farmers account for around 2/3 of population change in a booming region. Those farmers are around 30% wealthier than other farmers, and they spend around 70% of their income on urbanizing goods. If production had not boomed and if cocoa farmers had been *counter-factually* replaced by half less 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.[47] What share of urban employment

[44] 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. Cardinal (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." and "The industrious planter has been forced to hire labor in order to cope with the fruits of his industry and is gradually ceasing to be a working farmer with the inevitable result that in course of time he will be a non-working landlord."

[45] For each good, I regress a dummy equal to one if the household owns it on a dummy equal to one if the household produces cocoa, including village fixed effects. Results not reproduced here show that they more often own a fan, a radio, a TV, a bicycle, a bike and a car.

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

[47] 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

growth can be explained by booming urban expenditure is difficult to say, but evidence converges towards large consumption linkages.

The analysis in section 4 has confirmed that small cities significantly contributes to urban growth. In the *Centre-West* region of Ivory Coast, cities between 5,000 and 20,000 inhabitants explained 63.3% of urban growth between 1988-1998. They explained 53.9% of urban growth in the *Western* province in Ghana between 1984 and 2000. Although I do not have data on the composition of such cities, they are likely to be more "agricultural" than larger cities, where economic activities are more diverse and disconnected from the rural context. The fact that the primary sector explains more than 1/3 of urban employment growth is in line with this feature of the evolution of cities. Then, cocoa farmers living in city are mostly landowners. They are wealthier, are more likely to have sold or rented land in the last year and invest more in education than cocoa farmers living in countryside. Their urban residency could represent a preference for urban living.

B.1.2 Production Linkages

Cocoa cultivation could have backward production linkages if it requires inputs produced and distributed by the urban sector. This is very unlikely given the small level of "urban" inputs used in cocoa production. First, average cocoa yields have almost doubled between 1960 and 2009.[48] But this increase has been permitted by the diffusion of high-yielding cocoa trees (*Upper Amazon* variety and hybrids) from the 1960s (Ruf 1995*a*, p.75-79). Aside from this innovation, production has remained traditional and has not evolved much in one century. 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 (12.0% in 2002). This share was 0.4% in Ghana in 1987-88 (10.0% in 2002). Then, 23.5% of Ivorian cocoa farmers were using insecticides in 1985-88 (40.6% in 2002). This share was 11.6% in Ghana in 1987-88 (86% in 2002). From Ghanaian data reported by Teal, Zeitlin and Maamah (2006), I calculate that cocoa farmers only used 3.6 kg of fertilizer and 0.14 liter of insecticide per hectare in 2002. FAOSTAT data indicates that Indonesian cocoa farmers used 95 kg of fertilizer and 0.80 liter of insecticide per hectare. By comparison, the world used 94 kg of fertilizer and 3 kg of insecticide per hectare considering all crops. The data also reveals that each country imports its consumption of chemical fertilizers and insecticides. Those imports could necessitate traders for their distribution, but low adoption rates till very recently cast doubt on the magnitude of this channel.

Cocoa production has few forward production linkages. First, cocoa beans are not processed locally but directly exported. Cocoa farmers harvest cocoa pods during the peak season, which are open to collect fresh cocoa beans. Those are fermented between banana leaves, and dried by being spread in the sun on

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production was profitable, which was the case with cocoa and coffee.

[48] Cocoa yields have increased from 327 to 611 kg per hectare in Ivory Coast between 1960 and 2009, and from 236 to 400 kg per hectare in Ghana over the same period.

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." Asian cocoa-producing countries are penalized by the lack of dry season, which forced them to invest in artificial drying equipment. African countries are favored by their dry season, which has "maybe contributed, in Africa even more than in the rest of the world, to limit investment expenditures" (Ruf 1995*a*, p.296). Then, chocolate manufacturing is highly capital-intensive and high temperatures require refrigerated factories and ships so that chocolate does not melt. Those constraints and the failure of African countries to boost manufacturing due to rent-seeking (e.g., Bates, 1981) could explain why cocoa processing did not develop in Africa. Using FAOSTAT, I find that Ghana and Ivory Coast were responsible for 49.9% of cocoa exports in 2008, but only 0.9% of chocolate exports. Second, profits from cocoa cultivation could be reinvested to start new sectors. Yet, as explained by Laitner (2000), savings take the form of land accumulation in poor countries. The agronomic literature has shown how the proceeds of cocoa farming were mainly reinvested in buying new land, building houses and sending children to school (Hill, 1963; Ruf, 1995*a*). The cocoa sector is dominated by a myriad of smallholders and they have been reluctant to deposit their savings in the formal bank system (Ruf, 1995*a*, p.379). Proceeds from the cocoa industry were unlikely to fund local industrial projects. Third, cocoa beans must be transported from producing areas to the port. The logistics of cocoa beans export involves local and regional depots, transportation companies and port administration. Since their activity is mostly urban-based, this could translates into more urbanization. But I find that people working in the export of cash crops only represent 0.8% of the tertiary sector in the forest cities of Ivory Coast (1985-88). The contribution of "transport" to the growth of services in booming regions was thus related to the trade of other goods.

