

Heights and Development in a Cash-Crop Colony: Living Standards in Ghana, 1880-1980

Alexander Moradi*, Gareth Austin**, Jörg Baten***

*University of Sussex and CSAE

** The Graduate Institute Geneva

*** University of Tuebingen and CESifo

Version: 27 November 2013

Keywords: nutrition; health; anthropometrics; colonial; living standards

JEL classification: I30; I32; N37; O10

Address: Alexander Moradi
Department of Economics
School of Business, Management and Economics,
University of Sussex
Jubilee Building
Falmer, Brighton
BN1 9SL
UK
Phone: +44 (0)1273 87 7141
E-mail: A.Moradi@sussex.ac.uk

This is the last working paper version before this study was submitted and accepted. Please cite as Moradi, Alexander and Austin, Gareth and Baten, Jörg. "Heights and Development in a Cash-Crop Colony: Living Standards in Ghana, 1870-1980", Working Paper LSE/Tuebingen/Oxford, to be revised and resubmitted Economic History Review. Older version: ERSA Working Paper 325.

Acknowledgments

We are grateful to the General Headquarters of the Ghana Armed Forces, Personnel and Administration, Military Records for granting us access to records of the Gold Coast Regiment. We thank Moses Awoonor-Williams, Namawu Alhassan and Joana Acquah for excellent research assistance in Ghana. We are grateful for support from the Centre for the Study of African Economies at Oxford University, particularly Francis Teal. We are much indebted to David Killingray, who shared with us his expert knowledge on the Gold Coast Regiment.

Data collection was funded by a British Academy Small Research Grant to the first author, the financial support is gratefully acknowledged. We furthermore gratefully acknowledge financial support from ESRC First Grant (RES-061-25-0456). The usual disclaimer applies.

Abstract

While Ghana is a classic case of economic growth in an agricultural-export colony, scholars have queried whether it was sustained, and how far its benefits were widely distributed, socially and regionally. Using height as a measure of human well-being we explore the evolution of living standards and regional inequality in Ghana from 1870 to 1980. Our findings suggest that, overall, living standards improved during colonial times and that a trend reversal occurred during the economic crisis in the 1973-83. In a regression analysis we test several covariates reflecting the major economic and social changes that took place in early twentieth-century Ghana including railway construction, cocoa production, and urbanization. We find significant height gains in cocoa producing areas, whereas heights decreased with urbanization.

1 Introduction

Ghana became the most prosperous of the ‘peasant’ (or, perhaps more accurately, ‘indigenous rural capitalist’) economies in Africa, thanks primarily to the rapid African adoption and investment in cocoa cultivation from the 1890s onwards.¹ But the literature highlights major doubts about the developmental significance of this cash-crop achievement.² The ownership of cocoa farms was, from the first, distinctly unequal even among the population of the forest zone.³ Even more so, the majority of the country is savanna, unsuitable for cocoa cultivation. Thus the participation of the population of northern Ghana (the Northern Territories) in the cocoa-growing and mining economy of the forested south was very largely limited to the supply of migrant male labour.⁴ It has traditionally been argued that, as a mechanism by which the benefits of aggregate economic growth could ‘trickle down’, the migrant labour system provided the thinnest of channels.⁵ Generally, the pessimism of dependency theory about economic – let alone broader human – development under colonial rule in Africa has been reiterated by the more recent cross-country historical economics literature.⁶ Investigating the evolution of living standards in colonial Ghana by price-based data is notoriously difficult because of gaps in the data, #. In contrast, the present study approaches the problem with an exceptionally large, geographically comprehensive and reliable sample: the heights of African recruits to the colonial army in Ghana. We find that there was a

¹ Hill, *Migrant Cocoa-Farmers*, Austin, *Labour, Land, and Capital*, pp. 48-56, 77-86, 469-71, 476-8.

² A position epitomised in Howard-Hassmann, *Colonialism*.

³ On the continuity of inequality see Austin, *Labour, Land, and Capital*; on its extent see, e.g., Gunnarsson, *Gold Coast Cocoa Industry*.

⁴ Van Hear, *Northern Labour*; Austin, ‘Political Economy’.

⁵ E.g. Amin, *Modern Migrations*.

⁶ Acemoglu, Johnson, and Robinson, ‘Reversal of Fortune’.

considerable improvement in physical welfare during the colonial period, and one particularly associated with the growth of cocoa income. Strikingly, in view of the plausible queries raised in the previous literature, the improvements were by no means restricted to cocoa-farming areas, suggesting that the migration-based labour market was more effective at diffusing economic gains than previously realized.

The British colonized the far south of what is now Ghana in 1874, creating what they later called the Gold Coast Colony. In 1896 they extended their rule over the inland forest kingdom of Ashanti,⁷ and the northern savanna, adding part of the former German colony of Togoland during the First World War. In the early twentieth century, the future Ghana underwent a remarkable economic and social transformation. Exports of cocoa beans rose from zero in 1890 to the largest in the world in 1910-11. Szereszewski's early attempt at historical national income accounting estimated annual average per capita growth in GDP as 1.8% between 1891 and 1911. Non-traditional capital stock rose from £0.8 million at the end of 1890 to £13.8 million at the end of 1910, in 1911 prices.⁸ Meanwhile the growth of the agricultural export economy was facilitated by a transport revolution initiated by railways and continued, in the 1920s, by lorries.⁹ The raiding and trading of slaves was suppressed by the incoming colonial authorities, though in Ashanti and the Northern Territories slave-holding was only prohibited in 1908.¹⁰ A wage labor market developed with large numbers of laborers from the North migrating to the

⁷ Following convention, we use 'Ashanti' to refer to the kingdom or administrative region; 'Asante' to refer to its people.

⁸ Szereszewski, *Structural Changes*, p. 91. This does not fully reflect the significance of the capital formation, as its main component was the planting of cocoa trees whose peak yields lay ahead.

⁹ Austin, 'Labour and Land in Ghana'; Jedwab and Moradi, 'Colonial Investments'.

¹⁰ Austin, *Labour, Land, and Capital*, pp. 205-49, 504-15.

cocoa farms and European-owned mines in the forest zone.¹¹ Western education, promoted by Christian missionaries and to some extent the government, spread.¹² Public health, medical and hygienic knowledge became more advanced.¹³ Development, however, was uneven across the country, and the rapid growth and structural change of the early colonial era was not matched in later periods.¹⁴

How can we assess the impact of these changes on human development? Efforts to construct conventional price-based measures of well-being like income and wages are under way.¹⁵ They provide important insights but there are limitations. Data are lacking before the colonial conquest. Even after that, the majority of output was probably food crops which were not measured even when they were sold. Hence GDP reconstruction focuses on the export sector. Because development was uneven, country averages may mask important regional inequalities; which, as we have seen, is a critical issue in this case. Last but not least, evidence of economic growth alone is insufficient to demonstrate an improvement in 'human development', broadly defined.

This paper seeks to quantify human development with a precision which has previously not been achieved by applying an established methodology and drawing data from a new and comprehensive source. Measuring human development is one goal; explaining the changes in human welfare is another. We will undertake a statistical analysis correlating measures of economic and social change.

