Urbanization, a Magic Bullet for African Growth? On Cocoa and Cities in Ivory Coast and Ghana

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Abstract

While Africa was almost unurbanized one century ago, it has recently known dramatic urban growth. This is good news if cities are powerful engines of growth as emphasized by the economic geography literature. Yet, the agglomeration effects story was built on manufacturing and tradable services, two sectors underrepresented in African cities. We develop another story where agriculture-led rural windfalls feeds urban growth through consumption linkages, with a case study on cocoa production and cities in Ivory Coast and Ghana. We combine decadal district-level data on cocoa production and cities from 1921 to 2000, and we show how cities have followed the cocoa front. Our identification strategy uses the fact that cocoa is produced by "eating" the virgin forest: (a) areas suitable to cocoa production are forested regions, i.e. the southern half of both countries, (b) for agronomic reasons, cocoa farmers move to a new forest every 25-50 years, this movement causing regional cycles, and (c) the cocoa front has started from the (South-)East of both countries. The cocoa front had to move westward, within the South. We can thus instrument cocoa production with a westward wave that we model. We find that cocoa production explains more than half of non-primate urbanization in both countries. We discuss and give evidence for the channels underlying this relationship, distinguishing what happens in new and old cocoa-producing regions.

JEL classification codes: N97, O12, O18, R11, R12.
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"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."

Lions on the Move: The Progress and Potential of African Economies, McKinsey 2010.

"I had a marvellous 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 labourers, 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

While Sub-Saharan Africa was unurbanized at the turn of the 20th century, it has registered dramatic urban growth in recent decades and it has now a larger urban population than Northern America or Western Europe (Satterthwaite 2007, WDR 2009).[1] This is good news, as the growth literature has shown that development is highly correlated with urbanization (Acemoglu, Johnson and Robinson 2002, Henderson 2010). Development is indeed associated to the structural transformation, the economic transition from rural-based agriculture to city-based manufacturing and services (Caselli and Coleman II 2001, Michaels, Rauch and Redding 2008). Then, it can be argued that cities improve efficiency and promote growth in developing countries, making urbanization a powerful agent of development (Duranton 2008, Venables 2010). Those works are based on previous studies showing there are agglomeration economies, both within sectors (localization economies) and across sectors (urbanization economies), in both developed countries (Rosenthal and Strange 2004, Henderson 2005, Combes, Duranton, Gobillon and Roux 2011) and developing countries (see Overman and Venables 2005, Henderson 2010 and

[1]While the urbanization rate of Sub-Saharan Africa is estimated at 5% around 1900 (Bairoch 1988), it increased from 11 to 37.2% between 1950 and 2010 and it is projected to be 60.1% by 2050 (WUP 2009). It has been estimated that post-1950 Africa has experienced amongst the highest rates of urban change ever registered in the history of mankind (Satterwhaite 2007).

Venables 2010 for references). In particular, this potential role of urbanization as a key engine of African long-term growth has been recently highlighted by international organizations and specialized consulting firms (WDR 2009, Mc Kinsey 2010). As a result, a sound pro-urbanization public policy could consist in reducing the costs of urban congestion by providing public goods, implementing a titling policy for squatter settlements and deregulating the housing market, and removing barriers to internal migration and trade by ensuring peace, easing trade controls and investing in transport infrastructure (Duranton 2008, Venables 2010).

Yet, an optimistic view of urbanization in developing countries is contradicted by empirical evidence on Africa. "Explosive urbanization", "overurbanization" or "urbanization without growth" are expressions frequently read in the literature on African cities (Bairoch 1988, Fay and Opal 2000). They imply that Africa has urbanized without it being fully explained by economic development, unlike developed countries. This excessive urbanization is attributed to pull and push factors feeding rural exodus, using a simple Harris and Todaro (1970) model. First, cities are associated to a parasital public sector, that feeds itself on the (over-)taxation of rural farmers (Bates 1981, Bairoch 1988). An extreme version of the urban bias story is primacy, when the largest city in a country is oversized compared to the rest of the urban population (Davis and Henderson 2003). Henderson (2003) and Duranton (2008) show that primacy is detrimental to growth. Second, land scarcity and natural catastrophes can make rural living more difficult, this encouraging rural exodus (Barrios, Bertinelli and Strobl 2006). As poor rural migrants flock to the cities, they decrease urban welfare and governments of developing countries try to refrain them from doing so (Duranton 2008). They put barriers to formal residential development, this encouraging the formation of squalid slums (Satterwhaite 2007, Duranton 2008). Lastly, manufacturing has been the main sector behind the industrial revolutions in Europe and North America (Bairoch 1988, Williamson 1990, Kim 2007). It is the main contributor to current growth in China whereas India has based its development strategy on internationally tradable services (Satterwhaite 2007, Bosworth and Collins 2008). But manufacturing and tradable services are under-represented in African cities today, which asks two questions: (i) Where do African cities come from? What are the main sectors behind the African urbanization process? (ii) Given their economic composition, can we expect African cities to be powerful engines of growth?

Figure 1 plots urbanization rates and the GDP share from manufacturing and services for 42 developing countries in Asia and America and 39 developing countries in Sub-Saharan Africa in 2000. It indicates that urbanization relies on those two sectors in Asia and America. Yet, this correlation is not found in Africa. Figure 2 plots urbanization rates and the GDP share from the export of primary commodities in Africa, whether mineral products or cash crops. We use the GDP share in 2000 (subfigure *a.*) and the average GDP share between 1960 and 2000 (subfigure *b.*), which is less sensitive to recent oil discoveries. In both cases, we observe a strong correlation between urbanization and primary exports. African cities are thus intimately linked to oil, mining and cash crop windfalls, whether as producing, trade or administrative centers. Then, one can wonder if such an economic specialization of African cities can make them powerful engines of growth. In particular, agriculture-based rural windfalls might favor urbanization without making it a factor of long-term growth. While a few studies have argued that agriculture has strong linkages to the rest of the economy (Mellor 1995, Tiffin and Irz 2006, WDR 2008), other studies have shown that such linkages could not permit the massive rise in labor productivity needed to develop Africa (Hirschman 1958, Dercon and Zeitlin 2009, Collier and Dercon 2009). First, there are potentially large scale effects in agriculture but historical and institutional factors prevent commercial farms from competing with smallholders in Africa (Collier and Dercon 2009). Second, African agriculture has few backward and forward production linkages with the industrial sector (Hirschman 1958, Dercon and Zeitlin 2009). African agriculture has remained traditional, with a low level of mechanization and a low adoption of fertilizers and insecticides. And when such inputs are indeed used, they are often imported from abroad. Besides, cash crops are often not processed locally but directly exported to developed countries. Third, the agglomeration economics story is valid only for those sectors where knowledge is a key input, whether manufacturing or internationally tradable services. Fourth, agriculture has large consumption linkages, as farmers spend their rising income on urban goods (Mellor 1995, Dercon and Hoddinot 2005, Dercon and Zeitlin 2009, Henderson, Storeygard and Weil 2009). But those consumption linkages only create trade cities, and one can wonder whether such a specialization would determinedly raise African labor productivity in the long run. Lastly, rural windfalls contribute to the growth of national and regional capitals, but one can argue that they only serve to fund a non-productive and thus parasital state sector, in accordance with the urban bias and primacy literatures (Bates 1981, Bairoch 1988, Davis and Henderson 2003).

Our story of agriculture-led urbanization builds on a case study on the role of cocoa production on urbanization in Ivory Coast and Ghana, two exemplary countries of the African "cash crop revolution" (Tosh 1980, Austin 2007a). Cocoa has been the main motor of their economic development (Teal 2002, Cogneau and

Mesplé-Somps 2002, Austin 2007b). Production boomed after the 1920s in Ghana and the 1960s in Ivory Coast (see figure 3). It has contributed to more than one third of their total exports and one tenth of their GDP during the 1948-2000 period. Yet, as cocoa can only be produced in forested areas (Ruf 1991, Ruf 1995, Balac 2002), its economic effects were confined to the Southern and forested part of both countries. Then, while Ghana and Ivory Coast were very little urbanized at the turn of the 20th century, their respective urbanization rate is 43.8% and 55.2% around 2000, making them two of the most urbanized countries in Africa.[2] As figure 4 shows, the total and urban populations of both countries have dramatically increased after World War II. Figure 5 displays the urbanization rate of both countries and their primacy rate, which we calculate as the size of the largest city (Accra for Ghana, Abidjan for Ivory Coast) over total population. First, Ghana started its urban transition earlier than Ivory Coast, but both experienced spectacular urbanization after 1948. Second, most of post-1948 urbanization was driven by more secondary cities. Nowadays, most cities can be found in the former forested regions, those regions suitable to cocoa production (see figure 6).

We combine decadal data on cocoa production and cities at the district level from 1921 to 2000, and we show how the urban front has followed the cocoa front. Our identification strategy uses the fact that cocoa is produced by "eating" the virgin forest: (a) those areas suitable to cocoa production are forested regions, basically the southern half of both countries, (b) for agronomic reasons, cocoa farmers move to a new forest every 25-50 years, this movement causing regional cycles, and (c) the cocoa front has historically started from the (South-)East of both countries. This forced the cocoa front to move westward, within the South. We can thus instrument cocoa production with a westward wave that we model. First, our results suggest that local cocoa production has a large impact on local urbanization, whether one considers new cities or already existing cities growing further. In total, we find that cocoa production explains more than half of non-primate urbanization in both countries. Second, we distinguish what happens in new and old cocoa-producing regions. We observe strong urban growth in both, which indicates that cities keep growing even when cocoa production decreases. Third, we discuss and give evidence for the various channels through which the cocoa sector impacts the urban sector. In line with the discussion above, cocoa

[2]Ghana had nine cities of more than 5000 inhabitants in 1901 and its two largest cities were Cape Coast (28,948 inhabitants) and Accra (14,842). Ivory Coast did not have any such city, and Abidjan was then a small fishing village with less than 1000 inhabitants. The population of Accra and Abidjan were respectively estimated at 2,527,014 in 2000 and 2,955,578 in 1998.

production has strong consumption linkages, which causes the birth and growth of trade cities. In the long run, better infrastructure and natural demographic growth explain why cities keep growing in old cocoa-producing areas.[3] Yet, if their population increases, it is not clear yet what happens to per capita income. If labor productivity sufficiently increases to sustain a larger population, per capita income does not decrease and cash crops have a long-term development effect (optimistic scenario). If labor productivity does not increase enough, per capita income decreases and the development effect of cash crops is a short-term one (pessimistic scenario). Cities then pauperize.[4] We can use our framework to see what might happen in a few decades when both countries have entirely "eaten" their virgin forest, thus not being able to produce cocoa anymore.

Finally, our research is also related to the study of cash crop windfalls, as they have been highly relevant to the economic history of developing countries. Using FAO data, we calculate that agricultural exports contributed to 53.4% of total exports for least developed countries in the 1960s, while it decreased to 21.4% in the 1990s as more countries specialized in mineral exports. Many countries are still dependent upon one agricultural commodity. Amongst 125 developing countries in 2000, agricultural exports represent more than 50% of total exports for 20 countries, and more than 20% for 50 of them.[5] Then, while mining windfalls have been extensively studied by the resource curse literature (Sachs and Warner 1999, Caselli and Michaels 2009, Vicente 2010, Michaels 2010), there are few studies on the economic effects of cash crop windfalls (Bevan, Collier and Gunning 1987, Maxwell and Fernando 1989, Angrist and Kugler 2008, Collier and Goderis 2009). Although the cash crop sector can be taxed by the state (Bates 1981), one might expect a large share of sectoral profits to go to those producing regions and households, thus having large development effects. Considering urbanization as a valid development outcome, our study informs on the local benefits of cash crop produc-

[3]Our paper is also related to a large body of work on the role of geographical endowments and agglomeration economies in long-term development. In new cocoa-producing regions, agglomeration economies have not arisen yet, and we can study the role of geographical endowments on development (Gallup, Mellinger and Sachs 1998, Engerman and Sokoloff 2000, Davis and Weinstein 2002, Nunn and Qian 2010). In old cocoa-producing regions, geographical endowments are "lost", but agglomeration economies are realized (Rosenthal and Strange 2004, Henderson 2005, Combes, Duranton, Gobillon and Roux 2011).

[4]This is in line with of Chen, Ravaillon and Sangraula (2007) who show that absolute poverty has urbanized in the developing world, as more and more poor people live in city.

[5]Most of them are in Sub-Saharan Africa, with well-known stories such as cocoa in Ghana and Ivory Coast, tea and coffee in Kenya, Rwanda and Uganda, coffee in Burundi and Ethiopia, tobacco in Malawi, groundnut oil in Senegal, or cotton in Benin, Burkina-Faso or Mali.

tion. One can also use our framework to see if those effects might hold in the long run. African countries have highly benefited from their primary exports till the early 1980s, but the subsequent period has been characterized by macroeconomic disequilibria, social and political unrest and general impoverishment. Growth and poverty reduction have now resumed (Miguel 2009, Young 2010, Pinkovskiy and Sala-i-Martin 2010), but one can wonder whether this result is due to temporarily high terms of trade for African countries. Cash crop windfalls might then be subject to a resource curse in the form of "failed intertemporal redistribution".

The remainder of this paper is organized as follows. Section 2 details a theoretical discussion of rural-urban linkages when the rural-based cash crop sector booms or busts. Section 3 presents the agronomic and historical background of cocoa production in Ghana and Ivory Coast, while section 4 introduces the data. Section 5 gives a graphic analysis of cocoa and urbanization, and discuss endogeneity issues. Section 6 explains our econometric framework and displays our main results. Section 7 addresses complementary issues. Section 8 discusses the potential future of African cities and section 9 concludes.

2 Theoretical Discussion

The country can be divided into districts with district-specific locational fundamentals. Those districts suitable for cocoa production (the forested areas) experience urban growth when cocoa is produced (if the cocoa front has reached that district). Why would cocoa production lead to more urbanization? We need to develop a sequential model of urban settlement in a new forest.

In phase 1, which we label *no cocoa production yet*, a district with a virgin forest is relatively untouched and settlement is limited because it is difficult: land is not cleared yet, humidity and mortality are high.

In phase 2, which we label *new cocoa-producing area*, cocoa farmers settle there, the land is deforested and planted with cocoa trees, then cocoa production booms and the urbanization process is launched. The total population of the district increases, but we need this increase to be spatially concentrated for cities to appear and to grow. Indeed, only a few sublocations of the district will be driving the local urbanization process. Why would it be so? The first urbanizing effect of cocoa production is a pure settlement effect (effect A): when cocoa farmers move to new areas, they first settle in the few existing settlements or fund new settlements, to use them for the colonization of surrounding forested areas. The second urbanizing effect of cocoa production is a pure logistics effect (effect B): cocoa beans need to be transported from cocoa-producing areas to the coast, so as to be exported abroad. Cities serve as collection points and transportation nodes for cocoa beans. The third urbanizing effect of cocoa production is a pure wealth effect (effect C): the income of cocoa farmers rise and they spend their extra income on non-essential consumption goods. If those goods are *produced in* or *distributed through* the cities, then more cocoa income means more local opportunities in the cities. As cocoa beans are not processed in producing countries, most of those inter-sectoral linkages are consumption linkages. Migrants flow from non-producing regions to cities in producing areas. In other words, cocoa creates a large economic surplus, but this surplus being concentrated in the cities, those regions urbanize. The fourth urbanizing effect of cocoa production is an infrastructure effect (effect D): cocoa income allows those districts to pay the fixed costs of the primitive accumulation of physical capital (basic amenities such as roads, schools, health centres), and this has positive long-term effects on the size of those cities. Fifth, improved living standards and better infrastructure in those cities means reduced mortality and natural growth can quickly surpass rural-to-urban migration as the first source of urban growth (effect E). Effects D and E are long-run effects because cocoa does not directly impact urbanization as for effects A, B and C.

