Living Conditions in Côte d'Ivoire, Ghana and Western Africa 1925-1985: What Do Survey Data on Height Stature Tell Us?*

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1/ Introduction

Not much is known about living conditions in Africa during the colonial period. While the comparative economics literature shows a renewed interest in long-term historical perspectives, empirical works trying to explain differences in development are most often bound to correlate some characteristics of the colonial intervention: European settlement, indigenous population density, slave trade, land administration, etc.... with post-colonial outcomes. In contrast with broad-brush macroeconomic correlations (e.g., La Porta et al., 1999; Acemoglu, Johnson and Robinson, 2002, Nunn, 2008), recent works prove that regional data can be a more interesting and relevant alternative (e.g., on India: Banerjee and Iyer, 2005; Iyer, 2005; Chaudhary, 2008; on Philippines: Iyer and Maurer, 2008; on Western Africa: Huillery, 2008a & 2009; on Latin America: Bruhn and Gallego, 2008). These works are in particular able to document more precisely colonial policies and their evolution across time, as well as to explore a larger span of post-colonial welfare than only GDP per capita. They are still however confronted with the lack of data on outcomes during the colonial period, and still run the risk of compression of different periods and time paths (Austin, 2008). Coping with this lack is not an easy task. Colonial archives are one possibility, and in particular data on army recruits and military conscripts (Austin, Baten and Moradi, 2007 for Ghana; Moradi, 2009 for Kenya).

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We here exploit the alternative source constituted by household surveys implemented since the 1980s, where the older cohorts were born, raised and received their education during the colonial era. In particular, the so-called Living Standard Measurement Surveys (LSMS) for Côte d'Ivoire (1985-1988) and Ghana (1987-1989) are old enough to contain samples of reasonable sizes for cohorts born between 1925 and 1960; they also share the unique feature of having measured the height stature of both adult men and women. Additionally, they collected very precious pieces of information on individuals' parental background and district of birth. Unfortunately these LSMS surveys were the first to be implemented in Africa, and were never repeated in their original form in other countries. Regarding height stature of adults, the best alternative source comes from Demographic and Health Surveys (DHS) that are implemented at a regular pace in most African countries since the beginning of the 1990s; however, as they only measure the height of mothers between 15 and 49 years of age, they do not allow going back in time earlier than 1945 (Moradi, 2006). Appendix 1 provides a description of the surveys used in this paper.

The analysis of height stature in historical economics is now a well-established sub-field, since the works of Fogel (1993 & 1994), Steckel (2008), Komlos, Baten (Komlos and Baten, 2004) and others with various kinds of data sources (skeletons, military, slaves, surveys). The study of human growth is also an active sub-field of human biology and physical anthropology (see, e.g., Bogin, 2006). Height developments are related to the improvements of living conditions during childhood, and above all to the quantity and quality of nutrition received. This latter variable is also assumed to reflect parental income, then allowing to trace income and labor productivity evolutions across long periods of time. This series of inference is however severely questioned by Deaton (2007), who points out (i) that exposure to pathogens and hence the health infrastructure also come into play, and (ii) that at high levels of child mortality height stature evolutions may be affected by large selection effects. In this paper, we give some consideration to health infrastructure improvements by drawing from colonial administrative data on that aspect; we also thoroughly scrutinize the selection argument and try to assess its potential influence on our results.

We start from a very striking figure revealed by the survey data on Côte d'Ivoire and Ghana: a steep increase in the height stature of populations born during the late colonial period (1925-1960). Section 2 establishes these basic figures for both men and women, and further reveals a trend break in the post-colonial era, not only for Côte d'Ivoire and Ghana, but also for other West African countries. It scrutinizes the robustness of these figures with respect to the survey used (LSMS vs. DHS), to the population considered (men, women, mothers) to potential selection effects linked to adult and child mortality, and most importantly to shrinking at ages above forty. Section 3 then disaggregates these figures by parental background and district of birth. It provides evidence that a significant share of the increase of height stature during colonial times may be related to the structural changes of the economy and their correlated income gains: cocoa expansion, industry diversification and urbanization. Last, an important share of the benefits of urbanization in terms of height seems to be linked to the increased density of health agents and medical staff in towns and cities.

2/ A growth in height stature during colonial times, then a trend break after independence

2.1/ Colonial times: 1925-1960

Figures 1 to 3 document the spectacular increase in stature that is observed when comparing adult cohorts born in the 1920s and cohorts born in the late 1950s using the LSMS surveys implemented in Côte d'Ivoire and Ghana between 1985 and 1989.[1] As shown in Table 1, for men, the total growth in average height is of 3.2 cm in Côte d'Ivoire and 2.5 cm in Ghana, between the decennial birth-year cohorts 1925-34 and 1955-64 of country natives; for women it is respectively of 2.8 and 2.0 cm.[2] Strauss and Thomas (1998) already mention these two Côte d'Ivoire figures, along with similar ones over the same time span for United States, Brazil and Vietnam.

If true, these figures would be higher than the gain experienced by French or British men during the whole 19th century; between 1775 and 1875, Fogel (1994) provides a 2.6 cm increase for the French and a 1.4 cm for the British. Over the following hundred years (1875-1975), numbers are much higher: according to Fogel again, respectively 6.4 and 5.7 cm; this nonetheless makes around 0.6 cm per decade, i.e. a slower pace than what we observe for men in Côte d'Ivoire and even Ghana over 30 years.[3] Our time trend adjustment (by locally linear regressions) suggests a relatively regular rate of height increase from the mid-1920s to the 1960s, with the exception of Ghanaian men for whom the progress flattens between 1950 and 1960. For the overlapping birth cohorts of women in LSMS and DHS surveys (i.e. 1945-1969), statistical tests confirm the consistency of time trends (appendix table A.2a), even if a difference of about 0.75 cm in average height is observed between the two surveys that we could not explain (appendix table A.2b).

We first ask whether the height trends for men are different from women, taking advantage of LSMS data for which height is available for both genders. Over the whole period 1925-1964, the average level of sexual dimorphism is 10.7 cm in Côte d'Ivoire and 11.2 cm in Ghana, that is a relative difference of 7% that is rather usual. To test for differences in trends, we regress height stature on four degree polynomials (quartic) of birth year for each gender. Figure 6 and 7 plot the difference between adjusted polynomials across birth years. They show a significant difference only for Ghana between 1920 and 1930. We then

[1] We only analyze height for fully grown adults, i.e. 20 years and over individuals. We also exclude international migrants, in particular Burkinabè and Malian migrants living in Côte d'Ivoire, and consider only country natives whenever the surveys allow it, that is every time except with the Ghana DHS (however, according to the Ghana LSMS, foreign born only weigh 2% of the 20 year-old and over population).

[2] The changes in median height are very close to the changes in average height.

[3] Corrections for shrinking due to aging however lead to mitigate these spectacular comparisons, see thereafter.

conclude that height trends of men and women during the colonial period cannot be statistically distinguished and choose to analyze them jointly in section 3.

2.2/ Early post-colonial times: 1960-1985

Figures 2 and 3 also document the trend breaks in height stature after 1960 for the two countries: a slowdown in the case of Côte d'Ivoire, and a pure reversal in the case of Ghana. After 1960, in Côte d'Ivoire no growth in height is observed for mothers in the DHS, whereas in Ghana, mothers born in the mid-1980s have lost about 1.5 cm on average when compared with women born in the 1950s. DHS surveys Ghana and three other countries in the region (Benin, Burkina-Faso and Senegal) all indicate a statistically significant ($p<<.05$) trend break between 1950-1959 and 1960-1983 (Table 2); in the two other cases, Côte d'Ivoire and Mali, one can also observe either stagnation following growth or a slight regression following stability, but breaks are not significant due to sample size or small magnitude. In four cases, the break corresponds to a decrease in average height stature during the early post-independence period; in Côte d'Ivoire and Senegal, the wealthiest and most stable countries at that time, height evolutions just flatten. These trend breaks are observed even if countries differ in average height levels, with taller Sahelian populations on the one hand (Senegal, Mali, Burkina-Faso) and smaller forest populations on the other hand (Côte d'Ivoire, Ghana, Benin).[4]

We ask whether height of mothers (DHS) compare with height of all women (LSMS). The bulk of non-mothers pertain to the youngest 20-29 year-old decennial age range (table A.3a). Within this age group, less than 10% however did not give birth: 7% in 1985-89 Côte d'Ivoire and 9% in 1987-89 Ghana. Anyway, no significant difference in average height level is observed between the two samples (appendix table A.3b). In the data, early teen-mothers (who gave birth before 20) are indeed smaller than late mothers in Ghana, but this difference is not maintained after 20 year-old (see also Sear, Allal and Mace, 2004 on Gambia). When comparing trends of women and trends of mothers for the overlapping cohorts in LSMS and DHS, no difference is observed either (see again appendix table A.2a).