¹¹ Van Hear, *Northern Labour*; Austin, *Labour, Land, and Capital*, pp. 315-21, 527-9; Abdulai, 'International Migration'; Rouch, 'Migrations au Ghana'.

¹² Gifford and Weiskel, 'African Education'.

¹³ Addae, *History of Western Medicine*.

¹⁴ Austin, 'African Rural Capitalism', Teal, 'Export Growth and Trade Policy'.

¹⁵ Frankema and Waijenburg, 'Real Wages in British Africa'; Jerven, 'Estimating GDP for the Gold Coast'.

2 Height and Living Standards

Nutrition and health are key elements of human welfare, which this study will assess by the effect they have on the human body, specifically height. Mean adult heights illuminate the nutritional and health conditions a population cohort has faced. This is because children's body growth responds positively to a sufficient and good quality diet, whereas diseases and physical exertion absorb nutrients and therefore stunt growth. Children suffering from chronic malnutrition fall short of their genetic growth potential and, on average, become shorter adults. Mean height is a frequently used indicator in economic history.¹⁶

The stature measure has unique advantages especially where data are few and problematic, as tends to be the case in the study of African historical populations. Heights are consistent over time and applicable to the various socio-economic groups in Africa. Heights measure outcomes not inputs to human well-being. Last but not least, the analysis of stature can be based on a large population coverage allowing uniquely precise insights into groups and territories for which other quantifiable information is virtually non-existent – such as Northern Ghana in the period 1870-1900.

Final adult height represents the cumulative sum of increases in stature from birth to maturity, but not all years are equally important. It is widely held that height deficits at early ages are unlikely to be regained and will be carried on up to maturity. Thus, adult stature informs about conditions during the early years of life.¹⁷

¹⁶ Steckel, 'Heights and Human Welfare'.

¹⁷ Baten, 'Height and Real Wages', Billewicz and McGregor, 'Birth-to-Maturity Longitudinal Study', Hauspie et al., 'Height of Boys and Girls of West Bengal'.

In the first three years of life, the height of healthy and well-nourished children increases by about 45 cm on average.¹⁸ A growth shortfall at that age is likely to be large in absolute terms. Moreover, toddlerhood is a very critical and vulnerable period. The combination of high nutritional demand and exposure to pathogens after weaning lets adverse environmental conditions take a significant toll on physical development.¹⁹ However, there is increasing evidence that good environmental conditions during puberty may allow African populations to catch-up.²⁰

It is worth mentioning that genetics does not play an important role at the population level. Large height differences exist between rich and poor people of the same ethnic group, more so than between socioeconomic elites of different ethnic groups. This evidences the overwhelming influence of environmental conditions.²¹ Fiawoo, for example, found ten-year-old boys from Accra, Ghana's capital, who went to an expensive international school in 1966-68, to have an average stature equal to that of sons of Euro-American expatriates in Ghana and US boys of the same age.²² The privileged Accra boys, however, were seven centimetres taller than boys of the same age going to Accra's state schools. When analyzing *changes* in height between cohorts, genetics and other time-invariant factors over the last 120 years can be safely ignored.²³

¹⁸ Kuczumarski et al., '2000 CDC Growth Charts'.

¹⁹ Martorell and Habicht, 'Human Growth'.

²⁰ Akresh et al., 'War and Stature', Moradi, 'Nutritional Status', Moradi, 'Selective Mortality'.

²¹ Eveleth and Tanner, *Worldwide Variation in Human Growth*, Habicht et al., 'How Relevant Are Ethnic Differences?'

²² Fiawoo, 'Physical Growth and the School Environment'.

²³ Bogin, *Patterns of Human Growth*.

3 Data

Recruitment records of the colonial armies are a real treasure providing excellent population and temporal coverage. Armies were among the first organizations set up by colonial rulers; the rank-and-file were drawn from the indigenous population. The army collected information on the recruit's background including age, place of birth, ethnicity, religion, previous occupation, father's occupation, and educational attainment. Additionally, height was taken as part of routine medical examinations.

The subjects of our analysis are recruits to the Gold Coast Regiment (GCR), the colonial army based in what later became Ghana. The records are held by the General Headquarters of the Ghana Armed Forces at Burma Camp in Accra.²⁴ Our sampling strategy was guided by the aim of sufficient height measurements to achieve statistically reliable results as well as taking advantage of different recruitment regimes. By consulting Enlistment Books, which list the name and regimental number of every new recruit in chronological order, we could identify the men who enlisted in the period of interest. We drew an almost complete sample of recruits enlisted between 1912 and 1939 (Figure 1). For the enlistment period 1940-5 we sampled approximately 750 recruits for every year of war. For the post-war period, we sampled all recruits with even regimental numbers. The GCR recruited a substantial number of Africans born outside Ghana (20%-40% of personnel strength). These recruits were excluded from the analysis.

²⁴ The records are not publicly accessible, but need special permission from "Personnel and Administration". At the time of data of collection in 2007, the military records were stored in a Nissen hut. Enlistment books are located in a separate office, but in the same department. There is no archival designation.

We excluded extreme heights (<120 cm, >200 cm, N=23). We also excluded recruits younger than 16 and older than 50 (N=77), and include age fixed effects for the ages between 16 and 23, because final male height is often reached later than age 20 when nutrition was poor.²⁵ Overall, the data set consists of more than 14,000 Ghanaians born between 1875 and 1935.

The sample of army recruits allows height estimation for the 1870s to 1935 birth cohorts. Evidence in nutritional and health status for the post-independence period 1935-65 comes from the Ghana Living Standard Surveys 1987/88, which are representative for the time when the surveys were carried out.²⁶

4 Selection

Universal conscription was never introduced. GCR recruits can therefore not be treated as representative of the male population by default. It is long known that understanding selection at work is important to interpret results. Recently, Bodenhorn, Guinnane and Mroz (2012) presented an occupational choice model by which traits that are correlated with height or height itself are more rewarded in the civilian and military sector. Hence, in whatever sector the traits command a wage premium, one will find more individuals of that trait and correspondingly they are missing in the other sector. This will determine selection. Bodenhorn et al. (2012) conjecture that it is the civilian sector that pays higher wages for tall men.

Recruiting of soldiers was indeed subject to supply and demand in the labor market, with the military a direct competitor to other forms of employment.²⁷

²⁵ Bogin, *Patterns of Human Growth*, p. 92.

²⁶ World Bank, *Living Standard Measurement Study*.

²⁷ The following paragraph is based on Killingray, *Colonial Army in the Gold Coast*, pp. 203-212.

Higher-skilled men from higher social status had higher opportunity costs and, therefore, were less likely to enlist. For Southerners, it was generally more profitable to grow cocoa or work in the mines. Non-economic factors also played a role. After the 1900 uprising, Asante were regarded as potentially disloyal; alien men were trusted more. The fact that ethnic groups from the North dominated the rank-and-file generated antipathies and kept Southerners from joining the GCR. In peacetime the GCR was a small force numbering between 1000 and 1700 men, and therefore, the army could be rather selective. However, this changed during the world wars. The GCR was rapidly expanded; over 10,000 men enlisted during the First World War while over 65,000 men served in the Second World War. The army filled their ranks with those who previously would have been rejected on medical and other grounds. Recruitment was extended to ethnic groups and areas previously not - or less - targeted such as Asante and coastal peoples. Recruiting took compulsory forms. During the First World War, the British authorities applied pressure on chiefs who in turn used direct compulsion to provide recruits. In the Second World War a sophisticated system of district quotas was introduced.