B.2 The Long-Term Effects of Cash Crop Production

Given the lack of historical data at a fine spatial level for both Ghana and Ivory Coast, I limit my analysis to rough cross-sectional correlations on contemporary data. I compare new, old and non-producing districts. I discuss possible explanations for both aggregate income stagnation and urban irreversibility.

B.2.1 Urbanized But Poor in Old Producing Regions

For each country, I collect district data along various dimensions around 2000. For Ivory Coast, I use the same decomposition of 50 districts as for the panel data set on cocoa and cities. For Ghana, data is available for 110 administrative districts around 2000, which are significantly different from the 79 cocoa districts of my panel data set. Using historical data on cocoa suitability, production and yields, I create four district dummies: *Very Old Cocoa District* if production boomed there in the 1930s-1940s, *Old Cocoa District* if production boomed there in the 1950s-1960s, *New Cocoa District* if production boomed there in the 1970s-1980s and *Very New Cocoa District* if production boomed there in the 1990s-2000s. Districts where production never boomed are taken as a control group. This includes districts where land is not suitable and districts where land is suitable but production has never exceeded a certain threshold.[49] In Ghana, no district boomed in the 1970s-1980s, while in Ivory Coast no district boomed before the 1950s. I then regress various outcomes on the set of district dummies, including the same controls as before and clustering standard errors at the regional level. Results are reported in Table B.1 for Ivory Coast in 1998-2002 and Table B.2 for Ghana in 1998-2005. First, columns (1) confirm that producing districts are relatively more urbanized. Second, there is no clear relationship between the urban hierarchy and the income hierarchy of districts (see col.(1) and col.(2)). Third, very new cocoa districts have a relatively higher rural per capita income (see col.(3)). Other districts have the same rural income as non-producing districts. Fourth, the effects on urban per capita incomes depends on the context (see col.(4)). Cities in Ivory Coast have been directly hit by the economic crisis and adjustment programs. Ivorian producing districts had more cities but those cities were not necessarily wealthier. On the contrary, Ghana was experiencing economic growth, and this directly benefitted cities in producing districts (see Figure 1 which shows GDP for Ghana and Ivory Coast). Fifth, very new cocoa areas are receiving more interregional migrants (see col.(5)). Sixth, there is no clear pattern as regards the structural composition of producing districts. If new producing districts are slightly more industrialized in Ivory Coast, they are more agricultural in Ghana. Overall, the employment share of industry remains small in both countries. Although based on cross-district evidence, these results point to the following story: booming regions are wealthier and attract migrants. This creates job opportunities in the urban sector and cities arise. When cocoa production leaves the region, income decreases and there are potentially few production linkages. As cities persist, old producing districts are more urbanized but they remain poor. Income figures reported here use per capita consumption, which is around 70% of per capita GDP. This means that old producing regions have a per capita GDP of around 1,000 $1990 and an urbanization rate around 40-70%. This is consistent with aggregate figures.

[49]Ideally, we would identify district booms by using years in which district cocoa yields peak. Indeed, focusing on production hides the fact that farmers can compensate decreasing yields by exploiting formerly protected forests. In the absence of district yield data, I use district production per rural capita in Ivory Coast. I categorize districts according to which year the surplus per capita was at its highest. I then verify that this categorization is in line with regional yields data. For Ghana, I have historical production data for 79 cocoa districts but no data on rural population. Instead, I use the fact that the westward shift has been highly sequential. Production per capita (and regional yields) peaked in the *Eastern*, *Central* and *Volta* provinces in the 1930s-1940s. It peaked in the *Ashanti* and *Brong-Ahafo* provinces in 1950s-1960s. Production declined everywhere in the 1970s and 1980s as the producer price was low. It peaked in the *Western* province in the 1990s. I can thus identify the decade each suitable district has boomed by using the decade its province has boomed.