2.3/ The potential impacts of selective mortality and of shrinking

2.3.1. The case for a constant selective adult mortality across time

The study of a cohort of Norwegian males by Waaler shows that relative mortality risks between 40 and 69 are twice as high for the smallest as for the tallest; this differential was used by Fogel to explain the secular decline of mortality in Europe by the improvement

[4] This North-South gradient in average heights is already present in French colonial data on military conscripts in 1946: "Carte Anthropologique, Stature Afrique Occidentale Française, établie par le médecin Lieutenant Colonel L. Palès". We thank Laurent Heyberger (Recits, Université de Belfort-Montbéliard) for providing us this map.

of nutrition (e.g., Fogel 1993 & 1994). Other studies in Northern countries also show a negative gradient of late adult mortality with height, although it is hard to derive from them a causal inference, as height is also correlated to labor conditions and socio-economic status (Leon et al., 1995; Jousilahti et al., 2000). In any case, if this differential mortality would hold over our period of analysis, it would select taller individuals in early birth years, and bias downward the time trends we observe. With a rather extreme Waaler-like gradient, i.e. relative mortality doubling from the first quartile of height to the third quartile, simple computations show that the Côte d'Ivoire increase over 1925-1960 could be underestimated by around 1.5 centimeters. To our knowledge, little evidence is yet available on height-related mortality risks for African countries. One exception is Sear, Allal and Mace (2004), who estimate an event-history model for death spells on a sample of around 600 Gambian women observed in a rural area between 1950 and 1975. They obtain a U-curved parabolic relationship between mortality risk and adult height after 20 years of age: the smallest women die earlier, but the tallest women too. However, the range of variation of mortality risks with respect to height is such that between the first quartile of height (around 154 cm in the Côte d'Ivoire LSMS) and the third quartile (162 cm) mortality risk are equal (flat part of the U); only the first and last 5% of the height distribution reach estimated mortality risk that are double the median.

We can exploit the availability of multiple DHS surveys covering a 10 year-period to test for changes in the average height of surviving women as the cohorts get older, through a pseudo-panel analysis (appendix tables A.4). Unfortunately DHS only measure the height of mothers between 15 and 49, so that the impact of shrinking or of selective mortality at old ages over 50 cannot be studied. Between 20 and 50, female mortality in Africa is often caused by difficult childbirth or (starting in the mid-1980s) to the HIV/AIDS epidemics in countries that are most affected, like Côte d'Ivoire in Western Africa (see, e.g., Anderson and Ray, 2008). Surprisingly, in the case of Ghana, 20-39 year-old mothers as observed in 1993 are 0.4 centimeters taller in 1999 (that is when 26-45 year-old) , and even 0.7 cm taller in 2003 (when 30-49 year-old). A similar shift as high as 1 cm is observed between 1996 and 2006 in Benin (see table A.4a for both countries). However, the four other countries we examine do not exhibit the same features: no variation of height is observed across time for a fixed birth year cohort over ten years (results not shown but available upon request). At least, all these pieces of this evidence reject the possibility of a significant gradual shrinking as women age between 20 and 50. Besides, if we assume that the smallest women die earlier - which would explain this shift in average height we observe in Ghana and Benin, we expect the first quartile of height to increase more than the median, and even more than the third quartile. We observe exactly the reverse in Ghana where the first quartile moves more slowly than the median, and even more slowly than the third quartile. In Benin, the three quartiles exhibit the same changes (table A.4b). We are therefore more inclined to conclude that the changes we observe in Ghana (or Benin) are more due to some sample variation or measurement errors than to differential adult mortality.

Nevertheless, the height trends we observe across cohorts could be consistent with a higher likelihood to die early for taller, rather than smaller, women. The above cited evidence about Gambian women could also make us think that both smaller and taller die early, at least for heights at both extremes of the height distribution. Anyway, if taller women do not receive enough food to sustain their higher energetic needs and die early because this lack of somatic maintenance, then our time trends would be overestimated. However, if mortality risks were higher for taller people due to low nutrition, we would expect them to exhibit some level of underweight, as revealed for instance by a low Body Mass Index (BMI). Appendix table A.5 shows it is not the case: conversely, in the case of Ghana, men and women in the third quartile of height are even a little bit fatter when compared with the first quartile; it is also true for women in Côte d'Ivoire, whereas in this country tall men are just as fat (relatively speaking) as small men.

2.3.2. The case for variations in child or adult mortality across time or space

Differential (with respect to height) child mortality at early ages could have the same impact as differential adult mortality if we assume that child mortality was higher for cohorts born in the 1920s than for cohorts born in the 1960s. As argued by Bozzoli, Deaton and Quintana-Domeque (2008), and by Gørgens, Meng and Vaithianathan (2007) in the case of China's Great Famine, if child mortality selected taller children within the early birth cohorts, then we would again underestimate the growth in height.

Likewise, part of the difference in average height that we observe between countries, or within countries between groups like northerners and southerners, may be attributed to a difference in child or adult mortality across space rather than across time : this is how Deaton (2007) proposes to explain part of the unexpected high stature of Africa as compared to India. For instance, populations of Sahel countries, northern Côte d'Ivoire and northern Ghana might be relatively taller because of increased mortality (again, provided that mortality kills the smallest more often). Of course, other differences in terms of exposure to pathogens or quality of nutrition (protein intakes from cattle meat) may also be invoked to explain regional differences.

We unfortunately know nothing about child mortality during the colonial period. In Côte d'Ivoire, the child mortality rate fell from 186 to 130 per thousand between 1950-54 and 1970-74, and in Ghana from 149 to 108 (Tabutin and Schoumaker, 2004). These numbers also point out that height selective mortality has to be very strong, or changes in mortality very large, to have an influence on height evolutions: for instance, with around 5% additional lives of children being saved between 1950 and 1970, in order to give account of only 10% of the observed loss of 1.5 cm among women born during this period in Ghana, the height differential between old and new survivors would have to be as large as -3 cm $= -1.5$ cm $\times(0.10/0.05)$.

Here again, if mortality favors smaller individuals or if differential mortality with respect to height changes as mortality levels change, more complex bias patterns could be obtained. We could have for instance a very quick decrease in child mortality during colonial times resulting in the spectacular positive trend in height we observe if taller individuals become more and more likely to survive, followed by a slowdown in the mortality decrease velocity, resulting in the trend breaks we observe. But then the average evolutions would still reflect the improvements of health conditions. Moreover, most available evidence does not go in the direction of a positive correlation between mortality and height (on the negative correlation between child height and child mortality in Africa, see Smedman et al., 1987 for Guinea-Bissau; Salama et al., 2001 for Ethiopia; Fawzi et al., 2001 for Sudan).

At the end of the day, the only selection effect that would completely reverse the interpretation of the observed height trends is the one whereby an increase in mortality during the colonial period would have selected taller and taller survivors. This increase in mortality would in particular be driven by an extended exposure to pathogens brought about by contacts with Europeans, by migration and by urbanization. After 1960, despite the continuation of those trends, mortality would have started to fall thanks to increased public investments and more evenly distributed income growth. The trend breaks and even the trends reversals we observe after 1950 could then be attributed to this large fall of child mortality. A large increase in mortality during the late colonial era is however hardly credible. Furthermore, here again the magnitude of selection would have to be unrealistically strong to explain the very steep height increase we observe. Indeed, the results of section 3 thereafter show that height stature is strongly correlated to being born in an urban setting and from educated parents working outside of agriculture, and most importantly to the number of health agents in the district of birth. It would be very surprising if such factors were correlated with higher mortality. All DHS surveys implemented since the end 1980s confirm that child mortality is lower in urban areas. Furthermore, even if increases in medical staff could respond to the needs of more exposed to diseases communities, it is difficult to believe that endogenous placement of health investments would completely reverse its correlation with health outcomes.

2.3.3. The case for shrinking above 40 years of age

Shrinking at later ages makes a last important robustness issue.[5] If aging significantly reduces individual height stature then part of the height trend we observe is spurious, as we do not compare individuals at the same age, like we would do with military data on young age recruits. This is a matter for early cohorts who are observed at ages above forty: up to now, in the human biology literature, longitudinal studies on Western countries all agree on the fact that shrinking is not significant before forty years.[6] Sorkin, Muller and Andres (1999) provide a survey of sixteen longitudinal studies of the impact of aging on height stature. Unfortunately all recorded studies are for Western populations. Drawing from these studies, they propose a "consensual" rate at which height is lost at any age and for each gender. Cumulative loss in height is derived as a quadratic function of age: $0.1258age-0.0021age^2$ for men; $0.1727age-0.0027age^2$ for women. According to these two functions, height at 40 is not significantly different from age at 20, but both genders lose around 0.75 cm between 40 and 50. At age 60, men (resp. women) are around 1.75 cm (resp. 2cm) smaller than at 20. As the oldest cohorts we analyze have ages ranging between 50 and 60, such a shrinking effect seriously affects the magnitude of the height trends commented above.

We then compute shrinking-corrected height evolutions by applying the aforementioned Sorkin et al. (1999) consensual adjustment. Figures A.1 to A.4 in appendix eloquently demonstrate that such a correction is not innocuous. Table A.6 confirms that corrected

[5] We cheerfully than Alexander Moradi for having raised this issue, and for having provided us the corresponding references.