4.1 Geography of Recruiting

In the following, we examine whether our sample is geographically balanced. By matching place names we retrieved the exact longitude and latitude and therefore district of birth of 83% of the Ghanaian recruits from a geographical database of place names.²⁸ We then calculated the ratio of the total population, as

²⁸ Our GIS analysis slightly underreports the number of genuine Ghanaian northerners as it was more difficult to locate birth places in the Northern Territories. Using ethnicity as a rough indicator of

reported in the 1931 Census, to the number of Ghanaian recruits enlisted in the First World War, 1918-29, 1930-39, the Second World War and 1945-55. Equivalent to sample weights, the ratio can be interpreted as the number of persons in the district population that a recruit represents. We find that the sample of Ghanaian First and Second World War recruits is geographically balanced (Figure 2). There is a slightly greater divergence in the First World War sample, with a higher share of men from the Upper West and fewer men from the Western region or the Southeast.²⁹ In the Second World War, the district quotas seem to have worked well except in the Western region.

Deviations from the underlying population distribution are most striking in the inter-war period, when a North-South gradient is clearly evident with Northerners dominating the rank-and-file. In some districts of the Western region, not a single recruit was enlisted in a decade, within our sample. The pattern changed in the post-war period with groups from the South-East (in what is now the Volta Region), mostly Ewe, entering the army disproportionately.

Shifts in recruitment grounds can be addressed by inverse probability weighting: Recruits from groups that are over- or underrepresented relative to the underlying population receive correspondingly less or more weight. Using population figures from 1931 Census we constructed sample weights for two dimensions: ethnicity and district of birth.³⁰ Ethnicity is a fine geographic marker and we avoid attrition from failing to identify the geographic coordinates of the recruits' place of

geographic origin we identified 76%, 87% and 92% of the birth places for Northern ethnic groups, Asante and Southerners respectively.

²⁹ According to Akurang-Parry, 'African Agency', pp. 227-228 "overly harsh and exploitative policies" of colonial authorities caused strong resistance to military recruitment in the Sefwi District.

³⁰ District sampling weights correspond to the ratios shown in Figure 2.

birth.³¹ Administrative districts in contrast are better suited for ethnic groups that settle across a large area such as Asante; moreover, districts put the emphasis on conditions at birth (any recruit will be treated as a representative of the district population independent of ethnic identity). To be clear, sample weights only correct the bias, if recruits were randomly selected within their ethnic group and district. Unfortunately, we cannot construct sample weights for other dimensions such as occupational class or education because no equivalent information exists in the Censuses. However, we can try to control for recruits' social composition using information on the recruit's occupation before enlistment. This is suitable if height differences of socioeconomic groups are time invariant.³²

4.2 Minimum Height Requirement

The army used height as a measure of physical fitness and enlistees had to pass a minimum height requirement (MHR). As a consequence, men below a certain height threshold may be underrepresented so that height samples are deficient on the left tail of the distribution. In order to derive consistent mean height estimates we apply truncated regressions using a maximum likelihood estimator (MLE). We determine truncation point τ by examining height histograms by ethnic group and recruitment regime.³³ There is little sign of shortfall in World War One recruits (Figure 3). High MHRs were applied during peacetime, when the army could be more

³¹ For ethnic groups that are also located in neighboring countries such as Ewe, Kotokoli and Grunshi we use the place of birth to only include men who were born in what is now Ghana.

³² A rather implausible assumption under structural change and when, as in colonial Africa, new occupations and indeed elites were emerging (Bossuroy and Cogneau, 'Social Mobility'). For example, fathers of highly skilled recruits such as clerks frequently had a farming background.

³³ This is preferable to using official figures, which might or might not have been applied. Komlos, 'Deficient Height Samples'.

selective. For the interwar period, we located τ at 64, 65 and 66 inches for Asante, GCC and NT recruits respectively. In the Second World War τ is two inches lower at 62, 63 and 64 respectively. After World War Two a MHR of 65 inches was applied.³⁴ We nevertheless set τ one inch higher for NT recruits.

If the truncation point is close to the mean, knowledge of the variation can improve the precision of the MLE.³⁵ Komlos argued that standard deviations (σ) in height do not vary much across populations and over time.³⁶ On average σ is 6.86 cm, which he recommended to take as constraint in the restricted MLE.³⁷ We follow his recommendation.

Truncated regression, however, cannot correct for any clustering at particular values.³⁸ Killingray pointed to the existence of a height preference when saying that the army considered 5'8" an 'ideal height'.³⁹ A clustering of heights at 68 inches is indeed visible in the height distribution of NT recruits in the interwar period (Figure 3). Moreover, truncated regressions do not correct for any selection process operating for heights above the MHR, e.g. if a healthy - taller than average height - population was targeted, to which then the MHR was applied.⁴⁰

³⁴ CSO 22/6/166 *Recruitment for the Gold Coast Regiment RWAFF Reports*. PRAAD, Accra, Ghana.

³⁵ A'Hearn, 'Restricted Maximum Likelihood Estimator'. Jacobs, Katzur, and Tassenaar, 'Efficiency of Estimators in Truncated Height Samples' pointed to biases in truncated MLE if heights deviate from the normality assumptions, e.g. height distributions are heavily skewed. A'Hearn, 'Restricted Maximum Likelihood Estimator' found a rapidly increasing bias in the restricted MLE if the assumed σ deviates more than 0.5 cm from the true σ . In our case, point estimates of the restricted and unrestricted MLE are very similar. Therefore, to save space we only report results using the restricted MLE.

³⁶ Komlos, 'Deficient Height Samples'. See Moradi and Baten, 'Inequality' for a contrary view – that the height distribution also reflects inequality in nutrition and health status.

³⁷ From the nationally representative GLSS survey we calculated an average σ of 6.63, 6.66 and 7.11 cm in what was the Gold Coast Colony, Ashanti and Northern Territories respectively. We averaged five-year birth cohorts in order to limit upward biases in σ caused by secular trends in height.

³⁸ A'Hearn, 'Restricted Maximum Likelihood Estimator', p. 10.

³⁹ Killingray, *Colonial Army in the Gold Coast*, p. 213.

⁴⁰ A'Hearn, 'Restricted Maximum Likelihood Estimator', Bodenhorn, Guinnane, and Mroz, 'Sample-Selection Bias'.