In phase 3, which we label *old cocoa-producing area*, cocoa leaves the region but cities do not collapse, on the contrary. The first two urbanizing effects of cocoa have disappeared, and we are left with the three other channels. First, inter-sectorial linkages and agglomeration economies make those cities thrive as they are able to "reinvent" themselves (effect C). Second, the many investments in basic amenities make those cities still very attractive (effect D). Lastly, the demographic transition is first an urban demographic transition, and the contribution of natural increase to urban growth increases (effect E). As regards living standards, per capita income is likely to fall given demographic growth and diminishing total income from cocoa production (pessimistic scenario). But we could expect another scenario whereby capital accumulation and agglomeration economies would raise labor productivity enough to increase or at least stabilize per capita income (optimistic scenario).

In the very long run, the stock of virgin forest is exhausted and cocoa is no longer produced. All the districts that were suitable to cocoa production are in phase 3, where urban per capita income might be decreasing, stable or increasing, following which scenario is realized. Beyond those microeconomic effects, this could have a huge macroeconomic effect on government revenue and spending, if the cocoa sector is taxed by the state. We could then include to our model the redistributive effects of state taxation.

3 Agronomic and Historical Background

3.1 Agronomic Background

Cocoa is produced by "eating" the forest. Cocoa farmers go to a patch of virgin forest and replace forest trees with cocoa trees. Pod production starts after 5 years, peaks after 10 and continues up to 40 or even 50 years. When cocoa trees become too old, cocoa farmers have no choice but to move to another forest and start a new cycle. Indeed, removing forest trees alters the original environmental conditions and replanted cocoa trees are much less productive (Ruf 1991, Ruf 1995, Balac 2002).[6] That is why cocoa is characterized as a "migrant culture". Cocoa-producing countries have all experienced deforestation through regional cycles. When the forest rent is over, cocoa production moves to another country or continent[7], making it a significant contributor to deforestation in developing countries. The forested surface of Ivory Coast has decreased from 9 millions hectares in 1965 to 2.5 millions in 2000, while it has decreased from 8.2 millions in 1900 to 1.6 million in 2001 in Ghana. Recent studies have more generally emphasized the role of agricultural trade in worldwide deforestation (De Fries et al. 2010).

Then, more economic and political factors can accelerate or decelerate those cycles. Both countries have extracted almost the same quantity of cocoa throughout the 20th century (see figure 3): 24 millions of tons in Ghana vs. 22.1 millions in Ivory Coast. But, this amount has been extracted within a much shorter time period in Ivory Coast. In Ghana, three regional cycles did not overlap because the first two cycles were decelerated by extraordinary events and poor economic policy, which we describe just thereafter. In Ivory Coast, those regional cycles have been perfectly imbricated as no decelerating factor showed up during the period.

[6]By removing forest trees to plant cocoa trees, farmers change the environmental conditions that are essential to the long-term profitability of their cocoa farms. Cocoa trees are affected by: (i) spreading heliophile weeds, (ii) reduced pluviometry, (iii) a lower protection against winds, (iv) repeated attacks by new insects and diseases, (v) decreased soil fertility (the fertility of rainforests is contained in the trees and not the ground), and (vi) erosion. When cocoa trees are dying, cocoa farmers can plant new cocoa trees but the mortality rate of young cocoa trees is high while yields of those surviving trees is low. Discussions with agronomists have confirmed than replanting is twice more expensive than planting in a new forest. Here are two interesting quotes in Ruf 1991: "Before, cocoa plantations were productive; it's difficult now, young cocoa trees die..." (p.105), and "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]" (p.107).

[7]Cocoa production was dominated by Caribbean and South American countries till the early 20th century, then moved to Africa and is now spreading in Asia.

3.2 Historical Background

Cocoa was introduced to Ghana by missionaries in 1859, and reintroduced in 1878 by a Ghanaian blacksmith coming back from Equatorial Guinea. But it took 30 years before seeing cocoa being widely grown in Ghana, making it the world's largest exporter as soon as 1911. Cocoa production spread out in the Eastern province from Aburi Botanical Gardens, where the British sold cocoa seedlings at a very low price. Figure 7 shows the provinces of Ghana, the area suitable to cocoa production (basically, those regions with virgin forest one century ago) as well as Accra and Aburi (the historical starting point). Production peaked in the Eastern province in 1931, before plummeting as a result of both the Cocoa Swollen Shoot Disease and World War II which reduced international demand.[8] A second cycle started after the war in the Ashanti province. But low producer prices after 1958[9], restrictive migratory policies after 1969[10] and frequent droughts[11] precipitated the end of this cycle. Higher producer prices after 1983 pushed cocoa farmers to launch a third cycle in the Western province, the last forested region of Ghana.

Cocoa was first planted in Ivory Coast in 1888 by two French farmers not far from Abidjan. But it was not till 1910-1912 that the French governor decided to seriously promote cocoa production, thus trying to replicate the Ghanaian success story. Ivorians were originally reluctant to grow cocoa instead of food crops, except in Indénié (Abengourou) where local farmers heard of the increasing wealth of Ghanaian cocoa farmers (see figure 7, which exhibits Ivorian provinces, the area suitable to cocoa production and Abidjan and Abengourou). However, Ivorian production did not boom before the 1960s.[12] Cocoa moved from the Eastern forest to the Western Forest (see figure 7). Due to mounting deficits of the Caistab, the

[8]The Cocoa Swollen Shoot Disease was first recorded in 1938 in the Eastern region. Because no attempt could be made to control the disease until after World War II, millions of trees were killed and more millions had to be removed to try to control it (Thresh and Owusu 1986).

[9]Ghana after 1948 and Ivory Coast after 1960 fixed the producer price to protect farmers against fluctuant international prices. The Ghana Cocoa Marketing Board (COCOBOD) was in charge with cocoa in Ghana and the *Caisse de stabilisation et de soutien des prix des productions agricoles* (CSSPPA, or "Caistab") was its Ivorian equivalent. Yet, since the producer price was below the international price, this served as a taxation mechanism of the sector (Bates 1981).

[10]In 1969, the government enacted the Aliens Compliance Order, which led to the massive exodus of laborers from neighboring countries and created labor shortages in the cocoa sector.

[11]The 1982-1983 drought was the worse in fifty years and many cocoa farms were burnt.

[12]Two factors account for this Ivorian "lateness". First, cocoa did not reach the Ghanaian border before the 1910s. Ivorian production then increased but this boom was short-lived due to the Great Depression and World War II. Second, Ivorians had to provide the *corvée* (mandatory labour) for the colonial government, which forced them to grow food crops and coffee.

producer price was halved in 1989 and remained low thereafter, but this did not stop the colonization process as profits were still quite substantial.

Thus, in both countries, cocoa production was confined to the Southern (forested) areas and historically started in the South-East, for rather exogenous reasons. Cocoa being a "migrant culture", it moved to the West and within the South of both countries (as it could not move anywhere else). It is like a *pacman* game, except that the number of players have increased with time. As population growth was high and cocoa remained more profitable than other crops, more and more individuals specialized in cocoa production and participated to the colonization of the forest, thus accelerating the westward movement. Yet, in Ghana, the colonization of the forest has not been as linear as in Ivory Coast, due to natural events and more economic and political factors. As the forest rent is about to disappear, so will cocoa production, unless innovations increase yields in deforested land.

4 Data

To study the effects of cocoa production on cities in Ghana and Ivory Coast, we combine data on cocoa production and urbanization at the district level over the period 1921-2000. We briefly describe the data here but the full methodology and the numerous sources used can be found in the data appendix. Cocoa production data mainly comes from reports published by the government agencies responsible for the organization of the cocoa production system in each country: the *Caisse de stabilisation et de soutien des prix des productions agricoles* (CSSPPA, or "Caistab") in Ivory Coast, and the Ghana Cocoa Marketing Board (COCOBOD) in Ghana. Our cocoa production data is available at the level of administrative districts in Ivory Coast, and at the level of *cocoa districts* in Ghana. Then, from census reports and administrative counts, we obtain the size of each locality of more than 5000 inhabitants for various years. We then geocode this data and we use GIS to extract urban population for any spatial decomposition we want. In Ivory Coast, we recreate urban and rural population data using the administrative districts. In Ghana, since cocoa districts significantly differ from administrative districts, we are only able to recreate urban population data and not rural population data. In the end, in our regression framework, we use a panel of 46 districts $\times$ 6 years (1948, 1955, 1965, 1975, 1988, 1998) = 276 observations in Ivory Coast, and 73 districts $\times$ 7 years (1921, 1931, 1948, 1960, 1970, 1984, 2000) = 511 observations in Ghana. Between each district-year observation, we know how many tons of cocoa beans have been extracted and how many more urban inhabitants live there. We can therefore relate more urban inhabitants and more cocoa production. Since we have a deflated series of national cocoa producer prices, we work on the effect of the value of cocoa production (in 2000$) on urbanization. Figure 8 shows the value of cocoa production going to cocoa farmers during the 1921-2000 period. We start with a graphic analysis of the correlation between cocoa production and urbanization. We then study this relationship in an econometric framework. Lastly, we use various Ivorian and Ghanaian household surveys and census data sets to discuss and give evidence for the various channels underlying this relationship: the 1985-88 *Living Standards Measurement Study* (LSMS), and the 1998 and 2002 *Enquêtes sur le Niveau de Vie des Ménages* (ENV) for Ivory Coast, and the 1987-88 and 2005 *Ghana Living Standard Surveys* (GLSS) and the *2000 Population and Housing Census* IPUMS sample for Ghana.

5 Mapping and Econometric Framework

5.1 Cocoa and Cities: Mapping

Figures 9 to 13 show district density of cocoa production and cities every ten years or so (the first date is for Ghana, the second for Ivory Coast): 1948 (fig. 9), 1960-1965 (fig. 10), 1970-1975 (fig. 11), 1984-1988 (fig. 12) and 2000-1998 (fig. 13). Similar maps were created for 1921 and 1931 but are not reproduced. In 1948 (fig. 9), Ghanaian cocoa production has boomed in the Eastern province and is about to boom in the Ashanti province. Cocoa is also spreading to Ivory Coast. Most of Ghanaian cities at that time are coastal cities, administrative centers or localities in the cocoa-producing areas. The Ivorian urban structure is mostly the result of the colonial administrative system. We then see cocoa production moving westward in both countries. In Ghana, the main cocoa-producing province is Ashanti in the 1960s and 1970s (fig. 10 and 11), and Western in the 1990s (fig. 13). In Ivory Coast, production rapidly moves from the Eastern forest (fig. 9 and 10) to the Western forest (fig. 11, 12 and 13). This analysis shows that the correlation between cocoa production and urbanization is spatio-temporal. Pre-existing cities grow and new cities arise in both new and old cocoa-producing regions.

5.2 Cocoa and Cities: Econometric Framework

The main hypothesis we test is whether cocoa production drives urbanization. We focus on 1921-2000 Ghana and 1948-2000 Ivory Coast. We run panel data regressions for districts d and years t of the following form:

$$U_{d,t} = \alpha_d + \beta_t + \delta C_{d,t} + \gamma U_{d,t-1} + \phi_t X_d + u_{d,t} \quad (1)$$

where α_d and β_t are district and year fixed effects, and our dependent variable is urban population (in inhabitants) of district d at time t ($U_{d,t}$), controlling for urban population at time $t-1$ ($U_{d,t-1}$). Since urban dependency varies across time, given agglomeration economies for instance, we can allow the effect of $U_{d,t-1}$ to be period-specific (γ_t). $C_{d,t}$ is our variable of interest and is the value of cocoa (in millions of 2000$) produced between time $t-1$ and time t. X_d is a vector of baseline demographic, economic and geographic controlling variables whose coefficients are time-varying. Otherwise, they are included in the district fixed effect. In particular, we might wish to capture the time-specific effect of being suitable to cocoa production, which we define as a dummy equal to one if more than 50% of district area is suitable to cocoa production. As most of suitable districts are Southern districts, we control for the fact that trade and political economy factors could have a differential impact on the South and North of each country. $u_{d,t}$ are individual disturbances that are clustered at the district level.

We expect the two main cities of each country (Accra and Kumasi in Ghana and Abidjan and Bouaké in Ivory Coast) to receive a disproportionate share of public investments and their size is then explained by political economy (Davis and Henderson 1993). Since they bias downward our estimates, as those observations display a dramatic increase in urbanization without it being explained by cocoa, we drop the four districts that contain each city. We now have 71 districts and 7 time periods in Ghana, hence 497 observations. We have 44 districts and 6 time periods in Ivory Coast, hence 264 observations. Since we include lagged urban population, we drop one round and obtain respectively 426 and 220 observations.

We assume that the OLS effect of cocoa production on urbanization is causal. Yet, urbanization could drive cocoa production. However, rainforests are dense forests where human settlement is difficult. There are few cities in those forests before cocoa production booms. But more farmers are willing to overcome those settlement constraints when they obtain a high income, which is the case with cocoa and not with other less profitable crops. When cocoa is sufficiently well-entrenched in the region and when economic mass rises, more migrants arrive to fill pre-existing and new cities. Besides, cities consume forested land and constrains potential land for cocoa production. Additionally, cities are not very useful to cocoa production, since cocoa production involves little technology.

Second, omitted factors could drive both cocoa production and urbanization, even with district fixed effects. Culprits are transportation networks, initial population (as it could provide cheap labor to both the urban and cocoa sectors) or rainfall (as it could support the production of food crops, thus lowering food prices for both the urban and cocoa sectors). Transportation networks were either pre-determined and/or can be controlled for, or resulting from cocoa production itself.[13] Regarding population, Ghana, Ivory Coast and their neighbors form a large labor market, and many workers of the cocoa and urban sectors were not directly originating from the producing regions. Regarding food production, the soil and climate conditions that are suitable to cocoa are also suitable to the growing of plantain, cassava or yam, which are the main crops consumed by people living there. Lastly, random measurement errors on cocoa production could downward bias our coefficient. This cannot be solved unless we instrument cocoa production.

Our instrumentation strategy relies on the fact that cocoa production is confined to suitable (forested) areas and is moving westward in both countries, as a result of historical factors. We first create a dummy equal to one if more than 50% of district area is suitable to cocoa production. Figure 14 displays those districts that are suitable to cocoa using this cut-off. We then arbitrarily divide the territory into longitude bands of one degree, using the centroid of each district. Figure 15 reproduces those various longitude bands. We assume the cocoa front is moving one degree westward every X time period. We take $X = 2$ for Ghana and $X = 1$ for Ivory Coast. Indeed, regional cycles were not imbricated in Ghana, contrary to Ivory Coast, as explained in section 3.2. The instrument is the dummy "being suitable to cocoa production" interacted with a dummy "being *on* the cocoa front". Then, cocoa production is high both at the cocoa frontier and in the adjacent longitude bands. The right band was the cocoa frontier at time $t-1$ and production does not immediately collapse. The left band is the next cocoa frontier (at time $t+1$) and production is already increasing. Thus, comparing the sole cocoa frontier to the other longitude bands give a less powerful instrument than considering the cocoa frontier plus the two adjacent bands. The new instrument is then the dummy "being suitable to cocoa production" interacted with a dummy "being *close to* the cocoa front". We will test both. Here is the full IV model:

$$U_{d,t} = \alpha'_d + \beta'_t + \delta' C_{d,t} + \lambda F_{d,t} + \gamma' U_{d,t-1} + \phi'_t X_d + v_{d,t} \quad (2)$$

$$C_{d,t} = \alpha''_d + \beta''_t + \Pi S_d * F_{d,t} + \lambda' F_{d,t} + \gamma' U_{d,t-1} + \phi''_t X_d + w_{d,t} \quad (3)$$

[13] Discussions with agronomists confirm that farmers first go to the forest to plant cocoa trees and when production starts, they lobby the state to deliver proper evacuation routes (roads).

with S_d a dummy equal to one if the district is suitable to cocoa and $F_{d,t}$ a dummy equal to one if the district happens to be *on* or *close to* the cocoa front, depending on which IV we use. The other variables are defined as above (see (1)). The coefficients of interest are δ from equation (1) and δ' from equation (2), the OLS and IV estimated impacts of the value of cocoa production on urbanization.