[6] Likewise, the age of 20 is widely recognized as the threshold above which no significant individual growth is observed on average.

height evolutions turn less spectacular than reported in table 1. Now, in Côte d'Ivoire, the growth in height is 1.7 instead of 3.2 cm for men, and 1.4 instead of 2.8 for women, between the decennial birth-year cohorts 1925-34 and 1955-64: corrected height gains are simply half the original value. These numbers are more in line with Fogel's estimates of 0.6 cm per decade gains for French or British populations during the 20th century. Corrections are even larger in the case of Ghana, because a higher share of "naïve" height gains is observed between earlier cohorts: We get 1.0 instead of 2.5 cm for men, and 0.3 instead of 2.0 cm for women. This latter height gain for Ghanaian women is barely significant, however one could ask whether the 1925-34 figure is not "over-corrected": when focusing on later height gains (between decennial cohorts 1935-44 and 1955-64), we get 0.7 instead of 1.4 cm, i.e. a simple halving like in other cases. Last, corrected height evolutions are not only lower in magnitude much also less smooth: more than half of height gains are concentrated at the very end of the colonial period, i.e. during the 1950s. This latter fact is particularly striking in the case of Côte d'Ivoire where post-war colonial investments are known to have accelerated. This is what we examine in the next section.

3/ Disaggregating the height trend: the role of urbanization

3.1/ Data

As already mentioned, the LSMS surveys provide a wealth of information on adult individuals parental background, i.e. education and the main occupation (over the life course) of the father and of the mother, and on the district of birth.[7] We construct two dummy variables indicating whether the father or the mother of the individual ever attended school, and another dummy variable indicating whether the father was/is in agriculture (farmer, fisherman or livestock farmer).[8]

DHS surveys only provide a rough measurement of the childhood context taking the form of a self-declared urbanization level (capital or large city, city, town) of the place of residence when the interviewed individual was a child.[9] In the case of the LSMS surveys, it is a little bit tricky to reconstruct and indicator of urbanization for the district of birth across time. We make use of the data recently gathered by the e-Geopolis project about urbanization in Africa, that provides estimates for the size of each country main cities (with more than 5,000 inhabitants in 2000) for each decennial year between 1920 and 1970.[10] With this data, we

[7] In Côte d'Ivoire, 35 districts of birth can be distinguished in 1985 (CILSS 1), and 50 for 1986-88 (CILSS 2-4) thanks to an administrative reform. Unfortunately only 10 districts can be distinguished in Ghana. Of course, the degree of detail of the administrative grid influences the precision of the indicators described below. In particular, urban density in the district of birth cannot be easily compared between the two countries.

[8] If the individual still lives with her/his father/mother, the main occupation for the past 12 months is retrieved.

[9] With the exceptions of the DHS for Côte d'Ivoire and Burkina-Faso in 1998 where this variable is absent , and for Senegal in 2005, where it is miscoded.

[10] http://www.e-geopolis.eu/

compute for each individual the urban population density (number of people in cities and towns per square kilometer) of the district of birth at the time of birth.

Likewise, the wide expansion of cocoa production during colonial times is frequently cited as one of the main factors of economic and social change in Côte d'Ivoire and Ghana, those two countries being still the two first cocoa producers in the world today (on cocoa history: Ruf, 1995; Clarence-Smith & Ruf, 1997; on Ghana: Austin 2005; on Côte d'Ivoire: Balac, 1998). Unfortunately, we could not have access to regionally disaggregated series of cocoa production for years before 1960. We therefore rely on two maps shown in Figure 10, one from the Sahel and West African Club of the OECD for Ghana (ECOWAS-SWAC/OECD, 2007), and a more precise other from Eric Léonard (1997) for Côte d'Ivoire. As can be seen in those maps, the expansion of cocoa production is a "Conquest of the West" story, that is the progressive exploitation of wild forest spaces in the south-western part of each country. For each individual, we code whether cocoa was already produced in the district of birth at the time of birth.

Last, for Côte d'Ivoire we make use of the data collected in French colonial archives by Elise Huillery (Huillery, 2008b).[11] This data is extracted from the budgets of French colonial administrative districts ("*cercles*") between 1923 and 1956. It records in particular the number of teachers and the number of health agents (doctors, nurses, etc.) for all the 15 colonial "*cercles*" (litteral translation is "circle") and all years ending either by a 3 or by a 6 over the above mentioned period. Using the administrative census of each *cercle* for the year 1925, we divide these numbers by the population of the *cercle* in 1925. Data on the population of each *cercle* over time is unfortunately unavailable. By dividing by the 1925 population, we correct for the 1925 size effects but not for differential demographic evolutions. In particular, as urbanizing districts experience a larger population growth, we run the risk of overestimating the increase in the number of teachers or health agents in these districts. When using this variable we however control for the above mentioned indicator of urban population density that varies across time.

3.2/ Results

Figures 8 and 9 present a first regional disaggregation of national height trends that distinguishes individuals born in northern districts and individual born in southern districts of each country.[12] However the district of birth in these latter countries is unknown, so that

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[11] This data was collected within a broader project "Long-term history and resource distribution in Africa" directed by Denis Cogneau.

[12] Northern districts in Côte d'Ivoire are the following: Bondoukou, Bouna, Boundiali, Dabakala, Ferkessedougou, Katiola, Korhogo, Mankono, Odienne, Seguela, Tingrela, Touba (22% of the 20 year-old and over native population in the 1988 CILSS4) ; in Ghana: Northern, Upper West and Upper East (19% in the 1988/89 GLSS2). Recall international migrants are excluded from analysis, in particular Burkinabè and Malian migrants in Côte d'Ivoire, who weight more than 15% of the 20 year-old population. With respect to height level and trend, the foreign born in Côte d'Ivoire look alike the country northerners: they are much taller than Côte d'Ivoire natives in the oldest cohorts (above 170 cm for men, 160 cm for women) but progressively loose this advantage over time.

the same kind of analysis cannot be implemented for them. For Côte d'Ivoire, Figure 8 reveals a stagnation of height for people born in the North between 1930 and 1960, versus a continuous and steep increase in height for people born in the South who catch up with and even overcome the Northerners by around one centimeter in 1960. In contrast, for Ghana, the height trends of both birth regions are rather parallel, at least starting in 1930.

In table 3, we regress the height of each individual on the three variables of parental background and the two indicators of urban density and of cocoa expansion, as described above. For each country, we estimate three models labeled I, II and III. The first only introduces a gender dummy to control for a constant sexual dimorphism (recall we did not identify any difference in height trends between men and women). The second adds a series of district of birth dummies, i.e. controls for differences in average height levels between districts of birth. The third and last also absorbs a series of birth year dummies, i.e. the national height growth trend. As we try to explain the latter, model II is our preferred one; model I mixes the decomposition of the height trend with inter-regional differences in height, for instance between northern and southern districts. Of course, we are perfectly conscious that model II is far from capturing the causal impacts of each of our explanatory variables: for this, we lack appropriate natural experiments. As all variables including height share a common increasing trend (later cohorts have more educated parents and are more often born in towns or a cocoa region), we in particular run the risk of attributing too much of the height increase to the time variation of these variables. Conversely, with model III we only analyze deviations from the national trend, so that we would attribute too few. We also estimate quartile regressions with the same specifications, in order to check whether our explanatory variables have more impact at the bottom or at the top of the height distribution. First, second (median) and third quartile regressions do not provide coefficients that are significantly different from each other, and reach the same conclusions as ordinary least squares regressions. For that reason, they are not reproduced in this paper.

The differences of the coefficients of cocoa expansion between columns I and II reflects the height level disadvantage of southern cocoa regions when compared with northern regions (see Figures 8 and 9 commented above): when district of birth dummies are introduced in column II, the coefficient of cocoa expansion always increases. The coefficient of cocoa production becomes highly positive in Côte d'Ivoire, telling that the arrival of cocoa in a given district brings an increment of 1.89 centimeters in height to children born in that district when they reach adult age. In Ghana, the disadvantage of 0.75 cm against children born in cocoa districts in column I is just cancelled out in column II: the transition to cocoa does not seem to bring any gain in height. It must be remembered that the available administrative grid for Ghana is very rough, with only 10 districts of birth against 50 in Côte d'Ivoire. Besides, the cocoa expansion has come earlier for Ghana. As a result, over the 1925-64 period, the share of population born in cocoa producing districts passes from 28 to 59 % in Côte d'Ivoire (+27 percentage points), and only from 31 to 51% (+18). Hence, according to model II, the cocoa expansion contributes to the Côte d'Ivoire national height stature increase by $1.89\times0.27=+0.52$ cm.

The same upward move is observed between model I and model II for the coefficient of urban density, especially in Ghana where it doubles. In both countries, an increase of urban density translates in an increase in the height of cohorts born in the same district. Here again, the evolution across time of urban density in the district of birth between the 1925-34 and the 1954-64 cohorts provides the order of magnitude of both effects: according to model II, with a variation of +5.3 between these two cohorts, the increase in urban density corresponds to a +0.44 cm height growth in Côte d'Ivoire, whereas a variation of +13.3 in Ghana translates into a +0.29 cm increase.