4.3 From peacetime to wartime recruitment

We can use World War Two to get an idea of the size of the selection bias in the interwar period. In 1939 the recruiting regime quickly switched from peacetime to wartime recruitment when it was decided to use the GCR to counter the Italian threat - and later attack - in East Africa.⁴¹ We can positively exclude that large mean height differences between two cohorts recruited just one year apart are due to environmental changes at birth of the two cohorts. Hence, any sharp discontinuity in mean height in these two cohorts can largely be attributed to selection caused by factors at the time of recruitment, in our case wartime recruitment. This idea forms the basis of our testing strategy. We test the following model:⁴²

$$H = \alpha + \beta WW2 + X\gamma + \epsilon \quad (1)$$

where H stands for height of a recruit. $WW2$ is a dummy variable which separates the recruitment regimes. In our data, we observe a sudden and dramatic change from a monthly intake of about 40 recruits between January 1938 and July 1939 to 408 and 1,901 recruits in August and September 1939 respectively. Hence, we set $WW2=1$ if the recruit was enlisted in August 1939 or later. As controls X we use ethnic group, pre-enlistment occupation as well as age fixed effects to abstract from composition effects for which we will also control later on. When controlling for X , β gives us the discontinuity beyond observable contemporary factors.

We restrict the sample to enlistments 24 months before and to 12 months after August 1938. The asymmetric interval is to increase the number of peacetime

⁴¹ Killingray, *Colonial Army in the Gold Coast*, p. 339.

⁴² The model draws on RDD literature, see Lee and Lemieux, 'Regression Discontinuity Designs in Economics'.

recruitments.⁴³ We estimate equation (1) using the restricted MLE estimator, because we are interested in selection beyond MHR.⁴⁴ We can test for NT and GCC recruits. For Ashanti the pre-WWII sample size is too small to give meaningful results.

We find a significant discontinuity with the start of wartime recruitment in height for NT recruits, their mean height decreasing by an estimated 1.67 cm (column 2, Table 2). Including controls does not change coefficients (column 3 & 4, Table 2). We do not find any discontinuity in GCC recruits.

A potential concern is the reenlistment of the Reserve. The Reserve consisted of men who served before and thus were selected based on the recruitment regime when they enlisted for the first time. Hence, we exclude recruits who answered the question “Have you served before?” with yes. We also exclude recruits older than 25 years thereby excluding all soldiers that could possibly have done the 6 years of military service. The discontinuity for NT recruits is confirmed (column 5 & 6, Table 2).

In sum, results point to selection of NT recruits beyond the Height Minimum Requirement during the interwar period, but not so for GCC recruits.

⁴³ About half of the pre-WW2 sample falls into the [-24,-12] and [-12, -1] range. The choice of [-24, 12] months is somewhat arbitrary. Choosing [-24, 24] or [-36, 24] does not change results much. Extending the period however makes birth cohort effects more likely.

⁴⁴ Point estimates of the restricted MLE are much lower than OLS indicating that truncated regressions reduce much of selection effect in height.

4.4 Wartime recruitment – Rates of Rejection

Even during wartimes rejection rates were relatively high. About 40-50% of registered men were rejected. Rates were equally high in World War One and Two.⁴⁵ This is important to note, because it does *prima facie not* suggest that markedly different standards of physical fitness would cause very different sample selections.⁴⁶ Scattered army reports suggest that Guinea worm disease (dracunculiasis) and yaws were major causes of rejection.⁴⁷ In the following we take a closer look at observed heights and potential sources of selection.

The Commissioner for Civil Defence reported about the progress in meeting recruitment quota. One report available to us covers the period January to March 1941. It lists the quota, number of registered men and accepted recruits at the third administrative unit level, but only for the Gold Coast Colony excluding Accra region and Tarkwa state.⁴⁸ We test two variables. First, the number of men that registered with the army as a proportion of the quota (observed mean: 1.18, sd: 1.12). If Bodenhorn et al.'s mechanism is at work in the Ghanaian case, we should find a *positive* correlation: As work opportunities are bad in a state, a disproportionate large share of a cohort will find military service attractive and present themselves to the army and more of the tall labour will be found in the sample. The second variable is rejections as a proportion of registered men (observed mean: 0.58, sd: 0.25). On

⁴⁵ CSO 22/6/167 *Recruitment for the Gold Coast Regiment RWAFF Reports on 1941*. PRAAD, Accra, Ghana. Killingray, *Colonial Army in the Gold Coast*, p. 286.

⁴⁶ If the fittest 50% of the male population was selected in both World Wars, our results would not be driven by sample selection, but by changes in nutrition and health standards of the fittest 50% of the population. In this case, results will be representative for the 50% of the population. Moreover, this is also informative about the non-fittest 50%, unless inequality has changed dramatically.

⁴⁷ Killingray, *Colonial Army in the Gold Coast*, p. 213 We indeed find a significant positive correlation between prevalence of yaws as measured in the national search in 1989 and

⁴⁸ CSO 22/6/167 *Recruitment for the Gold Coast Regiment RWAFF Reports on 1941*. PRAAD, Accra, Ghana. We link recruits to the administrative region of recruitment using the geographic location of the recruit's place of birth.

the one hand, the rejection rate may proxy classic selection of the fit and tall: The more (typically shorter) men were rejected, the larger the observed mean height in the army sample. In this case we would expect a *positive* correlation. High rejection rates, however, also indicate poor health conditions, causing shorter attained heights.⁴⁹ This would imply a *negative* correlation. Because the predictions are of opposing sign, a regression can inform us what effect dominates.

We find a negative and non-significant correlation between height and the available pool of army recruits and we find a *negative* correlation with rejection rates (column 1 & 2, Table 3). The size of the coefficient is large. A one standard deviation increase in the rejection rate is associated with a 0.87 cm decrease in mean height, roughly 0.7 standard deviations in the mean height of the states in the Gold Coast Colony. We do not claim that these correlations are causal. However, if Bodenhorn et al.'s labour market selection story dominates in the Ghanaian case, we would expect a strong and significant relationship with the correct sign in a rather simple specification, which we do not find.

4.5 Heights of World War recruits and heights of villagers in 1940

We finally evaluate selection biases by comparing heights of GCR recruits with a different source. The 1940 draft 'Final Report' on 'Diet and Nutrition Surveys [in the] Gold Coast' reported summary data for five 'forest villages' in Ashanti and seven 'savanna villages' in the NT, based on a total of 2082 height measurements.⁵⁰ The compounds were described as representative of the locality surveyed, but only families who "have been established in the soil for several generations" were

⁴⁹ We find, for example, a positive correlation between prevalence of Guinea worm disease in 1989 and rejection rates in 1941. Guinea worm disease was not targeted by public health measures until the eradication campaign in 1989, see Hunter, 'Geographical Patterns'.

⁵⁰ Purcell, 'Final Report', pp. 76, 108. The report related nutritional conditions to height, arguing that the former accounted for the variations in the latter.

included.⁵¹ Information on ages is limited, but children were reported as a separate category or excluded from the heights survey and we can assume that elderly, presumably fairly few anyway, were excluded. Shrinking in old people and not yet fully grown young individuals do not seem to be an important concern. One relevant concern, however, are secular trends, in that the 20-50 year old village population consists of disproportionately more individuals who grew up under worse conditions than a cohort of largely 20-25 year old men. However, we would not expect an even strong secular trend to undo the fairly large mean height differences observed across space in Ghana.

We identified recruits of the two World Wars who were born in the surveyed villages and compare mean heights. The correlation between villagers and recruits is positive and strong (Figure 4). The line of best fit of the two World War recruits run nearly parallel, but World War One soldiers are shorter. A regression, not shown to save space, confirms that we cannot reject a 1:1 relationship in mean heights of recruits and villagers. This result holds when expanding the number of soldiers to a buffer of 10 km and 15 km around the village (though the correlation weakens) and including age fixed effects (insignificant).