To conclude, we instrument cocoa production by just saying "it has to move westward, within the South, as it cannot go anywhere else". Then, whether it is going North-Westward or South-Westward, e.g. due to transportation networks, is irrelevant since the IV permits us to get rid of those contaminating factors.

6 The Effect of Rural Windfalls on Urbanization

6.1 Local Cocoa Production and Local Urbanization

Tables 1 and 2 respectively present our first set of results, for Ivory Coast 1948-1998 and Ghana 1921-2000. For each country, we first show in panel A the OLS estimate (columns (1)), then the IV estimates without controls (column (2)), with a time-varying effect of lagged urbanization (column (3)), further adding a time-varying effect of being suitable to cocoa production (column (4)) and also including controls (column(5)). We report in panel B the first stage of our IV estimations. We privilege the IV estimates using the instrument "suitable to cocoa production" * "being *close to* the cocoa front" as the instrument is then powerful enough for both countries (see the Kleibergen-Paap rk Wald F stat which we report). The instrument "suitable to cocoa production" * "being *on* the cocoa front" is more powerful for Ivory Coast but much weaker for Ghana. Hopefully for us, the wave has no independent positive impact on cocoa production or urbanization (see the coefficients of "Close to the cocoa front"). Only its interaction with cocoa suitability has a positive impact on the value of cocoa production (see the coefficients of "Suitable to cocoa * Close to the cocoa front" in panel B). Then, our set of controls include: (a) dummies equal to 1 if the district is coastal, has a railway or a paved road going directly to the capital city, all interacted with a year trend, (b) year dummies interacted with the district distance to the coast, and the district average annual sum of rainfall for the period 1900-2000.

The OLS and IV estimates are not significantly different for Ivory Coast (see table 1). In Ghana (see table 2), the IV estimate is seven times higher than the OLS estimate. Since simultaneity and omissions biases are unlikely to vary across both countries, our guess is that our Ghanaian cocoa production data is subject to random measurement errors, and such errors can generate a high bias of the coefficient of interest in panel data models. While our Ivorian cocoa production data mostly corresponds to real data obtained from the *Institute of Statistics of Côte d'Ivoire*, our Ghanaian cocoa production data was reconstructed using many different sources and assumptions had to be made to create a consistent data set across periods. If we believe our estimates from column (5) in tables 1 and 2, one million 2000$ of cocoa production increases urbanization by 107.4 inhabitants in Ivory Coast and 86.6 inhabitants in Ghana. The two effects are not significantly different, which is comforting for our strategy. We then calculate the magnitude of each effect, that is to say how much of national urban growth between our first and last periods can be explained by this sole effect.[14] We find that this effect explains 58.2% of urban growth in Ivory Coast between 1948 and 1998 (excluding Abidjan and Bouaké) and 50.8% in Ghana between 1921 and 2000 (excluding Accra and Kumasi). Including those cities, the IV estimates are slightly reduced and their magnitudes decrease as our model cannot explain their growth. If we consider the sole districts suitable to cocoa, their magnitudes increase to 80%.

6.2 Specification and Robustness Checks

In table 3, we show that those IV results (with controls) are robust to specification checks, with Ivory Coast in columns (1) to (4) and Ghana in columns (5) to (8). Columns (1) and (5) report those results for column (5) from tables 1 and 2. As our panel data model includes a lag of the dependent variable, our estimates are subject to a *dynamic panel bias* (Nickell 1981). We therefore estimate in columns (2) and (6) a model where we consider the change in urban population as the outcome without including any lag of the dependent variable. Coefficients are almost unaffected. In columns (3) and (7), we explain urban density (district urban population / district area in squared km.) by value density (district value of cocoa production / district area in squared km.) but this does not alter our message. Lastly, in columns (4) and (8), our variable of interest is cocoa production in volume (tons). The coefficient for Ghana is lower than the coefficient for Ivory Coast, but urbanization has also been lower in Ghana than in Ivory Coast.

[14]If δ is the impact of the value of cocoa production on urban population and if the total changes in urban population and cocoa production over our period are respectively ϕ and τ, the total magnitude of this effect is $\frac{\tau \times \delta}{\phi} * 100$. This gives us how many percents of the total change in urban population can be attributed to this sole effect.

We check that the periodicity of our data does not impact our results. Instead of considering the change in urban population and the value of cocoa production between $t-1$ and t, we run the same regression dividing them by the number of years between $t-1$ and t. Results are unchanged. We also verify that the selection of the suitability cut-off (25, 50 or 75%) for our IV strategy does not affect our results. Lastly, we test that our results are not driven by a specific period.

6.3 Decomposing the Population Effect of Cocoa

In table 4, we investigate whether this urbanization effect is part of a more general population effect where cocoa production would increase both urban and rural densities. As our Ghanaian cocoa production data uses the spatial decomposition of *cocoa districts* and not *administrative districts*, we have no total population data to include to our model. We focus on Ivory Coast 1965-1998, for which we have both urban and rural population data. We study the impact of cocoa production value on total, urban and rural population (respectively col. (1), (2) and (3)), and on the urbanization rate (in %) which we define as urban population / total population * 100 (col. (4)). We only report the OLS (see equation (1)) as the instrument is too weak for the rural population regression, making the estimated coefficient unreliable. We are confident in doing so as the OLS and IV estimates are not significantly different for Ivory Coast (see table 1). We find that one million 2000$ increases population by 83.7 inhabitants and that this population effect is concentrated in city as no impact is found for rural population: the coefficient is -1.7, which means the rural population has grown to an equal pace in cocoa producing and not-producing districts. This is true if we consider rural density instead. This is again confirmed by the fact that cocoa production has dramatically increased the urbanization rates of those producing districts (col.(4)).

We then decompose urban growth (col. (2)) into the urban growth of cities already existing at time $t-1$ (col. (5)) and the urban growth of new cities, those passing the 5000 threshold between $t-1$ and t (col.(6)). Both effects are not significantly different and account for half of the total urban growth effect. Cocoa production thus reinforces the power of pre-existing urban settlements. It also has a strong "city formation" power. Since the urban growth associated to each new city is small (from less than 5000 to more than 5000 between $t-1$ and t), such a strong urban growth effect of new cities must result from many new cities. This is confirmed by col. (7), where 1 billion 2000$ is giving 9 new cities. Given the total value of cocoa production between 1965 and 1998, this gives 208 new cities, while there have been 313 new cities over the period. Thus, cocoa explains 66.4% of city formation. Results for Ghana are not shown but give very similar results.

6.4 Urban Growth in New vs. Old Cocoa-Producing Areas

We distinguish what happens in new and old-cocoa producing districts vs. the non cocoa-producing districts. We create a dummy equal to one if per capita cocoa production increases between $t-1$ and t and 0 otherwise (those districts are located in new cocoa-producing areas). Then, we create a dummy equal to one if per capita cocoa production decreases between $t-1$ and t and 0 otherwise (those districts are located in old cocoa-producing areas). We consider as an outcome total urban growth (col. (1) of table 5), urban growth in existing cities (col. (2)), urban growth in new cities (col. (3)) and the number of cities (col. (4)). As we do not have district population data for Ghana, we are unable to calculate per capita production. We nevertheless have regional population data for Ghana, so we use regional per capita production to create the same set of dummies. Results being very similar in both countries, we only show those results for Ivory Coast.

Results from column (1) indicate that old cocoa-producing regions experience higher urban growth: each old cocoa-producing district is receiving 78,188 urban inhabitants, while it is 59,878 for each new cocoa-producing district. Yet, as there are fewer old than new cocoa-producing districts, the latter are the main contributors to urban growth. Nevertheless, this indicates that cities in old cocoa-producing regions do not collapse, on the contrary. They grow even further, as if cocoa just launches an urbanization process that becomes self-reinforcing. Since no difference is noticeable as regards urban growth of existing cities (col. (2)), this difference between old and new cocoa-producing regions must come from new cities, as confirmed by columns (3) and (4). This could be due to urban decentralization. As the existing cities become more congested, there are strong incentives for other centers to appear. But this could also result from a cocoa front within the district. As land close to the already existing cities is fully exploited, the latest cocoa farmers entering the district colonize the more remote forests where no settlement can be found. Those remote settlements become cities the next generation, when aggregate district per capita production is already decreasing.

We replicate this analysis, this time using four dummies for highly/slightly decreasing/increasing per capita production (columns (5) to (8)). The goal of such an exercise is to show that our previous results are driven by those districts where production is either highly increasing or decreasing (for being highly decreasing, the production of those districts must have been highly increasing in the past).

7 Rural-Urban Linkages

We now discuss and give evidence for the channels through which cocoa production drives urbanization, distinguishing those in new and old cocoa-producing areas. Unfortunately, we cannot estimate the respective contribution of each effect to total urban growth, but we try to give some clue of the magnitude of each.

7.1 The Settlement of Cocoa Producers

In line with our theoretical discussion in section 2, cocoa farmers move to new areas. They settle in the few existing settlements or fund new settlements, to use them for the colonization of surrounding forests. Results from the previous section indicate that urban growth in new cocoa-producing areas is driven equally by pre-existing and new cities. In old-cocoa producing regions, new cities contribute relatively more than old cities to urban growth. Then, some of those settlements where cocoa farmers settle are urban or naturally evolve into cities. We thus expect a high share of urban inhabitants to be cocoa farmers. While they represent 52.3% of rural inhabitants in the Eastern and Western forests of Ivory Coast in 1985-88 (LSMS), they represent 20.5% of urban inhabitants. Similarly, we find that cocoa producers represent 45.2% of rural inhabitants and 14.8% of urban inhabitants in the forested regions of Ghana in 1987-88 (GLSS). This urban share has decreased to 9.7% in 2002 Ivory Coast (ENV) and 10.3% in 2005 Ghana (GLSS), as cities diversified with time. We could also calculate that those cocoa farmers living in city are wealthier, both in terms of income and ownership of land and durable goods, than those living in countryside. Thus, a first impact of cocoa production on urbanization is purely demographic: there are many cocoa farmers and some of them live in city, that is why there are more cities in cocoa-producing areas.

7.2 The Logistics of Cocoa Beans Export

Cocoa beans must be transported from cocoa-producing areas to the ports for export. The logistics of cocoa beans export involves local and regional depots, transportation companies and port administration. Since their activity is mostly urban-based, we expect a significant share of the urban labor force to work for cocoa export. We use the 1985-88 LSMS survey to look at the industrial composition of the urban labor force. We focus on the urban individuals aged from 15 to 60 with a job in the last twelve months, and we estimate that respectively 18.1% of them work in the export of primary commodities considering the Eastern and Western Forests in Ivory Coast. Although cocoa beans are not the sole commodity exported abroad, it certainly involves most of the employees of this sector. Unfortunately, the sectoral decomposition offered in the other household surveys does not allow us to identify those workers related to the export sector.

7.3 Production and Consumption Linkages

The cocoa sector could impact the urban sector through production and consumption linkages. Yet, backward production linkages are small as cocoa farmers use rudimentary tools and the adoption rate of fertilizers and insecticides is low. Forward production linkages are nil as cocoa beans are directly exported abroad and not processed locally (given a lack of knowledge of processing processes). Then, to study consumption linkages, assume a cocoa-producing household spends a share u of its income Y on non-essential goods. As non-essential goods are *produced in* or *distributed through* cities, they favor urbanization. If one region experiences a cocoa boom, the number of cocoa-producing households increases by N. The aggregate amount spent on *urbanizing* goods will then increase by $N \times uY$.

First, using census (1988, 1998) and household survey (LSMS, EP) data, we could calculate that the total population living in cocoa-producing households in the Western Forest of Ivory Coast has increased by 775,000 people between 1988 and 1998. Given an average household size of 8.6, this corresponds to 90,210 additional households. Most of this increase was concentrated in the *Centre-Ouest* region, where the influx of cocoa-producing households accounted for 76.5% of total population change. We then replicate this exercise in Ghana (censuses 1984 and 2000, GLSS) where the total population living in cocoa-producing households in the Western province (the last regional cycle) has increased by 446,000 people between 1984 and 2000. Given an average household size of 6.6, this corresponds to 67,580 additional households. This influx then explains 61.5% of total population change in that province. We now understand that a cocoa boom significantly alters the population size and occupational composition of the affected region.

Second, we verify that cocoa farmers are much wealthier than the non-cocoa farmers of the same region. Using household surveys, we regress household expenditure on a dummy equal to one if the household produces cocoa and we include village fixed effects so as to compare cocoa producers and non-cocoa farmers *within* the same village. Cocoa farmers are respectively 31.3% and 28.4% wealthier than their non-cocoa counterparts in the Eastern and Western forests of Ivory Coast in 1985-88 (LSMS) and 2002 (ENV). In the forest regions of Ghana, they are respectively 22.1% and 20.2% relatively wealthier in 1987-88 and 2005 (GLSS).

Third, we look at the structure of household expenditure for cocoa and non-cocoa farmers in the forest regions of each country. Table 6 shows this allocation for the cocoa farmers in Ivory Coast (1985-88 and 2002) and Ghana (1987-88 and 2005). Total consumption is divided into three consumption aggregates: home production, food expenses and other (non-food) expenses (in % of total consumption). We then divide each consumption aggregate into six consumption subaggregates (in % of the consumption aggregate). The whole structure is rather stable through space and time. If we look at the structure of household expenditure in 1985-88 Ivory Coast, food represents 32.1% (home production) plus 25.8% (food expenses) = 57.9% of household expenditure. Home production is chiefly starchy roots that are intercropped with cocoa. Food expenses mainly concern seafood, cereals (in particular rice, which is considered as a treat in West Africa), sweets, alcohol and meat. Cocoa farmers allocate a high share of their non-food expenditure to clothing, transfers and events, health and hygiene, housing and education. Although we cannot identify which good is *urbanizing*, we guess that food and non-food expenses imply the growth of the urban-based trade sector.[15] Looking more specifically at other expenditure, cocoa income must have an impact on other sectors such as the textile industry, education and health, construction or public administration. We then find that non-cocoa farmers have almost the same consumption structure (not reproduced here), although they are 20-30% poorer. This is in line with Dercon and Zeitlin (2009) who explain that the Engel's curve can be invalidated for low levels of income. Nonetheless, as cocoa farmers are 20-30% wealthier than their non-cocoa counterparts, they still spend 20-30% more on urbanizing goods. We also show that cocoa farmers own more durable goods that non-cocoa farmers in 1985-88 (LSMS) and 1998 (EP) Ivory Coast. For each good, we regress a dummy equal to one if the household owns this good on a dummy equal to one if the household produces cocoa, including village fixed effects so as to compare cocoa and non-cocoa farmers *within* the same village. Results from table 7 show that cocoa producers more often owns a fan, a radio, a TV, a bicycle, a bike and a car.

For the sake of concreteness, assume cocoa farmers spend 50% of their income

[15] 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.

on urbanizing goods. If the Western Forest of Ivory Coast has received 90,210 cocoa-producing households between 1988 and 1998, and if their income Y is 30% higher than the income of the non-cocoa farmers, it means that the total income spent on urbanizing goods has increased by $90,210 \times Y \times 0.5$, which is certainly a lot, and 30% more than if the region had been *counter-factually* colonized by non-cocoa farmers (the income gain would have then been $90,210 \times 0.7 \times Y \times 0.5$).