B.2.2 Aggregate Income Stagnation

Income figures reported in tables B.1 and B.2 use per capita consumption, which is around 70% of per capita GDP. This means that old producing regions have a per capita GDP of around 1,000 $1990 and an urbanization rate around 40-70%. How can this shed light on Figure 1, which shows that aggregate income has almost stagnated over half a century? First, the contemporaneity of regional cocoa booms and busts implies that aggregate income only slightly increases, since rising incomes in new producing regions are compensated by constant or declining incomes in old producing regions. Income does not collapse there, as cocoa trees can bear produce for up to 50 years. Around one third of the inhabitants of old producing regions still belong to a cocoa-producing household. Then, farmers can convert their old cocoa farms to the production of food crops for urban centers. In Ghana, the area devoted to maize and cassava has been multiplied by 2.7 in the old producing regions. In Ivory Coast, it is mostly yams which have benefited from reconversion. Second, evidence from the previous section indicates that old producing districts are more urbanized but not significantly richer than districts that have never experienced any boom. The lack of production linkages and limited agglomeration effects probably account for this result. Third, cocoa booms have probably contributed to the persistence of inefficient institutions in both countries, which have then affected economic development. According to Polity IV data, between 1960 and 2000, Ivory Coast has never been a fully-fledged democracy while Ghana has been one only for two years (1979, 1980). During the 1948-2000 period, the government has captured 40.5 cents in Ivory Coast and 49.9 cents in Ghana for each dollar of cocoa and coffee production. During the 1961-2000 period, the "cocoa tax" has then represented 17.8% and 18.8% of government expenditure in Ivory Coast and Ghana (with around two third being allocated to consumption and one third to investments). Their governments have adopted the "wrong" economic policies, such as high tariffs, large black market exchange rate premia or sovereign overborrowing (Teal, 2002; Cogneau and Mesplé-Somps, 2002). Historians have then documented how the rent was grabbed by the political elite and wasted on "white elephants". In particular, as a large share of government expenditure was concentrated in the main city (Accra and Abidjan), both countries have a high primacy rate around 2000 (30.5% in Ghana, 34.8% in Ivory Coast).[50] Weak institutions and the unequal distribution of the rent could then explain why the economy has not developed much despite the cocoa windfall.

[50] Houphouët-Boigny made his village of birth Yamoussoukro the capital of the country from 1983. Its population was multiplied by 119.2 between 1955 and 1998, which made it the fastest-growing city in the country. He built there an university, an international airport, and even a basilica, which costed the country 3.1% of the GDP in 1989. According to Transparency International and CCFD-Terre Solidaire, Houphouët-Boigny would have grabbed around 8 billion $2000, which makes him the fourth more corrupt dictator in the world.

B.2.3 Factors of Urban Irreversibility

There are a few reasons why cities persist despite a low income level. The model is blind to capital accumulation and population growth. First, capital accumulation make cities better places to live than villages. Cities in old producing districts could also be better places to live than other cities. Cities have advantages in production. Urban inhabitants are 74.7% and 90.0% wealthier than rural inhabitants in Ghana and Ivory Coast. Those premiums decrease to 29.5% and 32.5% when excluding the capital city and accounting for local prices. The difference could then come from urban inhabitants being more skilled and cities offering a higher return to human capital. Urban inhabitants are 57.2% and 101.4% more literate than rural inhabitants in Ghana and Ivory Coast. Another culprit behind the production advantage of cities is infrastructure. Using the same methodology and district decomposition as for the income analysis, I verify that both cities and villages in old producing districts have relatively better infrastructure around 2000. Appendix Table B.3 shows the main results for Ghana. Rural and urban inhabitants of old producing districts are more likely to have access to a primary school (col.(1)-(2)), a health centre (col.(3)-(4)), a post office (col.(5)-(6)), electricity (col.(7)-(8)) or a road (col.(9)). Results for Ivory Coast and other types for infrastructure (secondary schools, hospitals, telephone lines and water development) are similar (see Web Appendix F). Lastly, I cannot provide direct evidence on (the lack of) agglomeration economies, but the fact that the sectoral composition is not that different between old and other producing districts cast doubt on their magnitude. Cities have then advantages in consumption. People can show preference for urban living. The share of people working in leisure and recreational activities is 2.8 times higher in cities than in villages. Cities also have durable housing. I find that urban inhabitants are 3.8 and 3.0 times more likely to have their house built in hard material (concrete, stone, wood). Lastly, infrastructure also represent consumption advantages. For instance, urban inhabitants are 5.1 more likely to have access to electricity, i.e. light at night time. I find that cities of the old producing districts also have more advantages in consumption than other cities. Second, the demographic transition boosts urban growth. If human capital accumulation and health infrastructure decrease more urban mortality than they decrease urban fertility, the effect of natural resources is multiplied the next generation as a result of natural increase. I have collected data on mortality and fertility in capital cities, other cities and villages in both countries from 1960. The demographic transition has been “urban” first as mortality has decreased in cities first. The crude rate of natural increase _ the difference between the crude rates of birth and the crude rate of death _ reached its highest point (3.1% in Ghana, 3.7% in Ivory Coast) in the early 1970s for cities and the late 1980s for villages. Using the census data and a simple model of demographic growth as a function of natural increase and migration, I find that natural increase has become a major factor of urban growth. Its contribution was around 45% in the 1990s, excluding the capital city. This means that any district sees its urban population double in 20 years as a result of internal growth. Those results are described in Web Appendix F.