4.6 Concluding remarks

We did a number of various tests to assess selection biases. We found evidence for selection bias in NT recruits during the interwar period beyond MHR. Recruits of the two world wars can be treated as fairly representative of men's height. We restrict our analysis to recruits to the Two World Wars. This will limit the height time series to three points in time: WWI, WW2 and 1960 from GLSS. or map of the districts?

⁵¹ Ibid., p. ?.

5 Regional and temporal patterns in height, 1880s-1970s birth cohorts

As the colonial state organized the whole northern savanna as a single administrative unit, while dividing the forest and coastal zone into two or three territories, it is convenient for us to present height trends using a tripartite division: i) Gold Coast Colony (GCC) including British Mandated Togoland ii) the central Ashanti forest region, and iii) the Northern Territories (NT). This presentational device facilitates analysis, given the above-mentioned differences in environment and timing of colonization between the three divisions. Height trends are shown by the coefficients of birth cohort dummies. The first regression is OLS and serves as a benchmark to inform about the effect of corrections on height trends (col (1), Table 2). We then only apply truncated ML estimation. The simple form is without any controls (col (2), Table 2). We then add controls for the recruit's previous occupation and for recruitment regimes (col (3), Table 2). We finally apply sample weights by ethnic group and district of birth (col (4) and col (5), Table 2).

For GCC recruits, OLS indicates a strong upward trend – heights of the 1875-1884 birth decades are lower whereas the last birth decade is much higher – resulting in a total height gain of 2.55 cm (1.005 inch). Truncated ML regressions, in contrast, indicate a gain of 1.5 cm only. Differences within the truncated ML regressions are limited to levels not trends. This is because farmers (the reference category in col(3) to col(5), Table 2) are significantly shorter than other occupational groups among Gold Coast Colony recruits (ca. 0.5 inches). For Ashanti, occupational class differences are much less pronounced, but level estimates are lower when weighting by district (col (5), Table 2). For NT recruits height estimates of the first and last birth decade greatly vary. Moreover, the 3 cm increase in the 1905-14 birth

decade is highly implausible. We do not know of any population in which an increase of such a magnitude was observed in so little time. We rather attribute this to sample deficiencies that could not be corrected. The 1905-14 birth decade includes men recruited during the very selective 1928-1939 period. In the cohort we find men of an untypically homogenous stature of 5'8" which could be due to selection or height heaping.⁵²

Our preferred specification is (col (4), Table 2). From the coefficients of the three regional regressions, we can draw the following inferences (Figure 4).

- (1) Northern recruits were on average taller than southern recruits. Within the forest zone, Asante were shortest.
- (2) Mean heights declined in Asante cohorts born between 1880 and 1900, followed by a strong recovery of about 2.4 cm. In the 1930 birth cohort heights decreased by 1 cm.
- (3) Height development in the Gold Coast Colony was, by and large, similar to the Ashanti pattern. There was no downturn in the 1880-1900 cohorts however; heights rather stagnated. Heights increased by 1.5 cm in the 1910 birth decade and stagnated afterwards.
- (4) NT recruits saw an upward trend in height until the 1930 cohort.

5.1 Explanations for the regional difference between North and South

Why did Northern recruits tend to be taller than Southern ones? As higher incomes buy better diet and health, we would expect taller people in the richer

⁵² See discussion in section 4. Even if one ignores the 1910 cohorts altogether, we find an upward trend in the early twentieth century.

region, especially in the later period. At first glimpse, the taller stature in the north seems paradoxical: Everything points to the south as the richer region. The forest zone contained most of the natural resources that happened to be commercially valuable in the world markets of the nineteenth and twentieth centuries.⁵³ The south had greater purchasing power in the mid-1890s as well as ever since, in aggregate and per capita.

Heights do not always (positively) correlate with income. The divergence arises if correlation between income on the one hand and nutrition and health on the other, which heights approximate, is weak. 'Purchasing power' should be taken literally: what could be bought on the market. But, though markets were much more important than was assumed in the old stereotype of the subsistence economy, it is true that markets for food were at best not integrated, across the country as a whole.⁵⁴ So it is possible that food consumption (defined in calories, proteins etc) was higher in the north, if it included more generous provision of items that were scarce in the south for natural-endowment reasons.

An obvious candidate for explaining the height advantage in the north would be a higher consumption of high-quality proteins in the north, especially in the form of meat, including offal, skins, and milk.⁵⁵ Yet the cattle hypothesis is not entirely convincing for early twentieth century Ghana. Livestock diseases inhibited stock-rearing even in much of the north. Trypanosomiasis was present in part of the country and rinderpest spread in the late 1910s and 1920s.⁵⁶ Therefore, where northerners kept cattle they did so on a small scale. A. W. Cardinall, the Gold Coast

⁵³ Austin, *Labour, Land, and Capital*, Austin, 'Political Economy', Austin, 'Labour and Land in Ghana'.

⁵⁴ Austin, 'No Elders Were Present', Hopkins, *Economic History of West Africa*.

⁵⁵ Moradi and Baten, 'Inequality'.

⁵⁶ Patterson, 'Veterinary Department and Animal Industry'.

census officer, gives estimates of the number of cattle per 100 of the population in 1931.⁵⁷ In Ashanti, with its deadly environment for large livestock, the figure was 2.6, all of them presumably recently driven there for slaughter. Figures of the same order of magnitude are given for 4 of the 11 districts of the NT and Northern Section of Togoland: Mamprusi (3.3), Eastern Gonja (2.2), Western Gonja (3.1) and Krachi (1.5). Clearly, these districts were not primarily specialized on livestock. The districts with more than 10 cattle per 100 people in 1931 were Keta-Ada (down on the Accra plains, in the Gold Coast Colony), at 10.2; and in the north, Lawra-Tumu (12.9), Navrongo (19.0), Wa (15.3), Eastern Dagomba (10.9) and Western Dagomba (11.0). Interestingly, Cardinall concluded, 'the population of the Protectorate [the N.T.s] although owners of cattle are not in any way breeders or herdsmen'.⁵⁸ Moreover, the cattle reared in the NT were small, a humpless breed, locally known as 'Dagomba' cattle.⁵⁹

Overall, meat consumption was not high in Ghana, and consumption of beef was probably rare for most people. As late as 1931, Cardinall calculated 10.78 lbs (4.89 kg) as the per capita meat consumption for the whole population of Ghana. He added 'This compares favourably with other countries in Africa. But a closer analysis would show that the per capita consumption of meat is infinitely greater in the larger centres [which were mostly in the south] than in the rural districts where the people cannot be classified in any sense as meat-eaters.'⁶⁰

⁵⁷ Cardinall, *Gold Coast*, p. 102.

⁵⁸ *Ibid.*, p. 103.

⁵⁹ Deshler, 'Cattle in Africa'. There was a biological and pathological reason why the local cattle were small. When the colonial government established a veterinary laboratory, it reached the conclusion that 'the majority of the country's live-stock [sic] was or had been infected by trypanosomiasis.' Though not fatal to these animals, attacks from the disease restricted their growth (Great Britain, *Annual Report*, p. 26).