This impact of urban density is further reinforced by the negative correlation of height with the agricultural occupation of the father. A father farmer (even a livestock farmer) means a 2 centimeters handicap at adult age in Côte d'Ivoire. The negative impact on adult height of a father farmer is half that number in Ghana, reaching only one centimeter. The share of individuals having farmers as fathers decreased by around 17 percentage points (from 96 to 79%) between the 1925-34 and the 1955-64 cohorts in Côte d'Ivoire, and by 15 percentage points (from 83 to 68%) in Ghana. Hence, these changes translate in contributions to the national height trends of $2\times0.17=0.33$ cm for Côte d'Ivoire and 0.15 cm for Ghana. The dualism against agriculture is historically less pronounced in Ghana than in Côte d'Ivoire (Bossuroy and Cogneau, 2008). This is in particular true in terms of income (Cogneau and Mesplé-Somps, 2008), and the analysis of the causal impact of farm income indicates a high sensitivity of child height in Côte d'Ivoire (Cogneau and Jedwab, 2008; see also Jensen, 2000). Apart from income, this impact of fathers' occupation could however also reflect local supply factors like access to clean water and sanitation, proximity of dispensaries and hospitals, etc., even if we partially control for them through district of variables. Interestingly enough, this effect of father's agricultural occupation does not bite on the coefficient of urban density when we introduce the two variables successively in a within-district specification (model II); in contrast with cocoa expansion and urbanization which are necessarily identified in the longitudinal dimension of the data, the father farmer effect is essentially identified in the cross-sectional dimension. It makes that it is left unchanged when birth year dummies are introduced (model III): even within a given cohort born in a given geographical area, having a father farmer is a persistent handicap. This is less true of the educational dimension of parental background, whose coefficients are never statistically significant in the case of Côte d'Ivoire; whereas the father's schooling comes out as a significant advantage in the case of Ghana, the statistical significance of its impact is nevertheless diminished when we absorb the cohort's birth year. It is also striking to see that, while many studies underline the importance of mother's (rather than father's) education on child outcomes, and in particular child health, here it is the father's occupation and education which dominate. It must however be stressed that only a few mothers ever attended school among the cohorts we consider: only 1% (resp. 7%) on average for the 1925-64 birth years range in Côte d'Ivoire (resp. in Ghana), versus 7% (resp. 21%) for fathers.[13]

The impact of parental educational background is expectedly much higher when analyzing individual differences in literacy rather than individual differences in height (see appendix tables A.9a and A.9b). Unfortunately, we do not have data on parental height stature that allow us to control for a direct intergenerational transmission of height like we do in the case of literacy. The previously mentioned study of Sear, Allal and Mace (2004) on rural Gambia women between 1950 and 1975 finds for instance that children from tall women have much

[13] This early difference in the spread of primary education between the two countries, and even more generally between French and British colonies, is also a historical legacy (Benavot and Riddle, 1988; Bossuroy and Cogneau, 2008).

higher chances of surviving between birth and 5 years of age, with a pretty much 2% probability increase per each centimeter of height; they however cannot say whether this correlation stems from taller women having higher socio-economic status, from genetic inheritance or from health transmission per se (*in utero* or later on).[14] Anyway, if women with a higher genetic potential for height started to have more reproductive success during our period of analysis, their more numerous children would have inherited this genetic height potential, hence a historically determined natural selection process would explain part of the height growth we observe, through a pure intergenerational transmission of height. The same intergenerational transmission of height would hold also if non-genetically acquired mother height causes child height for behavioral reasons: for instance women that were fed or cured better during their childhood (and ended taller) would feed or cure better their children when becoming mothers. Any causal relationship between phenotypic mothers' height and child height would generate an intergenerational snowball effect, that could give account of part of the growth in height (but not the whole, as at least some exogenous push is needed), like in the case of literacy.

When taking all coefficients together, the Côte d'Ivoire model II of table 3 can explain +1.3 cm of the national height increase between 1925 and 1964, i.e. 0.5 (cocoa) + 0.4 (urban density) + 0.3 (father farmer) + 0.1 (parents education). This 1.3 cm predicted gain is slightly less than half of the observed gain for women (+2.8) or for men (+3.3 cm). The decomposition performs much less well in the case of Ghana: +0.6 cm from the model against +1.9 cm (women) and +2.7 cm (men) in the data. Perhaps some part of the residual half can be attributed to the direct intergenerational transmission of height whose possibility we just mentioned, and that is not taken into account in our models. But another part is probably attributable to the shrinking effect examined in section 2.3.3., as we can expect people from more advantaged background to shrink less over time. Table A.7 provides the results of the re-estimation of our model II on height data corrected for old-age shrinking with the Sorkin at al. procedure already described above. The first two columns of this table show that the shrinking correction results in slightly reducing the cocoa expansion and urbanization coefficients. This reduction is expected as the magnitude of these coefficients is linked to the range of height increases over time, that are very much mitigated by the shrinking correction (see again Figures A.1 to A.4). However, the decomposition now performs a little better. In the case of Côte d'Ivoire, cocoa expansion predicts 0.35 cm of height growth, urbanization 0.35 cm also, and family background 0.37 cm (0.31 cm for father farmer), i.e. in total 1.07 cm against a (corrected for shrinking) height growth of 1.7 cm for men and 1.4 cm for women (table A.6). Model II now explains respectively 65 and 79% of total height growth, with equal shares for cocoa, urbanization, and family background.

This kind of decompositions is only descriptive and not meant to be causal; it is however still possible that the bias on our variables coefficients are downward, because of large measurement errors, so that the true causal decomposition would be even more efficient. Indeed, a discrete indicator of cocoa production and a rough measurement of urban density at the district of birth level are very imperfect measurements of the structural changes at stake. If we had more information about the precise place of birth: whether cocoa was

[14] Bhalotra and Rawlings (2008) try to isolate this latter effect; they find a much lower mother height -child mortality gradient, i.e. a child mortality rate decrease of less than 0.1% per centimeter.

grown there at the time of birth, and how many people were gathered in the area, perhaps such a decomposition would be more efficient in explaining the national height trends. Likewise, we would like to be able to distinguish, among the fathers who are farmers, the cocoa growers from the others. Whether we analyze adult height (in tables 3 and 4) or adult literacy (in appendix tables A.9a and A.9b), the effect of variables at district of birth level always vanishes in model specifications III, that is when only differences within birth year cohorts are considered. The district-specific shocks on these latter variables do not generate enough variance to identify some divergence in height or literacy between individuals born in different districts. The low degree of spatial disaggregation that is available to us (50 post-colonial districts of birth in Côte d'Ivoire, 10 in Ghana, 17 colonial districts in Côte d'Ivoire) probably carries a large weight in the limitations of our empirical identification.

As imprecise as it is, the DHS also provide some information about the individual's (self-declared) urbanization status of the main place of residence during childhood.[15] For the post-colonial, tables A.8a and A.8b in appendix confirms the advantage of cities and towns in terms of height at adult age, not only for Côte d'Ivoire and Ghana, but also for Benin, Burkina-Faso, Mali and Senegal (coefficients of the urban origin variable indicate the height level differences for the year 1974). For cohorts born between 1950 and 1980, no difference in height trends is identified between the countryside and cities or towns, except slightly for Ghana where towns seem to have been protected from the strong reversal of height growth observed in that country.

For cohorts born between 1925 and 1956 in Côte d'Ivoire, table 4 additionally introduces a measurement of public investments in health and education by the French colonial administration. Results for parental background are roughly left unchanged, except for the fact that the strong correlation of father and mother education in this reduced sample generates some collinearity bias (with the coefficient of mother's education turning highly negative but statistically insignificant, and the coefficient of father's education turning highly positive). We estimate reduced models dropping the parental education background and check the other coefficients do not change (results available upon request). Regarding the four district of birth contextual variables, the impact of the number of health agents per capita in the district of birth strikingly dominates and completely absorbs the effect of urban density that was identified in table 3. The coefficient magnitude of the number of health agents dominates all other effects in model specification II, even parental background (table 1). However, when correcting this enlarged specification for old-age shrinking, the two last columns of table A.7 show that no longer obtain significant coefficients for colonial investments. This is much revealing of the fact that this latter result on health investments strongly relies on the developments of the early colonial period (1925-30), hence on cohorts of 55-60 years-old.

Apart from parental educational background, the same models estimated for individual literacy (measured as the self-declared capacity to read a newspaper and to write a letter) in appendix tables A.9a and A.9b put forward the same correlates as for individual adult height: the non-agricultural occupation of the father, the cocoa transition and the number of health

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[15] Here, recall that the mothers whose height are analyzed all range between 20 and 49 years old, so that correcting for shrinking is innocuous.

agents in the district of birth in Côte d'Ivoire. Here again, this latter variable entirely absorbs that of urban density in the district of birth and explains much more of the differences in literacy than the number of teachers. This latter result stands in contrast with Huillery's (2009) who finds that colonial investments in former French Western Africa had a specialized impact on post-colonial outcomes: health agents on height, teachers on education, and public works on households' connection to utilities (electricity, water). She however only considers the outcomes for younger cohorts or households as observed in the beginning 1990s (0-5 year-old children for stunting, 7-12 year-old for primary school enrolment). Therefore, she addresses the generation of disparities between colonial districts ("*cercles*") by early colonial policies implemented during the 1910-1928 period, and the persistence of such disparities, rather than differences in trends. In the case of literacy, forgetting the capacity to read or write is not as important as shrinking in the case of height. We estimate the same models with "ever attended school" as the dependent variable instead of literacy, and obtain almost exactly the same estimates.