Lastly, amongst those urban individuals aged from 15 to 60 with a job in the last twelve months in the Eastern and Western forests of Ivory Coast in 1985-88 (LSMS), 35.3% of them work in the primary sector, 20.6% in the secondary sector and 44.1% in the tertiary sector. Amongst those who do not work in the primary sector, 28.6% work in the export of primary commodities, 11.8% in retail trade (mostly clothing and food trade), 11.6% in the leisure industry (hotels, restaurants, bars, hairdressers, etc.) and 6.7% in technical services (banking, insurance, professional services, etc.). Thus, except those specialized in the production and/or export of cocoa, a high share of urban inhabitants work in the distribution (and production) of goods and services that are consumed by cocoa farmers.

7.4 Cocoa Production and Infrastructure Investments

As aggregate income rises, infrastructure investments are realized. If they make individuals more productive or if people value infrastructure per se, those locations with better infrastructure are more attractive in the long run, causing population growth. We use various data sets to show that infrastructure today is spatially correlated with cocoa production in the past, for both rural and urban settlements. Cities of the cocoa-producing regions could have better infrastructure, which would make them grow relatively more in the long run than cities of the other regions. Or rural settlements of cocoa-producing regions could have better infrastructure, which could help their urbanization (passing the 5000 inhabitants threshold).

We first build an original GIS data set of paved roads for Ivory Coast for those years 1965, 1975, 1988 and 1998 (to be consistent with our population data). We estimate for each district-year the total length of paved roads (in kms). In a similar spirit to equation (1) (see subsection 5.2), we regress the length of paved roads at time t on the value of cocoa production between $t-1$ and t, controlling for the length of paved roads at time $t-1$ and including district and time fixed effects. We find that cocoa production explains at least 50% of paved road building between 1965 and 1998 (results not reported but available upon request).

Second, using household surveys for Ivory Coast (EP + ENV), we estimate the share of rural and urban inhabitants with access to electricity, private tap water and toilet in 1998-2002. We drop those observations corresponding to Abidjan and Bouaké. We regress those shares on a dummy equal to 1 if per capita production is decreasing between 1965 and 1998 (the old cocoa-producing districts) and a dummy equal to one if it is increasing (the new cocoa-producing districts). Northern districts are taken as a control group. We expect residents of the old cocoa-producing regions to have a better access to infrastructure as they could realize such investments in the past. Results are reported in table 8. We do not notice any significant difference across cities of each group of districts (see columns (2), (4) and (6)). But villagers of the old cocoa-producing areas have a higher access to electricity (col. (1)), private tap water (col. (2)) and toilet (col. (3)). Considering the share of children attending school (col. (5) to (8)), this share is higher in the old cocoa-producing region than in the new cocoa-producing region where it is higher than in the Northern districts. We also have at our disposal administrative data on the number of primary and secondary schools in 1994 (Ministry of Education 1994) and the number of hospitals and health centers in 2003 (WHO 2003). This data does not distinguish rural and urban settlements, but it indicates that old cocoa-producing districts have more secondary schools and health centers per capita (results not shown but available upon request). No difference is noticed for primary schools and hospitals for which the spatial distribution is rather equal.

Third, we use the 2000 Ghanaian Facility Census to test whether past cocoa production has permitted infrastructure investments. For each administrative district and each type of settlement (rural/urban), we estimate the share of inhabitants less than 10 kms away from various facilities: primary school, junior secondary school (JSS), senior secondary school (SSS), health center, hospital, post office, telephone. We then use 2000 Population and Housing Census data to calculate for each district and type of settlement the share of inhabitants with access to electricity, private tap water and toilet. We then create a dummy equal to one if this district belongs to a region where cocoa production boomed in the 1930s (the very old cocoa-producing districts), one dummy equal to one if it belongs to a region where cocoa production boomed in 1960s (the old cocoa-producing districts) and a dummy equal to one if it belongs to a region where cocoa production boomed in the 1990s (the new cocoa-producing districts). Northern districts are taken as a control group. We expect very old cocoa-producing districts to be better endowed than old cocoa-producing districts, themselves better endowed than new cocoa-producing districts and non-producing districts. We drop those observations corresponding to Accra and Kumasi. Results from table 9 show that both cities and villages of the very old and old cocoa-producing areas tend to have a much better infrastructure than the other districts.

To conclude, although we cannot definitively prove that cocoa production causes infrastructure, the previous analysis illustrates that the old cocoa-producing regions are relatively more well-endowed in infrastructure than the other regions, and this is true along several dimensions: road, electricity, water, hygiene, education, health and communications. This is important for explaining why cities keep growing and rural settlements urbanize in old cocoa-producing regions.

7.5 Natural Increase and Urban Growth

In countries of the First Industrial Revolution, mortality was much higher in city than in countryside (Bairoch 1988, Clark and Cummins 2009). As a result, cities could not grow without massive influx of rural migrants. As both the rural-urban mortality gap and the urban-rural income differential were closing, natural increase became the main contributor to urban growth (Williamson 1990, Voigtländer and Voth 2010). In the Third World, mortality has always been much lower in city, making natural increase a strong factor of urbanization. To study this issue, we look at the urban and rural dimensions of the demographic transition in Ivory Coast and Ghana. Following Williamson (1990), we know that:

$$U_t - U_{t-1} = (UCRB_{t-1} - UCRD_{t-1}) * U_{t-1} + IM_{t-1} + UEM_{t-1} \quad (4)$$

$$R_t - R_{t-1} = (RCRB_{t-1} - RCRD_{t-1}) * R_{t-1} - IM_{t-1} + REM_{t-1} \quad (5)$$

where U_t and R_t are urban and rural population at time t, $U_t - U_{t-1}$ is urban population change between $t-1$ and t, and $R_t - R_{t-1}$ rural population change between $t-1$ and t. CRB and CRD are crude rate of birth and crude rate of death in city (U) and countryside (R). IM is the number of internal migrants, i.e. rural-to-urban migrants. UEM and REM are the number of external (foreign) migrants going to the cities and the countryside. For the model to be valid, the internal migration estimates (M_{t-1}) in the urban and rural equations must be consistent. For each inter-census subperiod in Ivory Coast (1965-1975, 1975-1988 and 1988-1998) and Ghana (1960-1970, 1970-1984 and 1984-2000), we know urban and rural growth, as well as the urban and rural crude rates of birth and death (the difference between the two being the crude rate of natural increase $CRNI$). Since our urban data can be decomposed between Abidjan/Accra and the other cities, our model has one rural equation, one equation for non-capital cities and one equation for the main city.

We first look at the evolution of urban/rural crude rates of birth, death and natural increase between the 1960s and the 1980s (see table 10). At independence, there is no urban-rural natality differential. Yet, we observe a strong reduction in urban natality after 1960 in Ghana and 1975 in Ivory Coast. Regarding mortality in 1965, it was lower in Abidjan/Accra than in the other cities, where it was lower than in the countryside. Throughout the period, it has been decreasing across all places of residence, but this evolution was more impressive in countryside. In Ivory Coast, natural increase in Abidjan and the other cities peaked in 1975, while rural natural increase peaked in 1988. In Ghana, natural increase had already peaked in Accra and the other cities in 1960, while it remained high in countryside. This confirms that the demographic transition is first "urban" then "rural".

We then use equations (4) and (5) to gauge the contribution of natural increase to urban/rural growth. For each intercensal subperiod, we estimate the urban/rural population change that can be explained by natural increase. We then compare it with the observed population change. The difference between both population changes is necessarily explained by either internal or external migration. Results are reported in table 11. In Ivory Coast, the contribution of natural increase has risen from 31% in 1965-75 to 80% 1988-98 in Abidjan and from 20% in 1965-75 to 45% in 1988-98 in the other cities. In Ghana, the contribution of natural increase to urban growth has peaked during the 1970-84 period. For instance, in the other cities, it increased from 56% in 1960-70 to 90% in 1970-84. Most of urban growth at that time was fed by newborns and not rural migrants. Then, with the end of the political and economic crisis and a new cocoa boom in the Western region, migration has become again the main contributor to urban growth. If one considers the last period for both countries, natural increase explains around 45% of urban growth in non-capital cities.

To conclude, natural increase has become a determining factor of urban growth, thus making urbanization a self-reinforcing process. By permitting household and community investments in physical and human capital (better housing conditions, education, health), cocoa production has contributed to long-term urban growth.

8 Discussion

8.1 The Potential Effects of Resource Exhaustion on Cities

[To be completed] The previous subsection shows that cities keep growing even when cocoa production decreases. Yet, predictions are not straightforward about per capita income in the cities of the old cocoa-producing areas. Per capita income is likely to fall given demographic growth and diminishing total income from cocoa production (pessimistic scenario). But we could imagine another scenario whereby capital accumulation and agglomeration economies would raise labor productivity enough to increase or at least maintain constant per capita income (optimistic scenario). This is an essential issue as cocoa production is doomed to vanish in both Ivory Coast and Ghana in a few decades. Cocoa is produced by "eating" the forest, and both countries are eating their last available forests. Their entire southern territory will then be in phase 3, with unproductive cocoa farms.

Beyond those microeconomic effects, resource exhaustion will have a huge macroeconomic impact via a collapse of government revenue and spending. By fixing the producer price below the international price and overvaluing their exchange rate, these governments have captured a large share of the cocoa windfalls to fund their own consumption and investments (Bates 1981). For the period 1961-2006, the average taxation rate is 43.8% in Ivory Coast and 49.5% in Ghana. Figure 16 then shows the cocoa tax and government consumption and investment in Ivory Coast. A similar figure is available for Ghana but not reproduced here.

As we do not have data on the spatial distribution of government spending, we use household survey and census data (1998 Census and ENV 2000 for Ivory Coast, 2000 Census for Ghana) to guess who might be affected by a fall in government spending. First, as most state employees are concentrated in city, this fall would harm the urban sector. We calculate that 80.4% of Ivorian public employees and 70% of Ghanaian public employees live in city. They respectively represent 10.8% and 11.1% of urban labor force in Ivory Coast and Ghana. Second, in line with the primacy literature (Davis and Henderson 2003), we expect the main city to be disproportionately favored by the central government. Then, since governments also adopt redistributive regional policies, we expect the state to be more represented per capita in the poorest regions of the country, i.e. the North. In Ivory Coast, the number of public employees per thousand inhabitants is 54.9 in the main city, 36.2 in Northern Cities and 18.1 in Southern Cities. In Ghana, those figures are respectively 58.7, 43 and 40.7. A cut in government spending would affect more the main city and Northern cities.

8.2 The Future of African Cities?

[To be completed] We have shown that urbanization could be driven by agriculture, with consumption linkages being the main channel behind this relationship. This raises a few issues. First, production linkages in the case of cash crop windfalls _ but the same story is applicable to oil and mining windfalls _ are too small to promote the development of manufacturing and tradable services. Second, consumption linkages cause urbanization, but cities then rely on domestic trade and a strong public sector. They also invest in infrastructure. But will this sectoral composition and those investments be enough to massively raise labor productivity? Besides, those linkages make those cities highly dependent upon the production and international price of the exported primary commodities. Third, current African growth might be driven by temporarily high terms of trade for mineral resources and cash crops. African countries might be again severely hit if international prices go down or if they exhaust their natural resources (mineral deposits, forests). Fourth, the structural transformation is the key to development if and only if manufacturing and tradable services are concomitant to this transition. Cities are not *per se* engines of growth. Fifth, the urban demographic transition might be a curse for African cities if all the future newborns cannot find employment. African cities would then be doomed to pauperize.

9 Conclusion

We look at the effect of one cash crop, cocoa, on urbanization in two African countries, Ghana and Ivory Coast, during the 20th century. Our results suggest that it explains more than half of non-primate urbanization in both countries. Thus, agriculture-led rural windfalls can drive urban growth through mainly consumption linkages. Cities then keep growing and arising in old cocoa-producing areas, as the urbanization process becomes self-reinforcing. While not being able yet to infer what will happen to per capita income in old cocoa-producing regions, we wonder whether cities might be powerful engines of growth in Africa. A missing manufacturing sector and an overgrown domestic trade sector in African cities could prevent them from driving national development.

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Data Appendix

Urban Data

Population data on Ivory Coast comes from the following documents: (i) *Annuaire Statistique de l'A.O.F.* 1949-1951 & 1950-1954, (ii) *Rapports périodiques des gouverneurs et chefs des services* 1895-1940 and *Rapports Statistiques* 1818-1920, collections of the French colonial archives, (iii) *Population de l'A.O.F. par canton et groupe ethnique 1950-1951*, Haut-Commissariat de l'A.O.F., Service de la statistique générale, (iv) *Répertoire des villages de la Côte d'Ivoire 1955*, Service de la statistique générale et de la mécanographie, Territoire de Côte d'Ivoire, (v) *Inventaire Economique de la Côte d'Ivoire 1947-1958*, (vi) *Côte d'Ivoire 1965: Population, Etudes régionales 1962-1965*, Synthèse, Ministère du Plan de Côte d'Ivoire, (vii) *Recensement général de la population 1975*, (viii) *Population de la Côte d'Ivoire, Analyse des données démographiques disponibles* 1984, Ministère de l'Economie et des Finances de Côte d'Ivoire, Direction de la statistique, (ix) *Recensement général de la population et de l'habitat 1988*, (x) *Recensement général de la population et de l'habitation 1998.* As regards population data, administrative boundaries have changed with time and we are able to get a consistent sample for the 1965-1998 period only. As regards urban data, we know the size and the geographical coordinates of any locality with more than 5000 inhabitants for the period 1901-1998. Using GIS, we are then able to recalculate district urban population for any spatial decomposition of the territory. Since we have cocoa production for 46 districts, we use those district boundaries to estimate total and urban populations.

Population data on Ghana comes from the reports of the following *Population and Housing Censuses*: 1901, 1911, 1921, 1931, 1948, 1960, 1970, 1984 and 2000. As regards total population data, administrative boundaries have changed with time and we are not able to get a consistent sample. As regards urban data, we know the size and the geographical coordinates of any locality with more than 5000 inhabitants for the whole period. Using GIS, we are then able to recalculate district urban population for any spatial decomposition of the territory. Since we have cocoa production for 73 *cocoa districts*, we use those district boundaries to estimate urban population. For the time being, as cocoa districts significantly differ from administrative districts in Ghana, we are not able to include total population to our sample.