Appendix Table B.1: The Long-Term Effects of Cocoa Production in Ivory Coast, 1998-2002.

Dependent Variable:	Urb. Rate (%)	Per Capita Consumption ($1990)			Migr. Other Region (%)	Employed in Sector: Agriculture	Industry	Services
Sample:		All	Rural	Urban	15-45 y.o.	15-45 y.o.	15-45 y.o.	15-45 y.o.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Very New Cocoa District	20.5***	39.1*	153.0*	-30.9	0.27***	-0.07	0.05***	0.04
Boom in the 1990s	(1.5)	(13.1)	(59.6)	(21.9)	(0.02)	(0.05)	(0.01)	(0.03)
New Cocoa District	33.1***	-98.6**	-24.8	-162.9***	0.07*	-0.05	0.06**	0.00
Boom in the 1970s-80s	(3.7)	(25.2)	(45.4)	(16.8)	(0.03)	(0.07)	(0.02)	(0.06)
Old Cocoa District	16.0***	-41.8*	48.6	-70.9	0.01	0.18	-0.04	-0.14
Boom in the 1950s-60s	(2.2)	(16.4)	(33.8)	(51.5)	(0.04)	(0.14)	(0.03)	(0.10)
National Average	39.7	702.3	645.1	841.6	0.32	0.61	0.07	0.31
Observations	50	50	48	50	50	50	50	50
R-squared	0.75	0.58	0.33	0.47	0.65	0.29	0.27	0.26
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Robust standard errors clustered at the group level = [very new, new, old] in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. I use the data set of cities and the 1998 and 2002 ENV household surveys to create variables at the district level around 2000, using the district decomposition of 1998 (N = 50). *Very New Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1990s. *New Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1970s-1980s. *Old Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1950s-1960s. ***Col. (1):*** *Urb. Rate* is the district urbanization rate (%) in 1998. ***Col. (2)-(4):*** *Per Capita Consumption* is 1998-2002 district mean per capita consumption in constant $1990 PPP for all the localities, rural localities only and urban localities only. A locality is defined as urban if it has more than 5,000 inhabitants. ***Col. (5):*** *Migr. Other Region* is the 1998-2002 district share (%) of 15-45 year-old active individuals born in another region. ***Col. (6)-(8):*** *Employed in Sector:* is the 1998-2002 district share (%) of 15-45 year-old active individuals employed in agriculture, industry and services. Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables.

Appendix Table B.2: The Long-Term Effects of Cocoa Production in Ghana, 1998-2005.