Then, at least for Côte d'Ivoire where the spatial disaggregation is sharper, we are able to correlate part of the large colonial growth in height stature to the structural changes of the economy and their correlated income gains: cocoa expansion, industry diversification and urbanization. Our disaggregation exercise cannot claim to assess whether the progresses of hygiene or medical knowledge have been more important than improvements of nutrition for explaining gains in height stature; it cannot either claim to disentangle the effects of public services and of private income. However, it corroborates the reality of this height increase that is found to reflect other long-term structural changes affecting the whole economy and society. Lastly, our disaggregation leaves rather untouched the mystery of the trend breaks in height growth that we observe during the post-colonial period in six Western African countries. Decreasing returns to income gains and to private or public investments may of course be invoked, and are certainly part of the story. The erratic macroeconomic and political trajectories of independent countries come also into play, in particular for explaining the Ghana trend reversal (Moradi, 2006). However, in the case of Côte d'Ivoire, macroeconomic and political stability prevailed at least up to the 1980s; a trend break is also observed for this country between 1960 and 1983 as compared to the 1950-59 period, but, consistently enough, it is much smoother than in Ghana, and even hardly significant (table 2). In Côte d'Ivoire the cocoa expansion and urbanization processes not only carried on their way, they were also complemented with large amounts of public investment (funded by cocoa export receipts; see, e.g., Berthélemy & Bourguignon, 1986). Perhaps the educational stance of public investment in Côte d'Ivoire somewhat crowded out the development of necessary health infrastructures. Or else a concomitant increase in dualism and economic inequality cancelled out the benefits of economic growth on health. More research is warranted in that dimension.

4/ Conclusion

Even when correcting for the bias arising from old-age shrinking, we find with survey data that the increase in height stature experienced by successive cohorts born in Côte d'Ivoire and Ghana during the late colonial period (1925-1960) is almost as high as the increase observed in France and Great-Britain over the 1875-1975 period, and higher than the estimated gains of the same countries in the previous century (1775-1875). In contrast, the early post-colonial period (1960-1985) is characterized by stagnation or even reversion, not only in Côte d'Ivoire and Ghana but also in other countries in Western Africa. The selection effects linked for instance to measuring the height of women rather than of men, then of mothers rather than of women, and most importantly the interactions between height and mortality cannot give account of these figures.

We then disaggregate these national trends by parental background and district of birth, and match individual data with district-level historical data on export crop (cocoa) expansion, urban density and colonial investment in health and educations. We provide evidence that a significant share of the increase in height stature may be related to the progresses of urbanization and of cocoa production.

Even if we are still not able to definitely discriminate between demand-side (private income) and supply-side (health infrastructures) explanations, we corroborate the reality and importance of height gains during the late colonial period in Côte d'Ivoire and Ghana. This result is in keeping with those obtained by Austin, Baten and Moradi (2007) and Moradi (2009) on the earlier 1900-1920 period in Ghana and Kenya, with data on British army recruits. This colonial height growth is found to reflect the long-term structural changes affecting the whole economy and society.

Figure 1

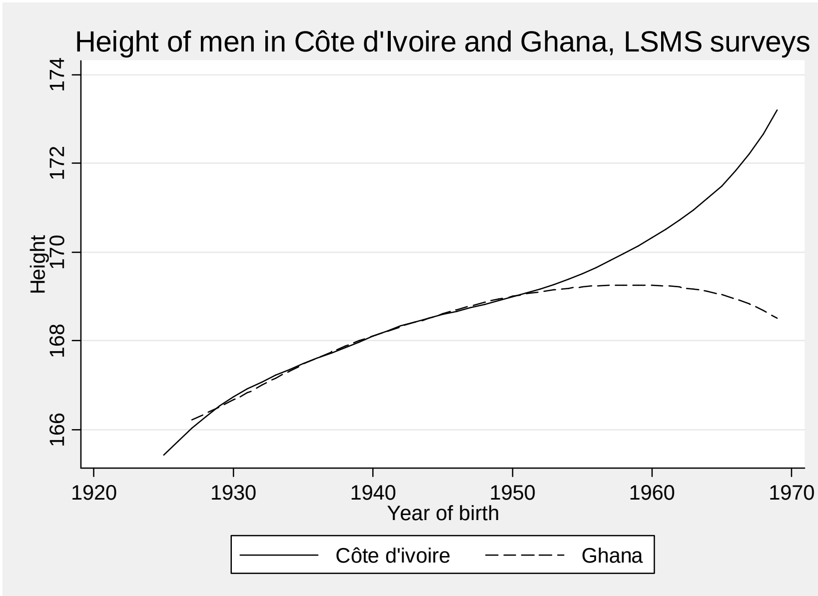


Figure 2

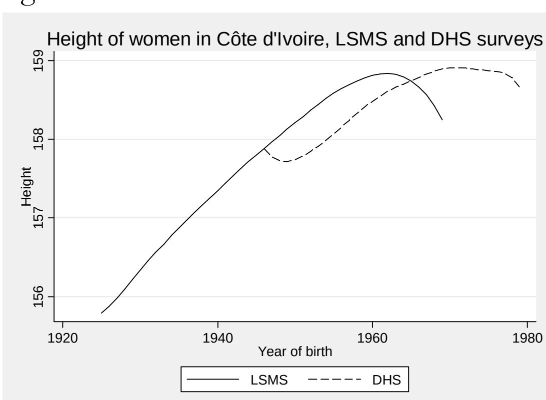


Figure 3

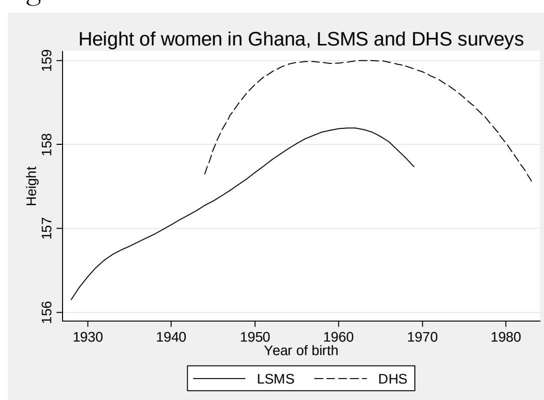


Figure 4

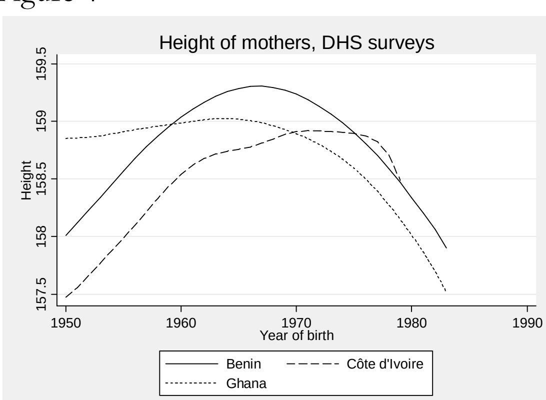
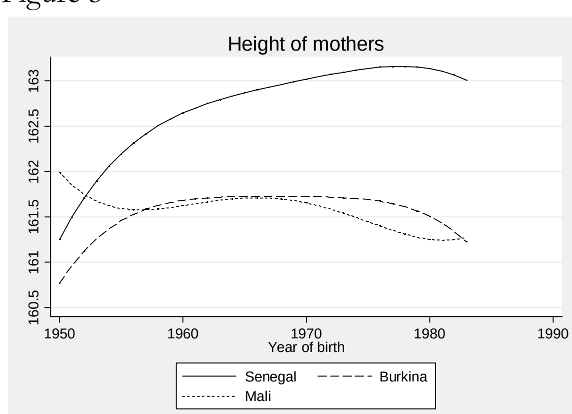


Figure 5



Method for Figures 1 to 5: Locally linear regressions ("lowess") with bandwidth 0.8.