Cocoa Production Data

Cocoa production data on Ivory Coast is obtained by crossing the information contained in many different sources. For the pre-independence period, our two major sources are: (i) *Annuaire Statistique de l'A.O.F.* 1949-1951, and (ii) *Inventaire Economique de la Côte d'Ivoire 1947-1958.* They list cocoa production at the colonial district level for the 1945-1958 period. We then use more minor sources to obtain data for the pre-1945 period as well as more refined spatial data for the post-1944 period[16]: (i) *Documentary Material on Cacao for the Use of the Special Committee on Cacao of the Inter-American Social and Economic Council*, 1947, Pan American Union, (ii) *Félix Houphouët-Boigny: Biographie*, Frédéric Grah Mel (2003), Editions du CERAP, Maisonneuve & Larose, (iii) *Problèmes de l'économie rurale en A.O.F.*, Ch. Robequain (1937), *Annales de Géographie* 46 (260): 137-163, (iv) "Immigration, Land Transfer and Tenure Changes in Divo, Ivory Coast, 1940-80", Robert Hecht (1985), *Africa: Journal of the International African Institute* 55(3): 319-336, and (v) "Immigration et économie de plantation dans la région de Vavoua (Centre-Ouest Ivoirien)", P. Brady (1983), unpublished thesis University of Paris 10. For the post-independence period, our major sources are: (i) *Annuaire rétrospectif de statistiques agricoles et forestières 1900-1983*, Ministère de l'agriculture et des eaux et des forêts de Côte d'Ivoire, 1983, and (ii) *Caisse de stabilisation et de soutien des prix des productions agricoles (CSSPPA)*, the agricultural marketing board of Ivory Coast till its dismantling in 1999. They list cocoa production at the district level for the 1959-1997 period. Those major sources were then complemented with more refined spatial data from: (i) *La boucle du cacao en Côte d'Ivoire, Etude régionale des circuits de transport* ,P. Benvéniste (1974), Travaux et Documents de l'ORSTOM, and (ii) *Atlas de Côte d'Ivoire, 1971-1979*, Ministère du Plan de Côte d'Ivoire. In the end, we obtain cocoa production in tons for 46 districts for the following years: 1924, 1930, 1936, 1945-1997. We use linear interpolation to recalculate cocoa production for the missing years: 1925-1929, 1931-1935 and 1937-1944. Lastly, we calculate how much tons of cocoa production were produced between each census year for each district. We then use the following sources to obtain the producer price (in CFA Francs) for the period 1948-2006: (i) *Annuaire Statistique de l'A.O.F. 1949-1951 & 1950-1954*, and (ii) FAOSTAT. We obtain CFAF/$ exchange rate data and $ deflator data from: (i) UN 2010, (ii) IFS 2010, World Bank, (iii) Teal 2002. By multiplying cocoa production and the deflated producer price (in 2000$), we get the deflated total value (also in 2000$) of cocoa production going to cocoa farmers. Likewise, we calculate how much 2000$ of cocoa production were earned between each census year for each district.

Cocoa production data on Ghana is obtained similarly, although only for the main crop[17]. For the pre-independence period, we use the following documents: (i) *1927 Yearbook of the Gold Coast Department of Agriculture*, Government of Ghana, (ii) *A Historical Geography of Ghana*, Dickson (1968), (iii) *Report on the Cocoa Industry in Sierra Leone, and Notes on the Cocoa Industry of the Gold Coast*, Cadbury (1955). Those documents respectively display a very detailed map of cocoa production for the years 1926, 1936 and 1950. We can then use GIS to recalculate cocoa production using any

[16]There are 19 colonial districts ("*cercles coloniaux*") at the time of independence. By obtaining additional data at the subdivision level (the spatial unit below the colonial district), we are able to reconstruct data using the post-independence district boundaries.

[17]The main crop extends from October to June, while the light crop is between July and September. We could only obtain data for the main crop, but this is not an issue as we could calculate that the main crop amounts to 94.7% of the total crop on average during the period 1947-2000.

district boundaries. We obtain national and regional data from the following documents: (i) *The Gold Coast Cocoa Farmer*, by Polly Hill (1956), Oxford University Press, (ii) *The Gold Coast Cocoa Industry: Prices, Production and Structural Change*, Christer Gunnarson (1978), Economic History Association, Lund, Sweden, (iii) *Annual Reports and Accounts of the Ghana Marketing Board* 1957-1962, 1965, 1970, (iii) *Enquiry into the Gold Coast Cocoa Industry, 1918-1919*, W.S. Tudhope (1919), (iv) *Reports of the Department of Botanical and Agricultural Department* 1904-1955, Government of the Gold Coast, and (v) *The Economics of Cocoa Production and Marketing*, Proceedings of Cocoa Economics Research Conference in Legon, April 1973, University of Ghana.

For the post-independence period, all the following documents list cocoa production at the cocoa district level for their respective year (it should be noted that cocoa districts differ significantly from administrative districts): (i) *Analysis of Cocoa Purchases by Societies, Districts and Regions* are repots edited by the Produce Department of the Ghana Cocoa Marketing Board and available for the following years: 1961-1975, 1989 and 1994-1999, (ii) *Ghana Cocoa Marketing Board Newsletter* 1966-1974, (iii) *Ghana Cocoa Marketing Board Monthly Progress Reports* 1972-1985, and (iv) a summary of 2001-2008 district cocoa purchases which was obtained from the Ghana Cocoa Marketing Board. Since district boundaries change from year to year, we use GIS to reaggregate our data so as to get a consistent sample of district cocoa production. In the end, we obtain cocoa production for districts for the following years: 1926, 1936, 1950, 1961-1982, 1989, 2001. We use linear interpolation to recalculate cocoa production for the missing years: 1911-1925, 1927-1935, 1937-1949, 1951-1960, 1983-1988 and 1990-2000. Lastly, we calculate how much tons of cocoa production were produced between each census year for each district. We then use the following sources to obtain the producer price (in 2000 Ghanaian 2nd Cedi) for the period 1900-2006: (i) *Cocoa in the Ghanaian Economy*, Merryl Bateman (1965), unpublished thesis, MIT, (ii) FAOSTAT, (iii) "Export Growth and Trade Policy in Ghana in the Twentieth Century", Teal (2002), The World Economy 25: 1919-1937. We obtain Cedi/$ official and parallel exchange rate data and $ deflator data from: (i) Dordunoo, Cletus. 1994. "The Foreign Exchange Market and the Dutch Auction System in Ghana." *AERC Research Paper* no 24, (ii) Lawrence H. Officer. 2009. "Exchange Rates Between the United States Dollar and Forty-one Currencies." *Measuring Worth*, (iii) Teal 2002, and (iv) UN 2010. We use parallel exchange rate data when the black market premium is significantly different from 0. By multiplying cocoa production and the deflated producer price (in 2000$), we get the deflated total value (also in 2000$) of cocoa production going to cocoa farmers. Likewise, we calculate how much 2000$ of cocoa production were earned between each census year for each district.

Other Data

In addition to urban and cocoa production data, we collect data from various sources on Ivory Coast and Ghana. First, forest data is derived from land cover GIS data compiled by Globcover 2009. The data indicates at a very fine spatial level those areas with virgin forest or mixed virgin forest/croplands, which were areas with virgin forest before it was cleared for crop production. We are then able to know the location of the virgin forest one century ago, before cocoa production even started.

For Ivory Coast, we first use three household surveys to calculate a range of statistics that we use for our empirical analysis: (i) the 1985-1988 Living Standards and Measurement Study (LSMS), and (ii) the 1998 and 2002 *Enquêtes sur le niveau de vie des ménages* (ENV). Third, in addition to the household surveys, we use the following infrastructure datasets: (i) a GIS data set on paved roads in 1965, 1975, 1988 and 1998 using information from Michelin road maps and the book *Elephants d'Afrique 1995-2000*, (ii) the 1988 urban infrastructure census (*Recensement des Infrastructures des Communes Urbaines*), (iii) allocation maps of primary and secondary schools in 1992 from the book *Elephants d'Afrique 1995-2000*, (iv) allocation map of health facilities in 2003 from the WHO website (http://gamapserver.who.int/mapLibrary/default.aspx). Fourth, demographic transition data is compiled crossing information from the following documents: (i) reports of *Recensement général de la population et de l'habitation 1998*, (ii) *Temps des villes, temps des vivres : L'Essor du vivrier marchand en Côte-d'Ivoire*, by Jean-Louis Chaléard (2000), Karthala, (iii) *La Côte d'Ivoire à l'aube du XXIe siècle : Défis démographiques et développement durable*, by Georges Tapinos, Philippe Hugon and Patrice Vimard (2003), Karthala, (iv) *Données démographiques sur la croissance des villes en Côte d'Ivoire*, by Jean-Paul Duchemin et Jean-Pierre Trouchaud (1969), Cahiers de l'ORSTOM, Série Sciences Humaines, 1-1969. Fifth, the cocoa tax is estimated using annual FAO data on the international price in dollars of cocoa beans and exchange rate UN data. Sixth, data on government total spending, consumption and investment comes from the African Development Indicators dataset of the World Bank.

For Ghana, we first use three household surveys and two censuses to calculate a range of statistics that we use for our empirical analysis: (i) the 1987-88 and 2005 *Ghana Living Standard Survey*, (ii) the 2000 *Population and Housing Census* IPUMS sample, and (iii) the 2000 *Facility Census*. Second, demographic transition data is compiled crossing information from the following documents: (i) Patterson, David. 1979. "Health in Urban Ghana: the Case of Accra 1900-1940." *Social Science and Medicine* 13B: 251-268, (ii) Caldwell, J.C. 1967. "Fertility Differentials as Evidence of Incipient Fertility Decline in a Developing Country: The Case of Ghana." population Studies 21(1): 5-21, (iii) *The Population of Ghana 1974*, CICRED Report, (iv) *Demographic and Household Survey* 1988, (v) Agyei-Mensah, Samuel. 2005. "The Fertility Transition in Ghana Revisited." Paper prepared for the 25th IUSSP International Population Conference, Tours, France, and (vi) *Ghana's Development Agenda and Population Growth: The Unmet Need for Family Planning*, National Population Council 2006.

Table 1: Cocoa Production and Urbanization, Ivory Coast, 1948-1998.

Dependent Variable:	District Urban Population (Pop. in ≥5000 Localities, Excluding Abidjan and Bouaké)				
	OLS	*IV*	*IV*	*IV*	*IV+Ctrls*
	(1)	(2)	(3)	(4)	(5)
Panel A: Main Equation					
District value of cocoa production	86.9***	117.5***	120.1***	129.1***	107.4**
(between $t-1$ and t, millions of 2000$)	[16.1]	[34.3]	[37.4]	[46.9]	[41.1]
Close to the cocoa front		4,711.1	3,877.8	2,513.7	3,811.3
		[3,204.7]	[3,369.3]	[3,480.5]	[3,542.2]
Panel B: 1st Stage					
Suitable to cocoa * Close to the cocoa front		212.6***	193.3***	145.5***	129.0***
		[59.3]	[55.8]	[49.1]	[45.3]
Close to the cocoa front		-46.9*	-31.8	-1.8	-4.3
		[25.2]	[23.6]	[15.1]	[19.4]
Kleibergen-Paap rk Wald F stat		12.8	12	8.8	8.1
Observations	220	220	220	220	220
R-squared	0.9	0.89	0.9	0.9	0.92
Year Fixed Effects	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y
Lag of Dependent Variable	Y	Y	Y	Y	Y
Year Dummies * Lag of Dependent Variable	N	N	Y	Y	Y
Year Dummies * Suitable to Cocoa	N	N	N	Y	Y
Controls	N	N	N	N	Y

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the district level. All the regressions include the lag of the dependent variable and year and district fixed effects. In column (3), we allow for the effect of the lag of the dependent variable to vary with time. In column (4), we include year dummies interacted with a dummy equal to 1 if the district is suitable to cocoa production. The set of controls we use in column (5) is: (a) dummies equal to 1 if the district is coastal, has a railway or a paved road going directly to Abidjan, all interacted with a year trend, (b) year dummies interacted with the district distance to the coast, and the district average annual sum of rainfall for the period 1900-2000.

Table 2: Cocoa Production and Urbanization, Ghana, 1921-2000.

Dependent Variable:	District Urban Population (Pop. in ≥5000 Localities, Excluding Accra and Kumasi)				
	OLS	*IV*	*IV*	*IV*	*IV+Ctrls*
	(1)	(2)	(3)	(4)	(5)
Panel A: Main Equation					
District value of cocoa production	12.1	30.4	44.8*	87.0***	86.6***
(between $t-1$ and t, millions of 2000$)	[16.2]	[23.3]	[22.5]	[31.1]	[31.2]
Close to the cocoa front		1,483.3	1,211.9	-1,060.4	-1,329.9
		[1,170.9]	[1,267.4]	[834.0]	[1,725.0]
Panel B: 1st Stage					
Suitable to cocoa * Close to the cocoa front		87.6***	86.7***	78.3***	94.4***
		[16.6]	[16.1]	[17.2]	[20.8]
Close to the cocoa front		-14.7*	-14.1*	-4	-20.1**
		[8.3]	[8.1]	[3.2]	[9.5]
Kleibergen-Paap rk Wald F stat		27.9	29	20.8	20.6
Observations	426	426	426	426	426
R-squared	0.9	0.9	0.92	0.91	0.91
Year Fixed Effects	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y
Lag of Dependent Variable	Y	Y	Y	Y	Y
Year Dummies * Lag of Dependent Variable	N	N	Y	Y	Y
Year Dummies * Suitable to Cocoa	N	N	N	Y	Y
Controls	N	N	N	N	Y

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the district level. All the regressions include the lag of the dependent variable and year and district fixed effects. In column (3), we allow for the effect of the lag of the dependent variable to vary with time. In column (4), we include year dummies interacted with a dummy equal to 1 if the district is suitable to cocoa production. The set of controls we use in column (5) is: (a) dummies equal to 1 if the district is coastal, has a railway or a paved road going directly to Accra, all interacted with a year trend, (b) year dummies interacted with the district distance to the coast, and the district average annual sum of rainfall for the period 1900-2000.

Table 3: Cocoa Production and Urbanization, IV, Specification Checks.

Dependent Variable:	District Urban Population (Pop. in ≥5000 Localities, Excluding the Two Main Cities)							
	Ivory Coast, 1948-1998				**Ghana, 1921-2000**			
	Level (1)	△ (2)	Density (3)	Level (4)	Level (5)	△ (6)	Density (7)	Level (8)
Main Equation								
District value of cocoa production	107.4**	113.4***			86.6***	99.8**		
(between $t-1$ and t, millions of 2000$)	[41.1]	[31.5]			[31.2]	[47.1]		
District density of value of cocoa production			78.5**				54.2*	
(between $t-1$ and t, millions of 2000$/sq.km.)			[32.4]				[32.0]	
District cocoa production				0.15**				0.08**
(between $t-1$ and t, tons)				[0.06]				[0.03]
Close to the cocoa front	3,811	4,062	1.0**	2,992	-1,330	-2,806	-1.5**	-1,392
	[3,542]	[3,534]	[0.5]	[4,052]	[1,725]	[2,701]	[0.7]	[1,650]
Kleibergen-Paap rk Wald F stat	8.1	7.1	14.8	10.2	20.6	19.8	29.1	16.7
Observations	220	220	220	220	426	426	426	426
R-squared	0.92	0.73	0.93	0.93	0.91	0.35	0.99	0.91
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Year Dummies * Lag of Dependent Variable	Y	N	Y	Y	Y	N	Y	Y
Year Dummies * Suitable to Cocoa	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the district level. All the regressions include year and district fixed effects, and year dummies interacted with a dummy equal to 1 if the district is suitable to cocoa production. Except in columns (2) and (5) where the outcome is the change variable, we also include year dummies interacted with the lag of the dependent variable. The set of controls we use include: (a) dummies equal to 1 if the district is coastal, has a railway or a paved road going directly to the capital city, all interacted with a year trend, (b) year dummies interacted with the district distance to the coast, and the district average annual sum of rainfall for the period 1900-2000. Those results are robust to the exclusion of controls.

Table 4: Cocoa Production and Total, Urban and Rural Populations, Ivory Coast, 1965-1998.

Dependent Variable:	**Population**				**Urban Population**		
	Total	Urban	Rural	Urban. Rate	In Old Cities	In New Cities	Number of Cities
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
District value of cocoa production	83.7*	91.3***	-1.7	0.01**	54.6***	56.8**	0.009***
(between $t-1$ and t, millions of 2000$)	[49.4]	[22.9]	[42.8]	[0.004]	[10.8]	[21.6]	[0.003]
Observations	132	132	132	132	132	132	132
R-squared	0.87	0.87	0.75	0.74	0.88	0.43	0.75
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y	Y	Y
Year Dummies * Lag of Dependent Variable	Y	Y	Y	Y	Y	Y	Y
Year Dummies * Suitable to Cocoa	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the district level. All the regressions include year and district fixed effects, and year dummies interacted with: (i) the lag of the dependent variable, and (ii) a dummy equal to 1 if the district is suitable to cocoa production. Those results are robust to the inclusion of controls.