⁶⁰ Cardinall, *Gold Coast*, p. 104.

Nevertheless, the fact that the northerners did not specialize in large-scale cattle exports to the Kumasi and similar regions could mean that they could consume on a decent scale themselves.⁶¹ Overall, it remains highly likely that meat consumption was slightly more common per head, and more widely distributed socially, in northern Ghana as a whole than in the forest zone. The effect may have been strong enough to account for a part of the greater average height of northerners compared to forest-zone dwellers.

The main explanation for the Northerners' height advantage may lie in the rest of the diet, and especially in northerners' consumption of groundnuts (peanuts). The issue was not systematically investigated in the early colonial period. Given that the northern height advantage persisted throughout and beyond the period, it is relevant to mention here the analysis offered in a report by the Gold Coast Dietetic Officer, Dr F. M. Purcell, in 1940:⁶²

The dietetic contrast of chief importance are between the children of the north and the children of the forest. The smaller and weaker Akan child eats roast plantain in the morning and mid-day (and gets very little meat or fish with supper), whereas the northern child who [sic] eats whole grain millet flour in water in the morning, and raw groundnuts at mid-day. Thus, during the all important growing years, the diet of the N.T. child contains qualitatively superior protein and more calcium; although at times the N.T. child may experience seasons of hunger unknown to the forest child. In this way the

⁶¹ The cattle imported into the forest zone for the meat trade of the colonial era were supplied by specialist pastoralists in Burkina Faso.

⁶² Public Records and Archives Administration, Accra: File ADM 11/1/1294 **Fehler! Nur Hauptdokument**, Purcell, 'Final Report', p. 140

contrast in stature and physique may be accounted for.

It is difficult to know how far the area of the north selected for the 1940 survey was representative of the diet of the NT as a whole. As Jérôme Destombes shows for a later period, the trajectory of different groups within the same district could vary considerably.⁶³ Another query is whether groundnuts were as prominent in northern diets before 1920, as they were in 1940, but there is no reason to expect a change over the period.

We could also imagine that inequality played a role. The height gain from an additional unit of food or health is positive but it will decrease the higher the consumption of food and health already is.⁶⁴ Therefore, at a given endowment of nutrition and health resources inequality affects average height negatively. The premise of a social gradient in nutrition is justified in the south. In the Asante case, though both rich and poor seem to have eaten the structurally similar mush of boiled and pounded carbohydrate called fufu, the content of the sauce or soup with which it was consumed differed sharply. According to T. Edward Bowdich, who visited Asante in 1817, 'the food of the higher orders is principally soup of dried fish, fowls, beef or mutton ... and ground nuts stewed in blood. The poorer class make their soups of dried deer, monkeys flesh, and frequently of the pelts of skins'.⁶⁵ In 1870 it was reported that in Ashanti only slaves ate cassava, which is nutritionally poorer than other staple sources of carbohydrate.⁶⁶ Thus, there was a social gradient in nutrition in Asante, with slaves at the bottom. In the savanna, there was also a social

⁶³ Destombes, 'Long-Term Patterns of Seasonal Hunger'.

⁶⁴ Steckel, 'Stature'.

⁶⁵ Bowdich, *Mission from Cape Coast Castle to Ashantee*, p. 319.

⁶⁶ Austin, *Labour, Land, and Capital*, p. 66, 474.

gradient in nutrition, but the majority of northerners lived in politically decentralized societies, where we can assume that such inequalities were relatively slight.

Summing up, if the analysis of the 1940 nutrition report is relevant, recruits from the north could have been taller because of eating more and/or better-quality protein in childhood, principally in the form of peanuts and to a lesser extent as animal proteins, given that markets were somewhat less thickly organized and inequality was lower.

5.2 Explanations for trends in 1880-1900 cohorts

We avoid any assumption that the situation revealed by our earliest data reflected a long-term equilibrium. The historiography shows that the various regions of what is now Ghana each experienced considerable change, of various kinds, over the eighteenth and nineteenth centuries. To put it another way, ‘the pre-colonial period’ comprises many periods, however delineated; and our data illuminate the last of those, compared to what was to happen after colonization.

The recorded decline in average heights of recruits born in Ashanti in the 1880s and 1890s is consistent with its political history. The cohesion of the Ashanti kingdom was shaken by its defeat by the British and their coastal African allies in 1874 – in a war which, for the first time in the kingdom’s history, involved a major (if temporary) invasion culminating in the burning of the capital, Kumasi, in 1874. There followed attempts at secession by parts of the kingdom, combined with countervailing efforts by the central state to reassert control and restore its finances through heavier taxation. The result was a revolution in 1883 followed by a civil war which lasted until 1888, which in turn led to large-scale emigration by the losing

chiefs and their followers, to the Gold Coast Colony. The British military occupation in 1896, followed by requisitions of forced labour, ultimately led to a major armed rising, mainly by Kumasis, in 1900.⁶⁷ The causality may be indirect, but it would not be surprising if the insecurity and disruption to family life of this period was bad for child welfare.

In northern Ghana, which was the main source of the slaves imported by the Ashanti kingdom through trade or tribute, there are strong indications that the 1860s-90s saw a big increase in slave raiding and related violence compared to the several decades before.⁶⁸ There was also drought and at least localized famine in the mid-1890s. In this context, the rise in the average heights of northern recruits born in the 1880s and 1890s is a surprise. On the other hand, part of the apparent improvement in physical welfare in the early twentieth century can be interpreted as a return to pre-1880s (or 1860s) levels.⁶⁹ Those, in turn, may or may not have been similar to, say, eighteenth-century levels.

5.3 What explains the recovery between about 1900 and 1913?

It is not surprising, for several reasons, that the inhabitants of the areas in which cocoa farming had begun became taller with the cohort born between around 1900 and 1913: Ashanti, the Eastern Region and indeed Central Province of the GCC (part of which was in the cocoa belt – Panel A, Figure 5). First, in the case of Ashanti,

⁶⁷ Wilks, *Asante*; McCaskie, *State and Society*.

⁶⁸ Wilks, *Asante*; Allman and Parker, *Tongnaab*: 31-32, quote at p. 32.

⁶⁹ Austin, Baten, and van Leeuwen, 'Biological Standard of Living', found that height in Northern Ghana and Burkina Faso were around 168-169 cm in the early 19th century, showing signs of decline around mid-century.

greater peace and personal security followed the 1900 Kumasi revolt.⁷⁰ Confidence in this was manifested by the return, spread over a number of years, of most of the Asantes who had exiled themselves at the end of the civil war.⁷¹ There was no significant change in peace and security in the Gold Coast Colony. Second, purchasing power increased, as there was better access to food produced locally (such as meat from hunters), food purchased from other parts of Ghana (notably fish from the coast), and from abroad. Part of the latter was beef from the Mossi cattle driven down from the French territory of what is now Burkina Faso:⁷² though this probably had little effect as yet on most forest-zone farming households, because of the still high prices. Another part was the growth of food imports via the sea, as the government Blue Books show. The main driver of increased purchasing power was the cocoa economy: farming, trading, and transporting cocoa beans; and supplying goods and services to the direct recipients of cash-crop income.