Figure 6

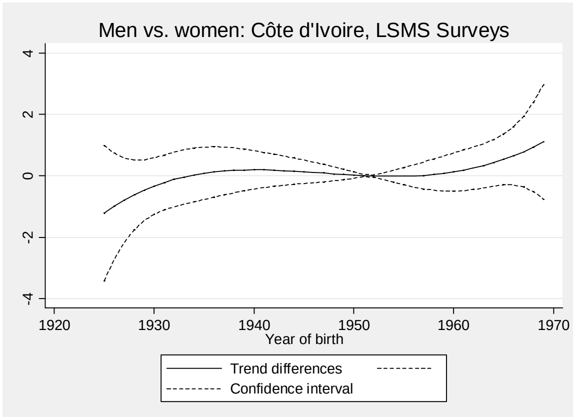


Figure 7

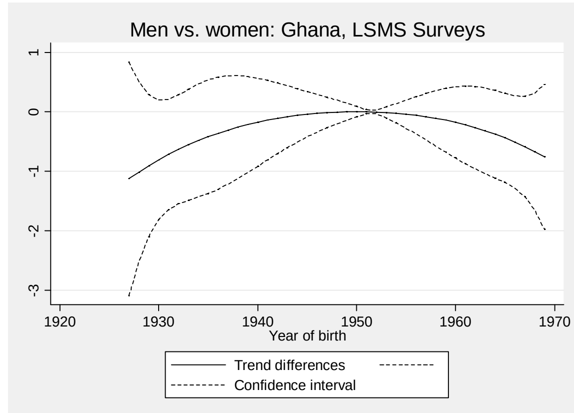


Figure 8

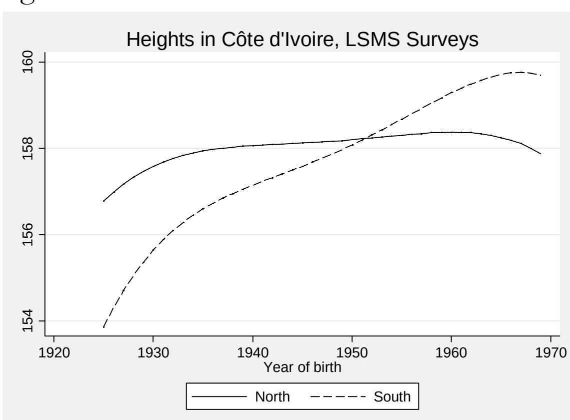
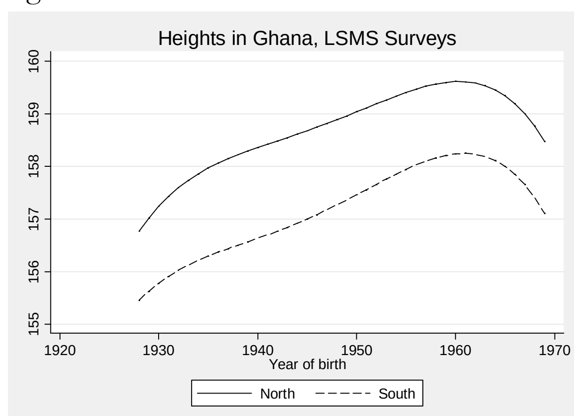


Figure 9



Method for Figures 6 to 9: Four degree polynomials in birth year; Figures 6 and 7 plot the difference between the polynomials estimated for each gender; in Figures 8 and 9, the polynomial adjustement includes a dummy for gender.

Figure 10

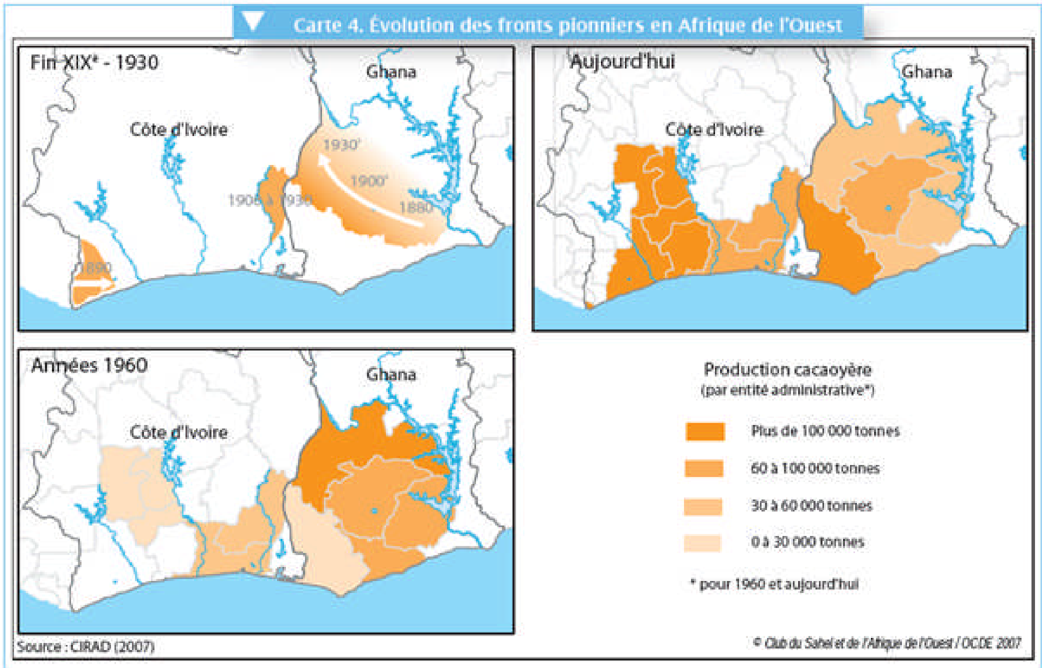
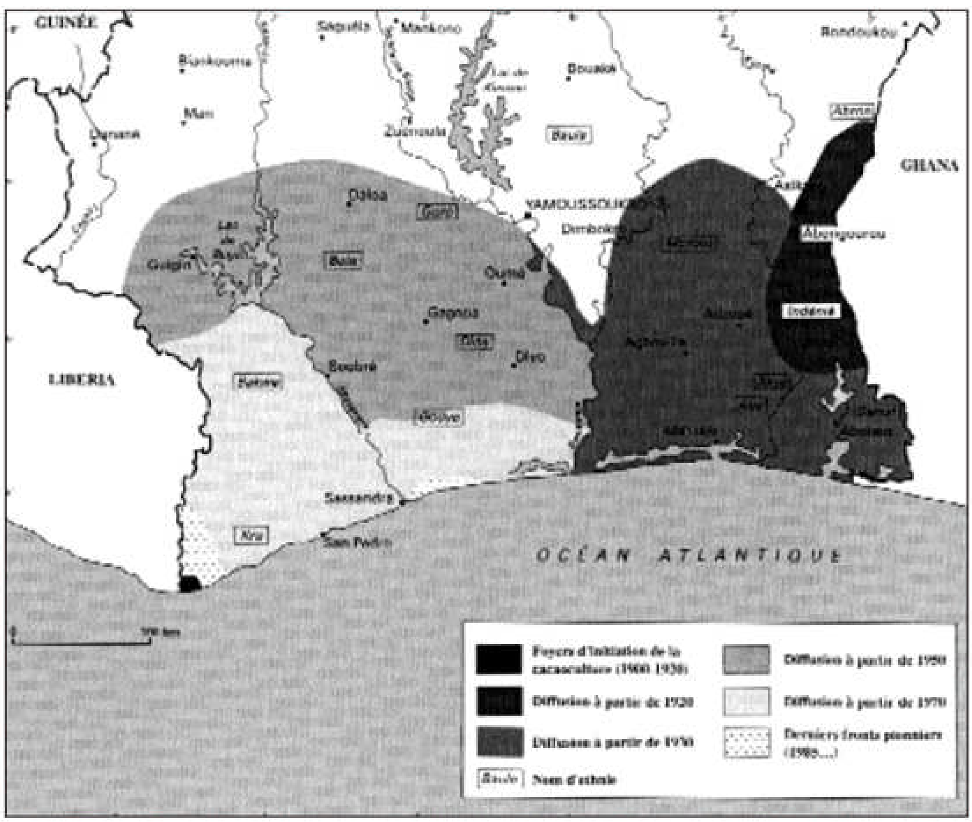


Figure 5 – Expansion des plantations de café et de cacao dans la région forestière en Côte-d'Ivoire



Source : É. Léonard, 1994.

Table 1 - Mean and median heights for decennial cohorts, 1925-1964

	Côte d'Ivoire				Ghana			
	Women		Men		Women		Men	
Year of birth	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
1925-1934	156.3	156.0	166.7	166.5	156.3	156.4	167.1	166.8
1935-1944	157.4	157.0	168.3	167.9	156.9	157.0	168.2	168.0
1945-1954	158.0	158.0	169.0	169.0	157.7	157.7	169.0	169.3
1955-1964	159.1	159.0	169.9	169.8	158.3	158.2	169.6	169.6

Coverage: Native men and women aged 20 to 60 years old, LSMS survey

Table 2 - Trend breaks after 1960: Height of mothers regressed on birth year

	Benin	**Burkina Faso**	**Côte d'Ivoire**	**Ghana**	**Mali**	**Senegal**
1950-1959	0.219	0.103	0.116	0.072	0.016	0.137
	(0.040)***	(0.040)**	(0.058)**	(0.050)	(0.035)	(0.045)***
1960-1983	-0.055	-0.041	0.015	-0.046	-0.020	0.019
	(0.008)***	(0.017)**	(0.023)	(0.013)***	(0.008)**	(0.017)
Test trend equality: Pr > F	0.00	0.01	0.15	0.04	0.35	0.03
Observations	17,948	6,951	3,593	7,661	22,266	5,561

Coverage: Mothers 20-49 year old, Demographic and Health Surveys; country natives, except in Ghana.
Standard errors in parentheses take into account the survey design (stratification and clustering)
* significant at 10%; ** significant at 5%; *** significant at 1%
The "Test trend equality" line provides the p-value of the Fisher test for equality of height trends between the two periods, i.e. the probability to mistakenly reject trends equality.