Table 5: Population Change in Old vs. New Cocoa-Producing Areas, Ivory Coast 1965-1998, OLS.

Dependent Variable:	**District Urban Population**							
	All Cities (1)	In Old Cities (2)	In New Cities (3)	Number of Cities (4)	All Cities (5)	In Old Cities (6)	In New Cities (7)	Number of Cities (8)
Decreasing pc Production	78,188***	59,004***	55,847***	7.3***				
	[13,791]	[8,068]	[12,485]	[1.7]				
Increasing pc Production	59,878***	60,998***	39,137***	5.2***				
	[20,128]	[5,362]	[7,084]	[0.8]				
Highly Decreasing pc Prod.					126,539***	76,296***	90,645***	13.0**
					[32,552]	[21,017]	[31,963]	[5.0]
Slightly Decreasing pc Prod.					64,904***	51,477***	48,739***	6.5***
					[13,147]	[8,331]	[9,967]	[1.2]
Highly Increasing pc Prod.					55,207***	57,402***	36,721***	5.0***
					[14,942]	[5,701]	[5,690]	[0.7]
Slightly Increasing pc Prod.					90,444***	66,337***	59,154***	7.8***
					[19,326]	[8,500]	[14,203]	[1.4]
Observations	132	132	132	132	132	132	132	132
R-squared	0.84	0.86	0.33	0.72	0.88	0.87	0.44	0.77
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Year Dummies * Lag of Dep. Var.	Y	Y	Y	Y	Y	Y	Y	Y
Year Dummies * Suitable	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	N	N	N	N	N	N

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the district level. All the regressions include year and district fixed effects, and year dummies interacted with: (i) the lag of the dependent variable, and (ii) a dummy if more than 50% of district area is suitable to cocoa production. Those results are robust to the inclusion of controls.

Table 6: Allocation of Household Expenditures for Cocoa-Producing Households (in %).

Ivory Coast, Forest, 1985-1988 and 2002								
	1988	2002		1988	2002		1988	2002
Home Production	32.1	28.9	Food Expenses	25.8	27.9	Other Expenses	42	43.2
Of which (%):			*Of which (%):*			*Of which (%):*		
Starchy roots	51.7	40.1	Seafood	30.0	29.0	Clothing	22.9	21.7
Cereals	25.2	24.5	Cereals	16.1	22.3	Transfers & Events	15.0	14.3
Vegetables	10.1	11.9	Sweets	13.9	8.6	Health & Hygiene	14.0	23.6
Meat	5.8	6.3	Alcohol	9.3	3.1	Housing	14.0	17.4
Oils	5.2	9.1	Meat	8.6	8.5	Education	12.2	6.6
Fruits	1.3	5.8	Oils	8.0	8.0	Bills & Fuel	9.1	11.3

Ghana, Forest, 1987-1988 and 2005								
	1988	2005		1988	2005		1988	2005
Home Production	36.3	18.5	Food Expenses	33.3	37.2	Other Expenses	30.1	44.3
Of which (%):			*Of which (%):*			*Of which (%):*		
Starchy roots	59.5	67.5	Seafood	35.8	35.1	Clothing	26.6	19.4
Vegetables	10.9	8.8	Starchy roots	17.5	6.0	Health & Hygiene	20.5	16.3
Cereals	9.9	6.7	Vegetables	11.0	12.1	Housing	9.4	10.6
Fruits	7.8	4.2	Cereals	9.1	17.5	Transfers & Events	11.9	10.9
Meat	6.2	4.0	Meat	8.0	7.4	Education	6.9	15.2
Oils	5	6	Oils	6	5	Bills & Fuel	8.9	11.3

Note: We use the 1985-88 LSMS and 2002 ENV household surveys for Ivory Coast and the 1987-88 and 2005 GLSS (1, 2 & 5) household surveys to estimate the allocation (in %) of total household expenditure for cocoa-producing households in the Forest regions of both countries. We first show the allocation across three consumption aggregates: home production, food expenses and other expenses. Second, for each of those consumption aggregates, we show the six main consumption subaggregates and their contribution (in %) to the value of the consumption aggregate.

Table 7: Cocoa Production and Ownership of Durable Goods, Ivory Coast, 1985-1988 and 1998.

Forest, Ivory Coast, 1985-1988								
Owns:	Gas Cooker	Fridge	Fan	Radio	TV	Bicycle	Bike	Car
Cocoa HH	-0.01***	-0.01	0.01**	0.11***	0.02***	0.13***	0.08***	0.03***
	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.00]
Observations	20443	20443	20443	20443	20443	20443	20443	20443
R-squared	0.19	0.34	0.4	0.19	0.37	0.32	0.22	0.17
Village-Time FE	Y	Y	Y	Y	Y	Y	Y	Y

Forest, Ivory Coast, 1998								
Owns:	Gas Cooker	Fridge	Fan	Radio	TV	Bicycle	Bike	Car
Cocoa HH	0.01*	0.01	0.03***	0.14***	0.08***	0.22***	0.02***	0.02***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.00]
Observations	9206	9206	9206	9206	9206	9206	9206	9206
R-squared	0.23	0.4	0.35	0.27	0.31	0.32	0.19	0.24
Village-Time FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. We use the 1985-88 LSMS and 1998 ENV household surveys and we create a set of dummies equal to 1 if the household owns the following goods: gas cooker, fridge, fan, radio, TV, bicycle, bike, car. We then regress each dummy on a dummy equal to 1 if the household produces cocoa. We also regress the number of spouses of the household head on the cocoa household dummy. As we drop those households that are not involved in agricultural activity, we mechanically compare cocoa producers and non-cocoa farmers (which we take as a benchmark). Since, we include a set of village-time fixed effects, we control for villages characteristics and we compare cocoa producers and non-cocoa farmers *within* their village.

Table 8: Cocoa Production and Infrastructure Investments, Ivory Coast, 1998-2002.

Dependent Variable:	**Share of Households with Access to**						**Share of Children Attending School**			
	Electricity		Private Tap Water		Toilet		6-11 yo		12-15 yo	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Old Cocoa Area	0.28***	-0.03	0.09***	-0.04	0.46***	0.05	0.18**	-0.05	0.20**	-0.02
	[0.09]	[0.11]	[0.03]	[0.08]	[0.15]	[0.07]	[0.08]	[0.06]	[0.08]	[0.08]
New Cocoa Area	0.12**	-0.03	-0.02	-0.07	0.16**	-0.01	0.13***	-0.03	0.1	0.01
	[0.05]	[0.05]	[0.02]	[0.06]	[0.07]	[0.06]	[0.05]	[0.05]	[0.06]	[0.05]
Observations	44	45	44	45	44	45	44	45	44	45
R-squared	0.22	0.01	0.2	0.03	0.27	0.01	0.19	0.02	0.11	0

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The 1998 EP and 2002 ENV surveys are used to estimate the share of inhabitants with access to private tap water, electricity, and toilets, as well as the share of children attending school for two age groups: 6-11 corresponding to primary schooling, and 12-15 corresponding to secondary schooling. Old cocoa areas correspond to districts whose per capita cocoa production has been decreasing between 1965 and 1998 (mostly in the Eastern Forest). New cocoa areas correspond to districts whose per capita cocoa production has been increasing between 1965 and 1998 (mostly in the Western Forest). Northern districts are taken as a control group.

Table 9: Cocoa Production and Infrastructure Investments, Ghana, 2000.

Dependent Variable:	**Share of Inhabitants ≤ 10 Kms From**									
	Primary School		JSS		SSS		Health Centre		Hospital	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Very Old Cocoa Area	0.04*	0.00	0.13*	0.00	0.16*	0.07*	0.14*	0.02**	0.12*	0.10
	[0.01]	[0.00]	[0.05]	[0.00]	[0.07]	[0.03]	[0.05]	[0.01]	[0.05]	[0.06]
Old Cocoa Area	0.04*	0.00	0.12	0.00	0.18	0.02	0.14*	0.01	0.17*	0.09
	[0.01]	[0.00]	[0.05]	[0.00]	[0.08]	[0.03]	[0.06]	[0.01]	[0.06]	[0.07]
New Cocoa Area	0.03	0.00	0.10	0.00	0.00	0.00	0.00	0.01	0.09	-0.02
	[0.01]	[0.00]	[0.05]	[0.00]	[0.07]	[0.03]	[0.05]	[0.01]	[0.05]	[0.06]
Observations	104	100	104	100	104	100	104	100	104	100
R-squared	0.27	0.00	0.30	0.00	0.13	0.04	0.19	0.02	0.13	0.03

Dependent Variable:	**Share of Inhabitants ≤ 10 Kms From**				**Share of Inhabitants with Access to**					
	Post Office		Telephone		Electricity		Private Tap		Toilet	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Very Old Cocoa Area	0.36**	0.11*	0.33**	0.17**	0.11**	0.12**	0.02**	0.07**	0.60**	0.27*
	[0.06]	[0.04]	[0.04]	[0.04]	[0.02]	[0.02]	[0.00]	[0.02]	[0.14]	[0.08]
Old Cocoa Area	0.30*	0.10*	0.25*	0.12*	0.15**	0.14**	0.01	0.01	0.55**	0.25*
	[0.09]	[0.04]	[0.08]	[0.04]	[0.03]	[0.02]	[0.01]	[0.03]	[0.14]	[0.09]
New Cocoa Area	0.12	0.01	0.13*	0.05	0.12**	0.18**	0	0	0.42*	0.21*
	[0.06]	[0.04]	[0.04]	[0.04]	[0.02]	[0.02]	[0.00]	[0.02]	[0.14]	[0.08]
Observations	104	100	104	100	104	100	104	100	104	100
R-squared	0.33	0.15	0.24	0.08	0.29	0.2	0.07	0.05	0.61	0.39

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are clustered at the region level. The 2000 Facility Census is used to calculate the average distance (in km) to various types of facility. JSS and SSS are junior and senior secondary schools. The 2000 Population and Housing Census is used to estimate the share of inhabitants with access to electricity, private tap water and toilets. Observations corresponding to Accra and Kumasi are dropped. Very old cocoa areas correspond to districts whose maximum cocoa production was reached during the 1930s. Old cocoa areas correspond to districts whose maximum cocoa production was reached in the 1960s. New cocoa areas correspond to districts whose maximum cocoa production was reached in the 1990s. Northern districts are taken as a control group.

Table 10: Crude Rates of Birth, Death and Natural Increase per Place of Residence.

Ivory Coast 1965-1998				Ghana 1960-2000			
Crude Rate of (%o)				Crude Rate of (%o)			
	Birth	Death	Natural increase		Birth	Death	Natural increase
Rural				**Rural**			
1965	50	30	20	1960	52	23	29
1975	48	20	28	1970	51	21	30
1988	52	15	37	1984	48	17	31
Urban				**Urban**			
1965	46	26	20	1960	49	20	29
1975	51	14	37	1970	45	14	31
1988	42	13	29	1984	37	14	23
Abidjan				**Accra**			
1965	47	14	33	1960	43	14	30
1975	50	9	41	1970	36	7	28
1988	42	9	33	1984	34	11	23

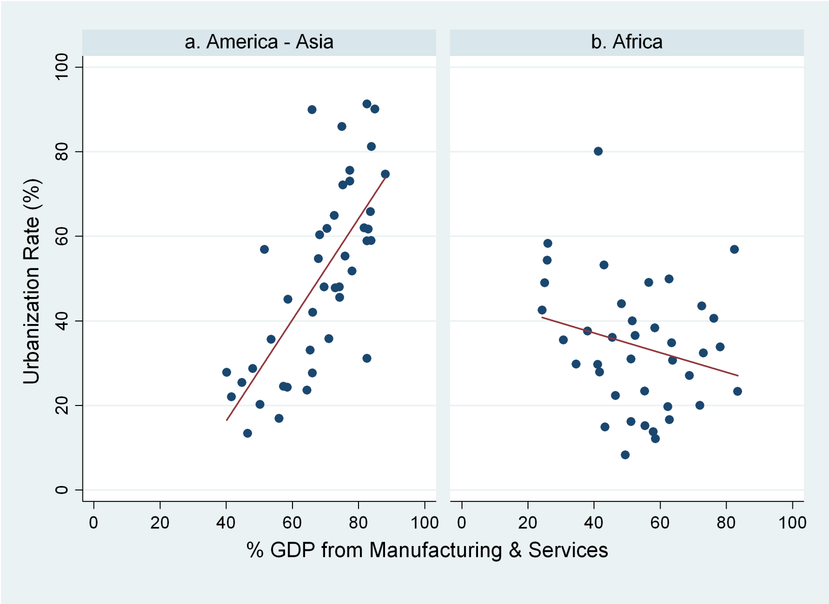
Note: see data appendix for details.

Table 11: Contribution (%) of Natural Increase and Migration to Population Change.

	Ivory Coast 1965-1998			Ghana 1960-2000	
	Natural increase (%)	Migration (%)		Natural increase (%)	Migration (%)
Rural			**Rural**		
1965-1975	84	16	1960-1970	227	-127
1975-1988	131	-31	1970-1984	139	-39
1988-1998	162	-62	1984-2000	264	-164
Urban			**Urban**		
1965-1975	20	80	1960-1970	56	44
1975-1988	46	54	1970-1984	90	10
1988-1998	45	55	1984-2000	46	54
Abidjan			**Accra**		
1965-1975	31	69	1960-1970	33	67
1975-1988	62	38	1970-1984	76	24
1988-1998	80	20	1984-2000	39	61

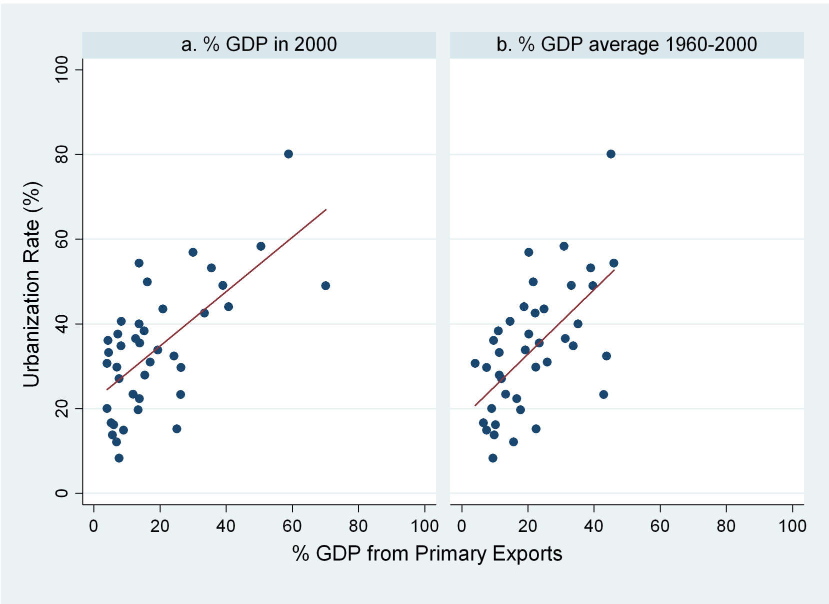
Note: We use historical data on population and crude rates of birth and death by place of residence (rural / urban / main city) to estimate the contribution (in %) of natural increase and migration to population change for each subperiod between two census dates. For each subperiod - place of residence, the contribution of natural increase (in %) is calculated as initial population times the rate of natural increase between year t-1 and year t over population change times 100. The contribution of migration (in %) is calculated as 100 minus the contribution of natural increase. Unfortunately, we cannot distinguish internal and external migration.

Figure 1: Manufacturing and Service Sectors and Urbanization in Developing Countries in 2000.