In the early period up to the 1920s, there would have been no trade-off between cocoa cultivation and food-growing. Ghanaians planted tall food crops, plantain and cocoyam, to shade the young cocoa plants. It is true that in the longer run there was a trade-off, because once the cocoa trees get tall enough to form a shade canopy, not only weeds but also food crops cannot survive on the land. In this early period of rapid expansion of the area under cocoa, farmers who had mature cocoa farms were almost invariably planting new ones as well, so they continued to supply their own food staples. It is true also that cocoa-growing areas sooner or later became net importers of food. For example, in the 1920s rice started to be grown in

⁷⁰ Gillespie, *Gold Coast Police*.

⁷¹ E.g. Gold Coast, *Annual Report on Ashanti for 1907-8*, pp. 9-10.

⁷² Patterson, 'Veterinary Department and Animal Industry'.

Ejura district, north of the forest zone, for sale in the Kumasi market. But this does not mean that there was an absolute decline in food crop output from within the cocoa areas.⁷³

Meanwhile the Northern Territories gained from the end of slave raiding and warfare after the colonial occupation in 1896.⁷⁴ The population increasingly participated in the growth of cocoa farming, but almost exclusively by supplying (mostly) male migrant labour to work on cocoa farms, or as porters for cocoa brokers and merchants, or in the construction and maintenance of the transport system that made cocoa exporting possible. The migrant labour system has often been regarded as inherently exploitative. But the fact that the northern population shared in the general growth of average heights during the colonial period is most easily explained – in large part, if not entirely – as a positive effect of remittances from labourers employed in the south, in mining and urban employment, and above all in the cocoa industry. It is notable that the episodes of rising average heights occurred, broadly, among the cohorts born when aggregate cocoa income was expanding most rapidly, before the First World War and in the twenty years after 1945, rather than in the more troubled economic conditions of the interwar period. This observation is contrary to the traditional view of migrant labour systems in colonial Africa as necessarily exploitative.⁷⁵ But it has been shown elsewhere that, following the prohibition of slave trading and (sooner or later) of slave labour, northern labourers were able to take advantage of the cocoa-derived demand for labour to secure

⁷³ Austin, *Labour, Land, and Capital*, pp. 54-6.

⁷⁴ On the latter see Van Hear, *Northern Labour*; Austin, *Labour, Land, and Capital*, pp. 315-17, 527-8.

⁷⁵ E.g. Meillassoux, 'From Reproduction to Production', pp. 102-3; Grier, 'Underdevelopment', pp. 25, 37-8.

increasingly favourable contracts from employers such as Ashanti cocoa-farmers.⁷⁶

5.4 Living Standards in Ghana, 1940-1980

Mean height of men continued to increase after 1940 in all three regions (Figure 4).⁷⁷ The mean height of women born in the 1950s to the late 1960s rose by 1.6 cm. In cohorts of the early 1970s, the post-1945 upswing came to a halt and mean heights fell by one centimetre. In this respect, Ghana's experience is not exceptional. In most African countries, increases in average statures could be observed for cohorts born after 1950; which stopped in cohorts born in the late 1960s and early 1970s.⁷⁸

Moradi found income growth (at birth and puberty) to be a very strong determinant of post-1945 female adult height in 28 African countries.⁷⁹ Ghana's height development is in line with this story. Over the 1950-70 period, growth in per capita income averaged 1.2%. In 1973-83, Ghana was hit by an economic crisis with GDP/c falling by 3.4% per year.⁸⁰ Mean heights follow this pattern very closely.

6 Comparing First and Second World War recruits: correlates of changes in height

An important dynamic of the colonial economy was the creation of an infrastructure for mechanized transport: railways and motor roads. Tsey and Short stressed negative consequences for public health, as the increased mobility of goods

⁷⁶ Austin, *Labour, Land, and Capital*, pp. 401-30, 540-45.

⁷⁷ One must not combine the height series of recruits and GLSS men. For example, DHS and GLSS heights – both surveys are representative – do not overlap. GLSS women are about 1.5 shorter than DHS women. However, trends – and this is important – completely agree.

⁷⁸ Moradi, 'Nutritional Status'.

⁷⁹ Ibid.

⁸⁰ Maddison, *Historical Statistics*.

and people facilitated the spread of communicable diseases.⁸¹ Scott reported higher morbidity rates including smallpox, relapsing fever and sleeping sickness in communities on main roads.⁸² Patterson documented the spread of the influenza epidemic of 1918/19 along the railways.⁸³ Modern infrastructure, however, also created new economic activities and a higher income. Jedwab and Moradi showed that railways reduced transportation costs and extended the area of cocoa cultivation. They estimated that income of a (small) farmer who adopted cocoa increased by 45% to 90%.⁸⁴ Moreover, the integration of food markets could have improved nutrition in the south. Overall therefore, negative effects on public health could have been offset. Using heights we can test the hypothesis that railways were associated with a decrease in net nutritional status (Panel A, Figure 5). We can also estimate the height changes in cocoa-growing regions.⁸⁵

Early twentieth century Ghana was urbanizing faster than other countries in West Africa (Panel B, Figure 5). The 1931 Census located 34% and 10% of the population in settlements with more than 1,000 and 5,000 inhabitants respectively. We would expect an urban penalty due to the limitations in public health measures such as access to clean drinking water and health care and a functioning sewage system.⁸⁶

⁸¹ Tsey and Short, 'From Headloading to the Iron Horse'. Haines, 'Growing Incomes, Shrinking People' made a similar argument on the effect of trade on heights in the nineteenth century United States, Netherlands, and England.

⁸² Scott, *Epidemic Disease*.

⁸³ Patterson, 'Influenza Epidemic'.

⁸⁴ Jedwab and Moradi, 'Colonial Investments'. A "small" farmer had four acres, as estimated by Cardinal in Gold Coast, *Report of the Department of Agriculture*, p. 87; migrant cocoa farmers had much larger cocoa farms, see Hill, *Migrant Cocoa-Farmers*, p. 49.

⁸⁵ For data sources see notes below Figure 6.

⁸⁶ Patterson, 'Health in Urban Ghana'. The Gold Coast, *Gold Coast Report for 1929-30*, gave an infant mortality rate of 196 and under-five mortality rate of 304 in "six of the principal towns", p. 36.

Health facilities in 1900 were limited to the coast and were overwhelmingly intended for Europeans (Panel C, Figure 5). In 1930 African hospitals and dispensaries were more numerous and surprisingly equally distributed. Between 1900-04 and 1925-9 health expenditures as a percentage of total government expenditures increased from 3.2% to 6.7%.⁸⁷ Colonial authorities focused on (cheap) preventive rather than curative care. In 1930, for example, 413,745 vaccinations were performed in a population of three million.⁸⁸ Mobile dispensaries served rural areas.⁸⁹ One would expect that the spread of Western medicine – limited though it was – in an adverse health environment such as in tropical Africa should have a positive impact on height.⁹⁰

In our analysis we only include First and Second World War recruits. The regression model follows a Difference-in-Differences specification taking the following form

$$H_i = \beta_0 + \beta_1 T_i + \beta_2 X_i + \beta_3 T_i X_i + \epsilon_i \quad (1)$$

where H is the height of recruit i , T is a dummy for Second World War recruits, and X stands for an explanatory variable of interest (distance to railway, cocoa cultivation, city size, and health facilities). X is measured at the place of birth in 1930. We add controls such as ethnic group and age fixed effects. As the controls are not

⁸⁷ Kay and Hymer, *Political Economy*, p. 362, 365. Health expenditures peaked at 12% in 1930-34 and reversed to levels around 5% after the Second World War.