Table 3 - Adult height stature and childhood context

Dependent variable: Height	Côte d'Ivoire			Ghana		
	I	**II**	**III**	**I**	**II**	**III**
Mother attended school	0.187	0.255	0.295	0.293	0.248	0.256
	(0.643)	(0.632)	(0.615)	(0.246)	(0.243)	(0.244)
Father attended school	0.595	0.434	0.249	0.415	0.518	0.420
	(0.347)*	(0.353)	(0.348)	(0.213)*	(0.212)**	(0.214)*
Father in Agriculture	-2.031	-1.998	-1.766	-0.967	-1.097	-1.022
	(0.264)***	(0.277)***	(0.272)***	(0.189)***	(0.187)***	(0.188)***
Urban density in district of birth	0.065	0.083	0.040	0.010	0.022	0.009
	(0.010)***	(0.013)***	(0.015)***	(0.004)***	(0.005)***	(0.006)
Cocoa in district of birth	0.678	1.892	0.736	-0.785	-0.124	-0.442
	(0.185)***	(0.277)***	(0.306)**	(0.161)***	(0.280)	(0.315)
Controls						
Gender	Yes	Yes	Yes	Yes	Yes	Yes
District of birth		Yes	Yes		Yes	Yes
Year of birth			Yes			Yes
Observations		8,260			9,771	
R-squared	0.47	0.48	0.49	0.43	0.44	0.44

<u>Coverage:</u> Native men and women of Côte d'Ivoire aged 20 to 60, LSMS survey

<u>Years of birth covered:</u> 1925-69 for Côte d'Ivoire and Ghana

Linear regression (OLS)

Survey design standard errors in parentheses (clustering)

* significant at 10%; ** significant at 5%; *** significant at 1%

Dummy variables for missing values of father/mother education and father occupation are included

Table 4 - Adult height stature and colonial investments in Côte d'Ivoire

Dependent variable: Height	**IIa**	**IIb**
Mother attended school	-2.154	-2.153
	(1.427)	(1.425)
Father attended school	1.692	1.650
	(0.602)***	(0.613)***
Father Farmer	-2.129	-2.093
	(0.378)***	(0.378)***
Urban density in region of birth	0.225	-0.101
	(0.055)***	(0.134)
Cocoa in district of birth	1.298	1.202
	(0.434)***	(0.434)***
# Health agents per thousand p. (1925) in d. of birth (a)		1.480
		(0.559)***
# Teachers per thousand p. (1925) in d. of birth (a)		0.309
		(0.751)
Controls		
Sex	Yes	Yes
District of birth	Yes	Yes
Observations	4662	4662
R-squared	0.48	0.48

Coverage: Men and women of Côte d'Ivoire aged 29 to 60 years old, LSMS survey

Years of birth covered: 1925-1955

Linear regression (OLS)

Survey design standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Dummy variables for missing values of Father/mother education and Father occupation are included

(a) Number in the district of birth at the time of birth divided by the population of the district in 1925

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Appendix Tables

Table A.1: Surveys

LSMS	Country	Survey	Date of surveys	Men and women (20-65), height non missing
	Côte d'ivoire	CILSS 1-4	Feb.1985-Apr.1989	8,130
	Ghana	GLSS 1-2	Sep.1987-Jul.1989	9,943

DHS	Country	Survey	Date of surveys	Mothers (20-49), height non missing
	Benin	DHS-III and Measure DHS+	1996, 2001 and 2006	19,090
	Burkina Faso	DHS-II, DHS-III and Measure DHS+	1992/93, 1998/99 and 2003	15,988
	Côte d'ivoire	DHS-III	1994 and 1998/99	4,890
	Ghana	DHS-III and Measure DHS+	1993, 1998 and 2003	7,720
	Mali	DHS-III and Measure DHS+	1995/96, 2001, 2006	23,540
	Senegal	DHS-II and Measure DHS+	1992/93 and 2005	5,811

Table A.2a: Do height trends differ between LSMS and DHS surveys?

	Côte d'Ivoire	**Ghana**
Year of birth	0.076	0.035
	(0.017)***	(0.021)*
Year of birth*Survey	0.021	-0.025
	(0.037)	(0.028)
Controls		
Dummy survey	Yes	Yes
Observations	5,060	6,365

Coverage: Mothers (DHS) and women (LSMS) aged 20 to 49 years old; country natives in Côte d'Ivoire.

Years of birth: 1945-1966 for Côte d'Ivoire; 1945-1969 for Ghana

Survey design standard errors in parentheses (clustering)

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A.2b: An unexplained difference in average height level between LSMS and DHS surveys in Ghana

Dependent variable: Height				
Survey dummy				
LSMS	*Ref.*	*Ref.*	*Ref.*	*Ref.*
DHS	0.952	0.777	0.655	0.701
	(0.201)***	(0.209)***	(0.218)***	(0.218)***
Controls				
Year of birth		Yes	Yes	Yes
Link to the household head			Yes	Yes
Religion			Yes	Yes
Ethnicity			Yes	Yes
Region of residence				Yes
N. of years spent in primary school				Yes
Urban/rural				Yes
Observations	6,317			
R-squared	0.01	0.01	0.02	0.04

Coverage: Women (LSMS) and mothers (DHS) in Ghana aged 20 to 49 years old. Country natives in LSMS.

Years of birth covered: 1945-1969

Standard errors in parentheses take into account the survey design (clustering)

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A.3a: Share of youngest women in non-mothers

	Côte d'Ivoire	Ghana
20-25 year-old	51%	64%
20-29 year-old	63%	81%

Coverage: Native women aged 20 to 60, LSMS survey

Table A.3b: Height of mothers and non-mothers

	Côte d'Ivoire		Ghana	
	N	Mean	N	Mean
Height of mothers	779	159.43	777	158.31
		(0.54)		(0.65)
Height of non mothers	106	159.88	148	158.2
		(0.58)		(0.75)
Test of equality : Pr>|T|		0.443		0.883

Coverage: Native women aged 20 to 29, LSMS survey

Table A.4a: Height of an adult cohort across time: Ghana and Benin

		Ghana		Benin	
Year of survey	*1993*	*Ref.*	*Ref.*		
	1999	0.40	0.40		
		(0.24)*	(0.24)		
	2003	0.71	0.65		
		(0.21)***	(0.21)***		
	1996			*Ref.*	*Ref.*
	2001			0.19	-0.01
				(0.22)	(0.21)
	2006			1.23	1.01
				(0.20)***	(0.20)***
Controls			Yes		Yes
Observations		5,652	5,651	12,568	12,453

Coverage: Mothers aged 20 to 39 years old at the first survey (1993 in Ghana and 1996 in Benin), and aged 30 to 49 years old at the last survey (2003 and 2006); country natives in Benin.

Robust standard errors in parentheses, clustered and weighted

* significant at 10%; ** significant at 5%; *** significant at 1%

Controls: Age at first pregnancy, childhood place of residence, urban/rural, number of years spent in primary school

Table A.4b: Height of an adult cohort across time: quartiles

Quantile regression of height on the year of the survey

	Ghana	Benin
Q1	0.04	0.15
	(0.03)***	(0.02)***
Median	0.08	0.14
	(0.03)*	(0.02)***
Q3	0.14	0.15
	(0.02)***	(0.02)***
Year of birth	Yes	Yes
Observations	5,652	12,568

Coverage: Mothers aged 20 to 39 years old at the first survey (1993 in Ghana and 1996 in Benin); country natives in Benin.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A.5: Body Mass Index and Height Stature

Mean BMI (Body Mass Index)	**Côte d'Ivoire**		**Ghana**	
	Women	**Men**	**Women**	**Men**
Smaller than the 3d quartile	22.00	22.20	21.77	20.67
	0.71	0.05	0.09	0.57
Larger than the 3d quartile	22.43	22.10	22.03	20.88
	0.11	0.09	0.14	0.09
Test of the equality (pvalue)	0.00	0.33	0.04	0.02
Smaller than the 1st quartile	21.63	22.04	21.63	20.54
	0.10	0.09	0.12	0.09
Larger than the 3d quartile	22.43	22.11	22.04	20.92
	0.11	0.10	0.14	0.10
Test of the equality	0.00	0.60	0.01	0.00

Coverage: Native men and women in Côte d'Ivoire and Ghana, aged 20 to 60 years old, LSMS survey
Years of birth covered: 1925-1969 for Côte d'Ivoire and Ghana
Standard errors in parentheses take into account the survey design (stratification and clustering)

Table A.6 - Corrections for shrinking

	Côte d'Ivoire				**Ghana**			
	Women		**Men**		**Women**		**Men**	
Year of birth	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
1925-1934	157.4	157.1	168.0	167.8	157.7	157.7	168.4	168.2
1935-1944	157.7	157.3	168.7	168.3	157.3	157.3	168.7	168.5
1945-1954	157.7	157.6	168.9	168.9	157.5	157.4	168.9	169.3
1955-1964	158.8	158.6	169.7	169.7	158.0	157.9	169.4	169.4

Coverage: Native men and women aged 20 to 60 years old, LSMS survey
Corrected heights according to the Sorkin, Muller and Andres (1999) quadratic model for cumulative losses in height due to aging (see section 2.3.3 in the text).