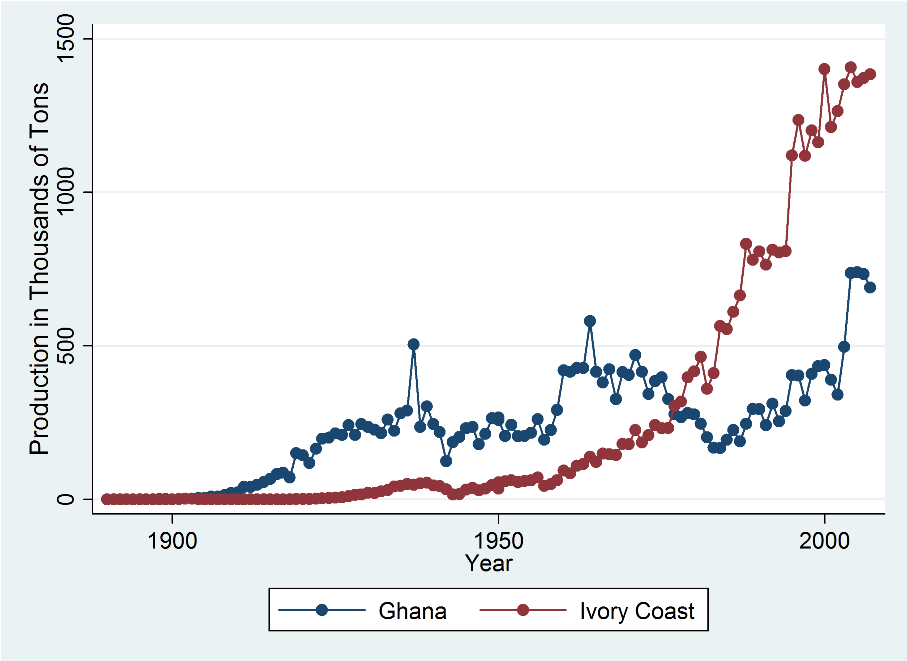
Sources: WUP 2009, WDI 2010, Author's Calculations. America-Asia includes developing countries from Caribbean (4), Central America (8), South America (12), Eastern Asia (2), South and Central Asia (7) and South-Eastern Asia (9). Africa includes countries from Sub-Saharan Africa (39). Small island and enclave countries are intentionally excluded from this analysis.

Figure 2: Primary Exports and Urbanization in Africa, 2000.



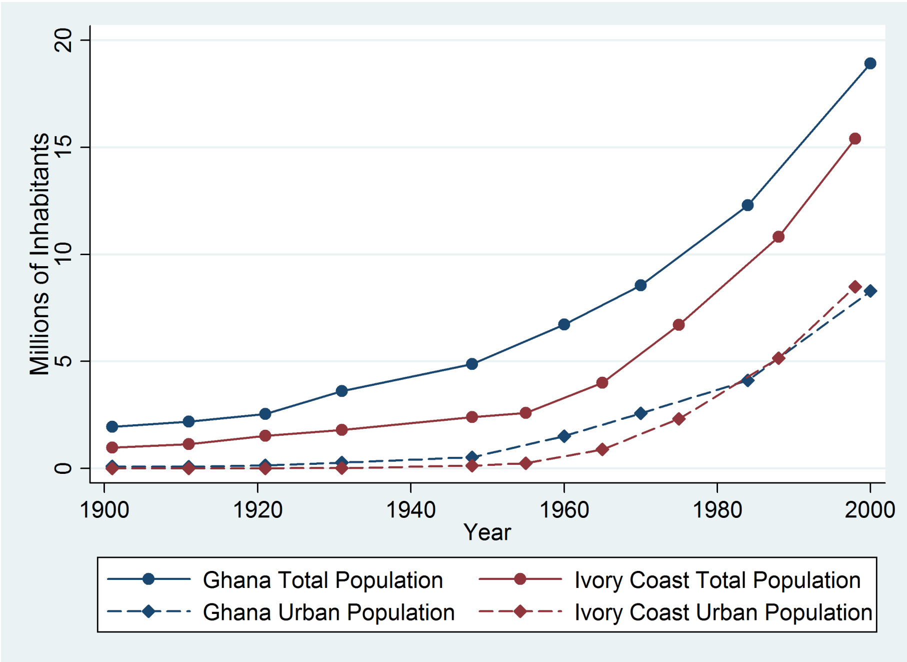
Sources: WUP 2009, WDI 2010, USGS 1960-2000, Author's Calculations. Our sample consists of 39 Sub-Saharan African countries, thus excluding small island countries. Primary exports include the exports of mineral products and cash crops. Subfigure *a.* uses their contribution (in %) to GDP in 2000, while subfigure *b.* uses their average contribution to GDP (in %) between 1960 and 2000, using a 5-year panel I constructed.

Figure 3: Cocoa Production (in thousands tons), 1890-2007.



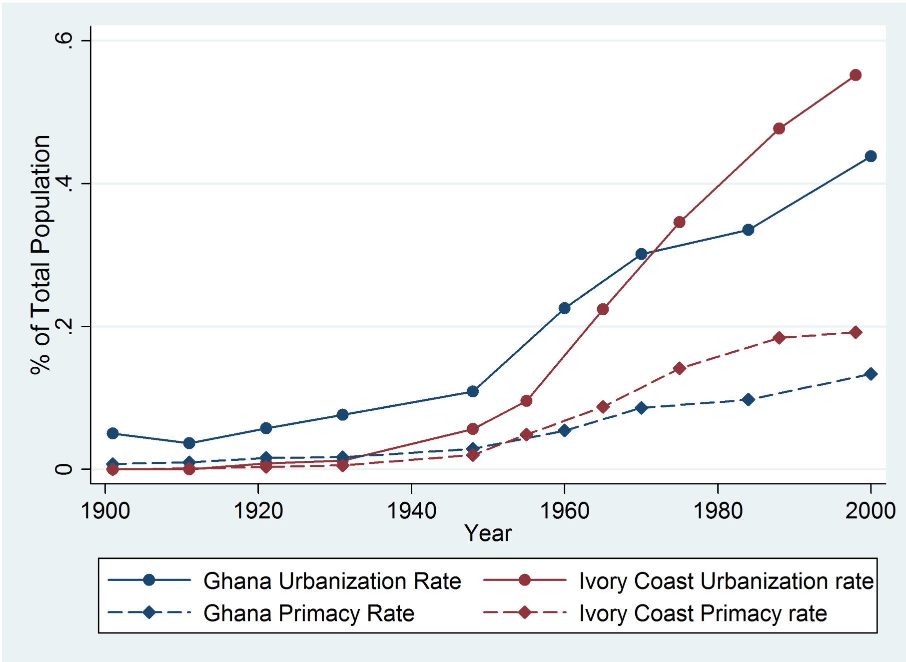
Sources: see data appendix for more details.

Figure 4: Total and Urban Populations, 1900-2000.



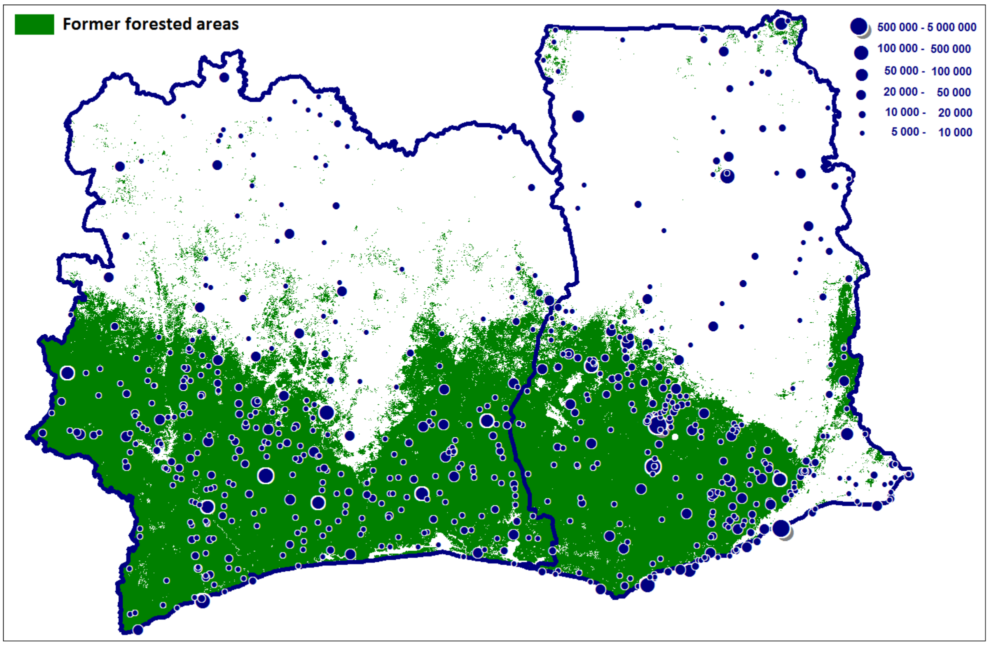
Sources: see data appendix for more details.

Figure 5: Urbanization and Primacy Rates, 1900-2000.



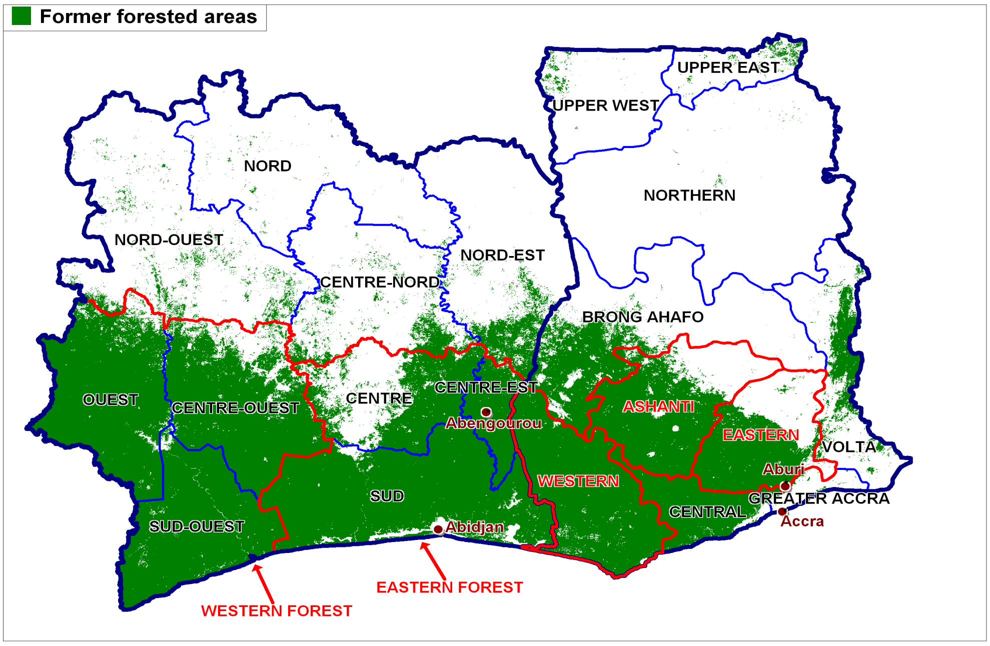
Sources: see data appendix for more details. The urbanization rate is defined as urban population over total population * 100, and the primacy rate is the size of the capital city over total population * 100.

Figure 6: Former Forested Areas and Cities in 1998 (Ivory Coast) / 2000 (Ghana).



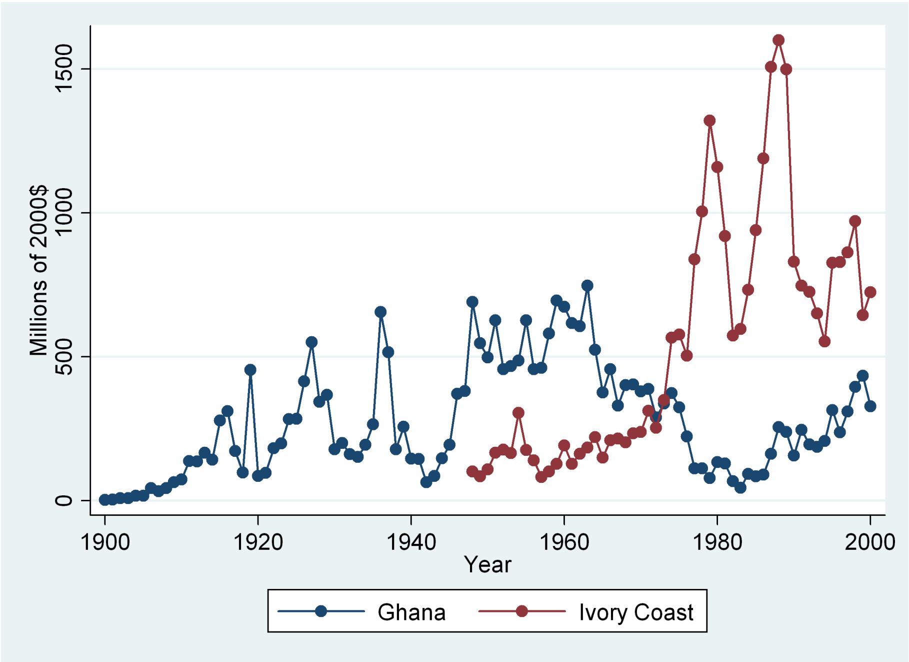
Sources: see data appendix for more details. Former forested areas were a virgin forest one century ago, before cocoa production started.

Figure 7: Former Forested Areas, Regions and Historical Starting Points.



Sources: see data appendix for more details. Former forested areas were virgin forests one century ago, before cocoa production started. Aburi is the historical starting point of Ghanaian cocoa production. Abengourou is the historical starting point of Ivorian cocoa production.

Figure 8: Value of Cocoa Production Going to Cocoa Farmers, 1900-2000.



Sources: see data appendix for more details. The value of cocoa production in year t is calculated as the quantity produced that year (in tons) multiplied by the price per ton (in 2000$) that year.

Figure 9: District Density of Cocoa Production and Cities around 1948.

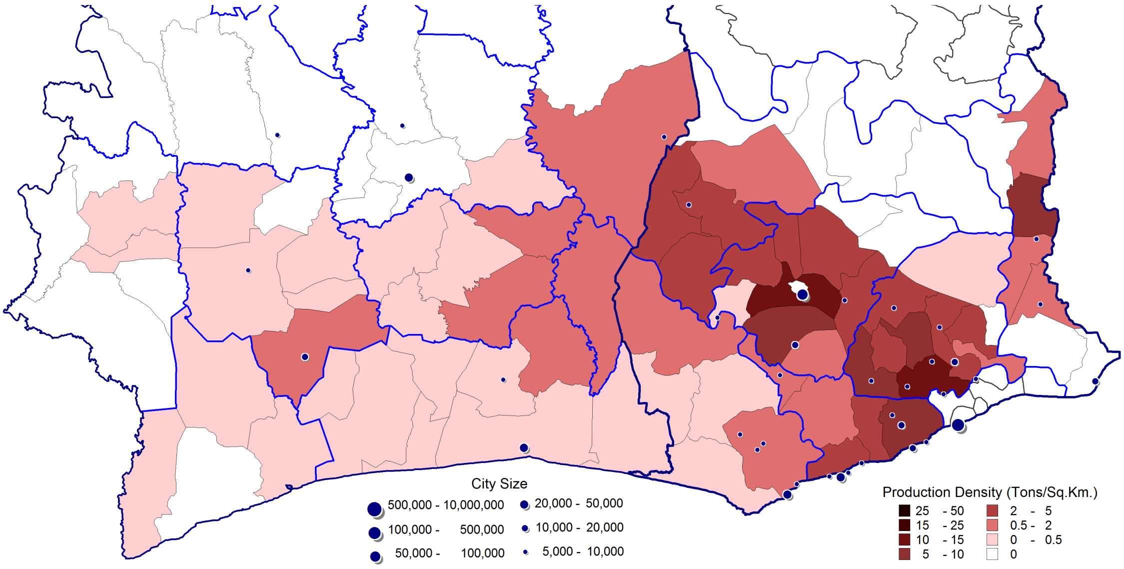


Figure 10: District Density of Cocoa Production and Cities around 1960 (Ghana) / 1965 (Ivory Coast).