Dependent Variable:	Urb. Rate (%)	Per Capita Consumption ($1990)			Migr. Other Region (%)	Employed in Sector: Agriculture	Employed in Sector: Industry	Employed in Sector: Services
Sample:		All	Rural	Urban	15-45 y.o.	15-45 y.o.	15-45 y.o.	15-45 y.o.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Very New Cocoa District	6.8	197.2***	124.7**	260.5***	0.18***	0.06***	-0.01	-0.05***
Boom in the 1990s	(3.3)	(32.6)	(38.8)	(41.8)	(0.02)	(0.01)	(0.01)	(0.01)
Old Cocoa District	13.7***	108.7**	-22.8	406.1***	0.08**	0.01	-0.02	0.00
Boom in the 1950s-60s	(2.0)	(25.6)	(32.8)	(64.6)	(0.02)	(0.02)	(0.01)	(0.01)
Very Old Cocoa District	11.1**	-59.5	-153.0**	47.7	-0.03	0.03	-0.02*	-0.01
Boom in the 1930s-40s	(2.9)	(52.5)	(41.2)	(66.9)	(0.02)	(0.02)	(0.01)	(0.01)
National Average	28.6	658.7	614.6	810.4	0.27	0.63	0.14	0.23
Observations	110	110	95	49	110	110	110	110
R-squared	0.54	0.54	0.42	0.54	0.45	0.73	0.54	0.77
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Robust standard errors clustered at the group level = [very new, old, very old] in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. I use the data set of cities, the 1998 GLSS household survey and 2000 *Population and Housing Census* to create variables at the district level around 2000, using the district decomposition of 2000 (N = 110). This decomposition significantly differs from the decomposition of cocoa districts used in the analysis (N = 79). *Very New Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1990s. *Old Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1950s-1960s. *Old Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1930s-1940s. No district has boomed in the 1970s-1980s. ***Col. (1):*** *Urb. Rate* is the district urbanization rate (%) in 2000. ***Col. (2)-(4):*** *Per Capita Consumption* is 1998 district mean per capita consumption in constant $1990 PPP for all the localities, rural localities only and urban localities only. A locality is defined as urban if it has more than 5,000 inhabitants. ***Col. (5):*** *Migr. Other Region* is the 2000 district share (%) of 15-45 year-old active individuals born in another region. ***Col. (6)-(8):*** *Employed in Sector:* is the 2000 district share (%) of 15-45 year-old active individuals employed in the agriculture, industry and services. Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables.

Appendix Table B.3: Cocoa Production and Infrastructure Investments in Ghana, 2000.

Dependent Variable:	Share of Inhabitants $\leq$ 10 Kms From (%) Primary School		Health Centre		Post Office		Share of Inhabitants with Electricity (%)		Density of Paved Roads (Meters/Sq.Km.)
Sample:	Rural (1)	Urban (2)	Rural (3)	Urban (4)	Rural (5)	Urban (6)	Rural (7)	Urban (8)	(9)
New Cocoa District	0.01**	0.00	-0.06***	0.01**	-0.03**	-0.03**	0.06**	0.14***	-4.08
Boom in the 1990s	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(4.58)
Old Cocoa District	0.02**	0.00	0.08**	0.00	0.16***	0.06**	0.06**	0.11***	4.09*
Boom in the 1950s-1960s	(0.00)	(0.00)	(0.02)	(0.00)	(0.02)	(0.01)	(0.02)	(0.01)	(1.55)
Very Old Cocoa District	0.03***	0.00	0.10**	0.02*	0.19**	0.05**	0.06*	0.06***	21.8***
Boom in the 1930s-1940s	(0.00)	(0.00)	(0.02)	(0.01)	(0.03)	(0.01)	(0.02)	(0.01)	(1.61)
National Average	0.98	0.99	0.77	0.98	0.57	0.94	0.16	0.61	34.8
Observations	110	106	110	106	110	106	108	106	110
R-squared	0.61	0.99	0.61	0.58	0.65	0.38	0.40	0.34	0.69
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Robust standard errors clustered at the group level = [very new, old, very old] 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 around 2000, using the district decomposition of 2000 (N = 110). This decomposition significantly differs from the decomposition of cocoa districts used in the analysis (N = 79). *Very New Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1990s. *Old Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1950s-1960s. *Old Cocoa District* is a dummy equal to one if the district has experienced its main cocoa boom in the 1930s-1940s. No district has boomed in the 1970s-1980s. ***Col. (1)-(6):*** % share of rural or urban inhabitants who are less than 10 km from a primary school, health centre and post office in 2000. A locality is defined as urban if it has more than 5,000 inhabitants.***Col. (7)-(8):*** % share of rural or urban inhabitants with access to electricity in 2000. ***Col. (9):*** district density of paved roads meters / sq km in 2000. Controls are described in the footnote of Table 1, while Data Appendix A explains in details how I construct the variables.