Figure A.1

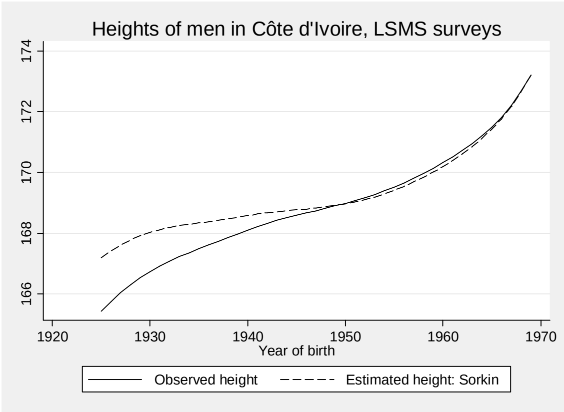

Figure A.2

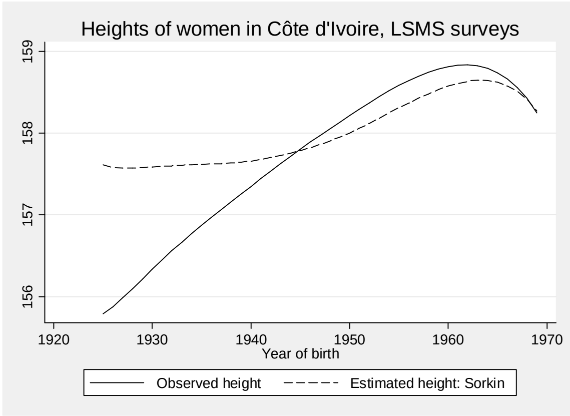

Figure A.3

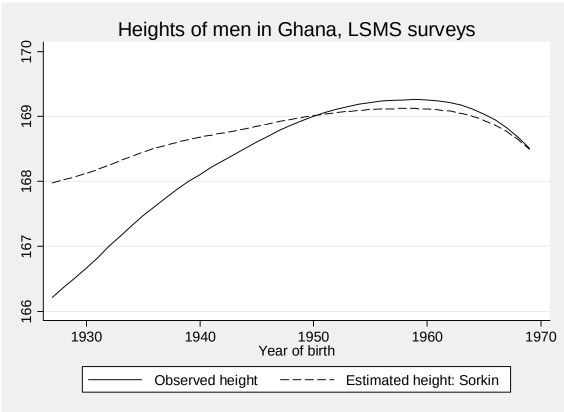

Figure A.4

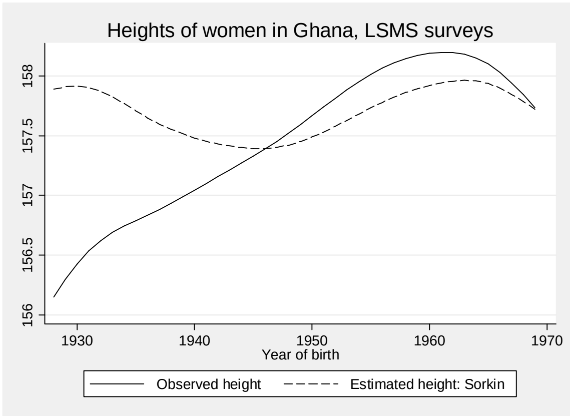

Table A.7: Influence of Old-age shrinking

Dependent variable: Height corrected by Sorkin et al. model	1925-1969 birth cohorts		1925-1955 birth cohorts	
	Côte d'Ivoire	**Ghana**	**Côte d'Ivoire**	
Mother attended school	0.301	0.251	-2.162	-2.130
	(0.625)	(0.244)	(1.380)	(1.388)
Father attended school	0.351	0.430	1.476	1.440
	(0.348)	(0.211)**	(0.602)**	(0.607)**
Father Farmer	-1.904	-1.060	-2.058	-2.051
	(0.277)***	(0.187)***	(0.385)***	(0.384)***
Urban density in region of birth	0.065	0.012	0.128	-0.038
	(0.013)***	(0.005)***	(0.056)**	(0.130)
Cocoa in district of birth	1.279	-0.389	0.584	0.582
	(0.272)***	(0.280)	(0.429)	(0.430)
# Health agents per thousand p. (1925) in d. of birth (a)				0.250
				(0.560)
# Teachers per thousand p. (1925) in d. of birth (a)				0.583
				(0.736)
Controls				
Sex	Yes	Yes	Yes	Yes
District of birth	Yes	Yes	Yes	Yes
Observations	4662	4662	4662	4663
R-squared	0.47	0.48	0.48	0.49

Tables 3 and 4 models of type II are re-estimated with corrected heights according to the Sorkin, Muller and Andres (1999) quadratic model for cumulative losses in height due to aging (see section 2.3.3 in the text). For the rest, see tables 3 and 4.

Table A.8a: Differences in height according to urban origin: Côte d'Ivoire, Ghana

		Côte d'Ivoire	Ghana
Urban origin	*Child in the countryside*	*Ref.*	*Ref.*
	Child in the capital or a large city	0.742	
		(0.519)	
	Child in a city	0.237	0.694
		(0.535)	(0.256)***
	Child in a town		0.125
			(0.215)
Year of birth		0.033	-0.045
		(0.030)	(0.013)***
Year of birth* city or town		-0.013	0.036
		(0.045)	(0.020)*
	Observations	2,230	7,718

Coverage: Mothers aged 20 to 49 years old, DHS survey; country natives in Côte d'Ivoire.
Years of birth covered: 1944-1974 in Côte d'Ivoire and 1943-1983 in Ghana.
Survey design standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
For Côte d'Ivoire, the 1998 DHS Survey is not used, as urban origin is missing.
Years of birth are centered in 1974: Estimates of height differences in level between urban origins are for that year.

Table A.8b: Differences in height according to urban origin: Other countries

		Benin	Burkina Faso	Mali	Senegal
Urban origin	*Child in the countryside*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
	Child in the capital or a large city	0.288	0.586	1.919	
		(0.212)	(0.338)*	(0.215)***	
	Child in a city	0.308		1.038	0.430
		(0.189)		(0.242)***	(0.609)
	Child in a town	0.247	0.646	0.731	0.063
		(0.184)	(0.247)***	(0.301)**	(0.667)
Year of birth		-0.022	0.000	-0.022	0.057
		(0.009)**	(0.009)	(0.007)***	(0.023)**
Year of birth* city or town		-0.024	0.026	0.011	-0.048
		(0.014)*	(0.022)	(0.016)	(0.044)
	Observations	16,294	12,254	21,833	2,877

<u>Coverage:</u> Native mothers aged 20 to 49 years old, DHS survey

Years of birth covered: 1950-1983, centered in 1974

Survey design standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

For Burkina Faso, the 1998/99 DHS Survey is not used, as urban origin is missing.

For Senegal, the 2005 DHS Survey is not used, as urban origin is miscoded.

Table A.9a: Adult literacy and childhood context

Dependent variable: Literacy	Côte d'Ivoire			Ghana		
	I	**II**	**III**	**I**	**II**	**III**
Mother attended school	3.649	3.086	2.663	3.032	2.959	3.047
	(1.296)***	(1.011)***	(0.777)***	(0.345)***	(0.331)***	(0.363)***
Father attended school	7.855	7.208	6.478	2.872	2.506	2.428
	(1.080)***	(0.968)***	(0.927)***	(0.215)***	(0.186)***	(0.188)***
Father in Agriculture	0.357	0.357	0.432	0.462	0.495	0.502
	(0.035)***	(0.037)***	(0.047)***	(0.034)***	(0.038)***	(0.039)***
Urban density in d. of birth	1.060	1.080	0.998	1.012	1.009	0.999
	(0.006)***	(0.007)***	(0.007)	(0.002)***	(0.002)***	(0.002)
Cocoa in district of birth	2.878	6.154	1.832	1.925	1.184	0.994
	(0.253)***	(0.878)***	(0.319)***	(0.171)***	(0.127)	(0.124)
Controls						
Gender	Yes	Yes	Yes	Yes	Yes	Yes
District of birth		Yes	Yes		Yes	Yes
Year of birth			Yes			Yes
Observations		15,017			10,881	

Notes: Logistic regression. Odds-ratios (Maximum Likelihood estimates); for the rest, see table 3.

Table A.9b: Adult literacy and colonial investments in Côte d'Ivoire

Dependent variable: Literacy	**IIa**	**IIb**
Mother attended school	0.895	0.674
	(0.527)	(0.455)
Father attended school	11.363	12.232
	(2.801)***	(3.193)***
Father Farmer	0.329	0.341
	(0.049)***	(0.053)***
Urban density in region of birth	1.304	1.041
	(0.027)***	(0.060)
Cocoa in district of birth	6.799	5.841
	(1.269)***	(1.122)***
# Health agents per thousand p. (1925) in d. of birth (a)		7.157
		(1.809)***
# Teachers per thousand p. (1925) in d. of birth (a)		0.576
		(0.188)*
Controls		
Sex	Yes	Yes
District of birth	Yes	Yes
Observations	8,566	

Logistic regression, Odds-ratios (Maximum likelihood estimates); for the rest, see table 4.