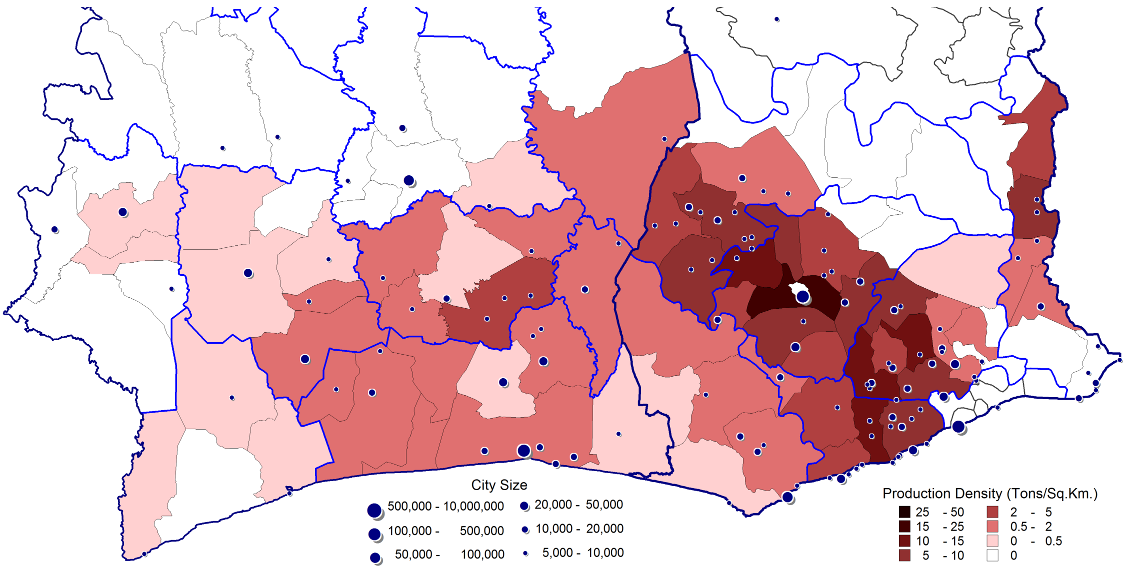


Figure 11: District Density of Cocoa Production and Cities around 1970 (Ghana) / 1975 (Ivory Coast).

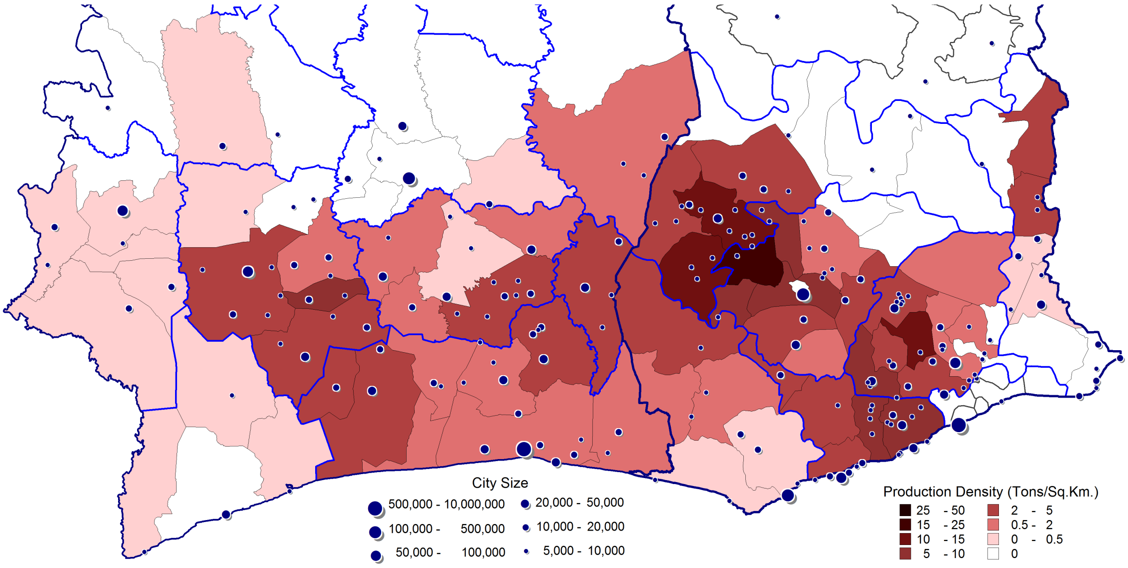


Figure 12: District Density of Cocoa Production and Cities around 1984 (Ghana) / 1988 (Ivory Coast).

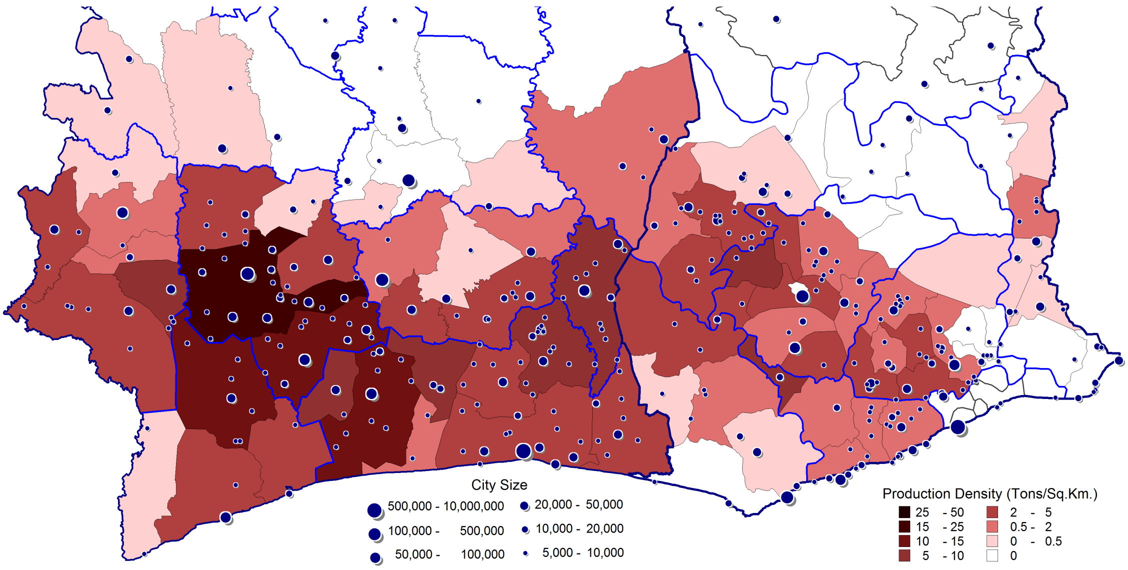


Figure 13: District Density of Cocoa Production and Cities around 2000 (Ghana) / 1998 (Ivory Coast).

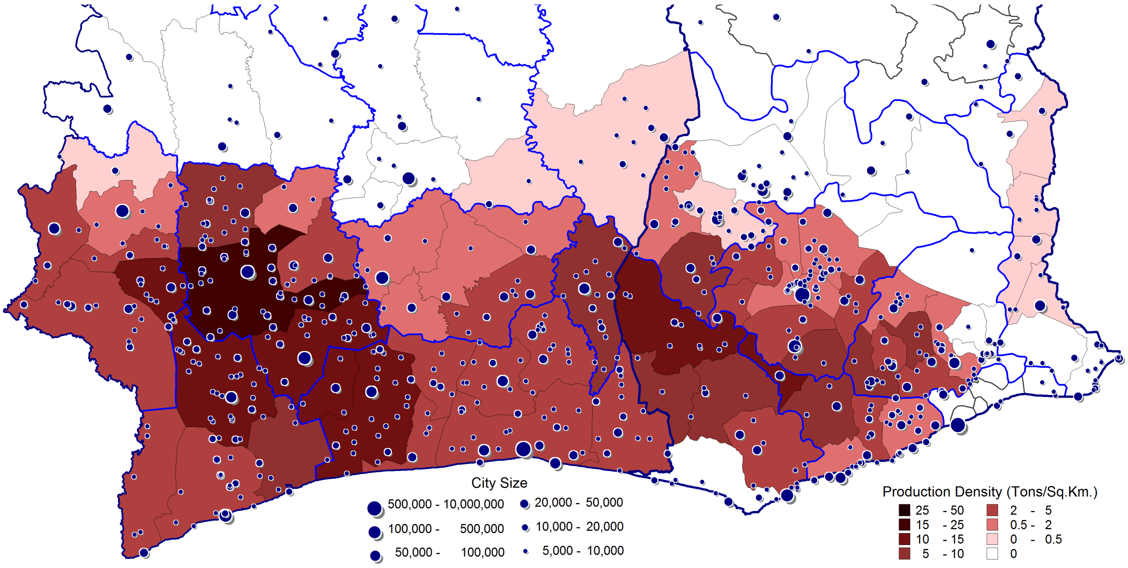
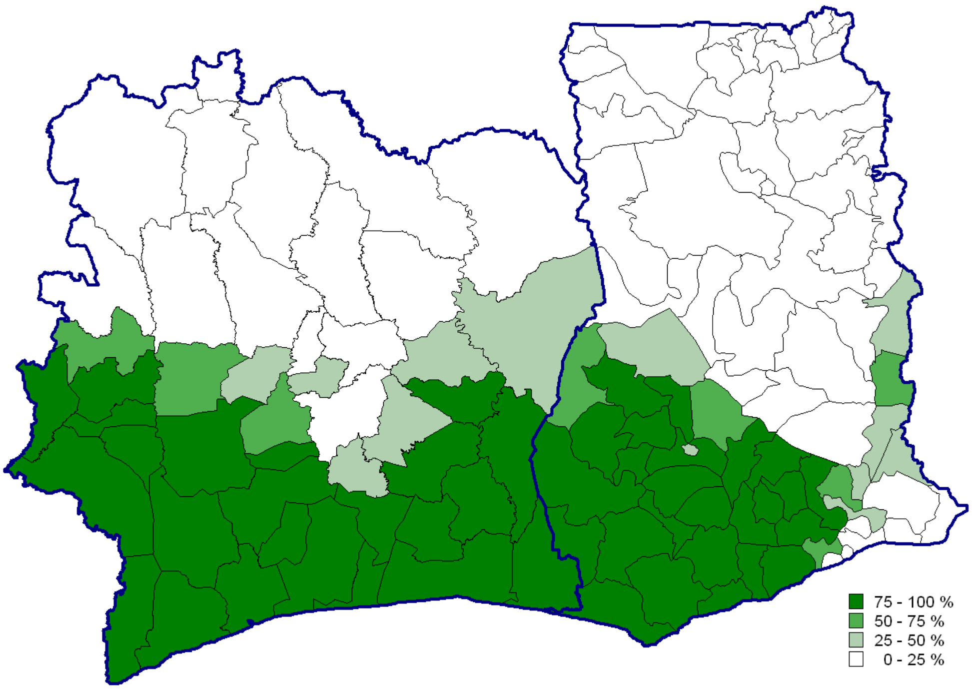


Figure 14: Share of District Area Suitable to Cocoa Production.



Sources: for each district, we calculate the share of district area being suitable to cocoa production (with a virgin forest one century ago). We create four categories of land suitability: when the share is inferior to 25%, when it is between 25 and 50%, 50 and 75% or more than 75%.

Figure 15: Centroids and Longitude Bands of One Degree.

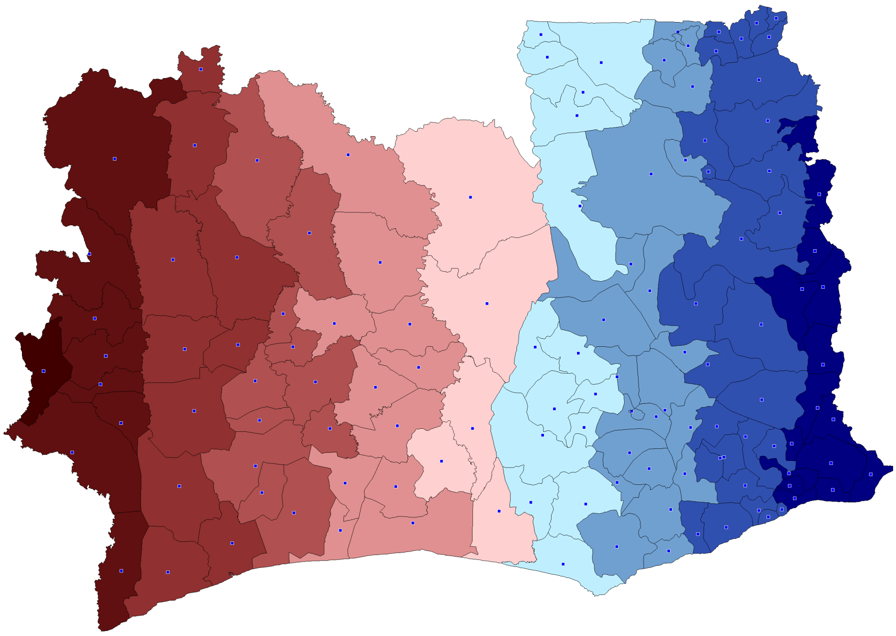
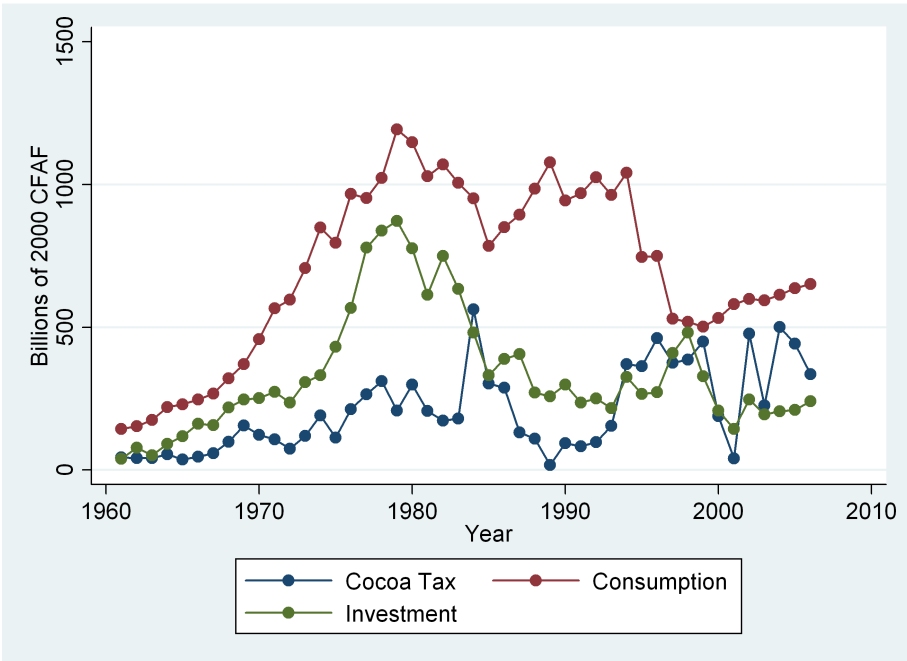


Figure 16: Cocoa Tax and Central Government Spending, Ivory Coast 1961-2006.



Sources: see data appendix for more details. Cocoa tax is the total revenue going to the state, as a result of the difference between the international price and the producer price of cocoa beans. Government spending includes government consumption and investment.