⁸⁸ Gold Coast, *Medical and Sanitary Department* for the year 1929/30. Cardinall, *Gold Coast*. In our sample of Second World War recruits, 10% had vaccination marks. We find a small negative correlation between vaccination marks and distance between place of birth and health facilities in the Gold Coast. No vaccinations marks were recorded in WWI recruits.

⁸⁹ The 1931 report of the Gold Coast Medical and Sanitary Department gives a detailed account of one such mobile dispensary in the Lawra-Tumu district in the very North-West of the Northern Territories, pp. 142-8. It recorded 17,253 treatments with the 1931 Census reporting a district population of 93,125. Treatments in 1900 were nil.

⁹⁰ Curtin, *Death by Migration*.

interacted with T , they are assumed as time invariant, that is, of equal size for First and Second World War recruits. The estimator is OLS because there is no visible truncation in recruits of the two world wars (Figure 3). We are careful to avoid strong causal claims. The explorative nature of this analysis is justified, because correlations can give important hints and contradict prominent but untested hypotheses.

7 Results

In the first regression, we only test for railway infrastructure. Being born in a place which became a rail station in 1930 is not significant for either First or Second World War recruits (column (1), Table 3). Interestingly, First World War recruits born within 10 km of the railway were 0.4 inches (or one centimetre) shorter. First World War recruits form our baseline and the railway was built *after* they were born. Compared to this baseline Second World War recruits born at the *same* distance were 0.3 inches taller. From this we conclude that claims of deteriorations in nutrition and health conditions along the railway are unfounded. The net effect is slightly positive.

Next we add cocoa production within 2 km and 2-5 km distance of the place of birth to the regression (column (2), Table 3). About 10% and 5% of the recruits in our world wars sample came from places where 100 tons and 200 tons respectively were produced in 1927. The equal frequencies support the view that the two samples are very much comparable. If selection effects were present, we would expect different frequencies across the samples. We find a similar pattern as for the railways. First World War recruits born at places that later adopted cocoa farming were significantly shorter. After adopting cocoa in those places heights of Second World

War recruits increased by 0.4 inches for every 100 tons of cocoa. The effect is locally limited to a 2 km radius. The railway is not significant anymore suggesting that it is cocoa production that was driving the railway effect. Because we included ethnic group fixed effects in the regression, the pattern cannot be attributed to the shorter average height of farmers of certain ethnic groups dominant in the forest zone such as Akim (0.6 inch shorter than average), Asante (-0.7 inch), and Krobo (-0.9 inch). Overall, the cash crop revolution had a significantly positive impact on height in those regions in which it took place. This is despite evidence that, in one of the oldest cocoa-growing districts of Ashanti, fertile land was scarce enough by the 1940s to induce farmers to substitute a less nutritious crop, cassava, for a more nutritious one, plantain, on the farm and in the diet (in *fufu*), because it tolerates less-fertile soils.⁹¹ Presumably, the income effect of cocoa generally outweighed the effect of this substitution.⁹²

Next we test how heights changed with urbanization (column (3), Table 3). WWI recruits born in places that were cities and towns in 1931 were taller than average.⁹³ Compared to this, the height of Second World War recruits born in those places was significantly lower. This raises the question as to whether the urban penalty already existed around 1900: 37% of places that developed into towns by 1931 had populations under 1,000 and therefore did not qualify as towns in 1901. The same is true for 71% of the cities. However, we find the same result if we use

⁹¹ Austin, *Labour, Land, and Capital*, pp. 66, 474.

⁹² The effect of the cash crop revolution outside the cocoa belt is hard to test in the regression framework, because we do not have a measure of male migrant labour to work on cocoa farms.

⁹³ The 1931 Census is known to underreport the number of inhabitants, see Kuczynski, *Demographic Survey*. We use categorical variables for places with populations of more than 1000 and 5000 inhabitants and a residual category of "rural" places. These variables are not meant to be interpreted as important thresholds; the variables give a sense of "big" and "not so big". In a regression context as in equation 1, underreporting and measurement error leads to attenuation bias working against findings.

population size of 1901 and restrict the analysis to First World War recruits. Taller individuals were apparently living in urban areas in early twentieth century; thereafter nutritional and health status of urban dwellers worsened.

We finally look at public goods (column (4), Table 3). We find the location of health facilities not significantly associated with changes in height.

The dummy for Second World War recruits is significant in all specifications. This suggests that the variables presented in Figure 5 capture geographic *inequalities*, while there is a significant increase in heights throughout, between First and Second World War recruits of about 0.6 to 1 inches.

We clustered standard errors by administrative district of 1931 to address the increased homogeneity of individuals from the same places (column (5), Table 3). We also excluded recruits born in the Northern Territories, because most of the explanatory variables relate to conditions in the South (column (6), Table 3). Results do not change. Our preferred specification is column 3, Table 3, because the model includes relatively unproblematic variables. Jedwab and Moradi, for example, showed that cocoa production was driven by railway construction, which in turn was determined by mining and factors unrelated to nutrition and health conditions in 1890.⁹⁴

8 Conclusions

We used physical stature as a measure of net nutritional status and, more broadly, as a measure of how well basic elements of the physical quality of life were met. The recruitment records of the British colonial army in the Gold Coast provided

⁹⁴ Jedwab and Moradi, 'Colonial Investments'.

us with anthropometric data for the pre-colonial and colonial era; survey data complemented this for the later periods. Thus, for the first time it was possible to draw a long run trend that includes experiences from the pre-colonial, colonial and post-independence era. Our results indicate that in Ashanti the difficult situation of the 1880s and 1890s led to decreasing heights. In the first 15 years of the twentieth century, and again between 1940 and 1970, height values in all regions of what is now Ghana improved substantially, suggesting that the rural population flourished and poverty fell significantly. In 1973-83, when Ghanaians were hit by a severe economic crisis, mean adult heights decreased.

Our results challenge the conventional wisdom that living standards did not improve significantly under colonial rule. For Ghana, it cannot be said that the colonial decades in the twentieth century were particularly bad in these terms. Quite the contrary: living standards improved dramatically in the first decade of the twentieth century when cocoa cultivation took off. Similarly, the post-First-World-War height series shows its largest increment under British rule. Taking this together, despite the absence of democracy and collective self-determination, in terms of the physical well-being of the population the record of the colonial era is better than that of the early post-independence period – though the latter saw unprecedented levels of investment in public health and education⁹⁵

That changes occurred under colonial rule does not mean that they occurred because of it. Certain colonial policies surely did contribute, directly or indirectly, to improving living standards. The abolition of slave raids (primarily pertinent to the North) and the establishment of the colonial ‘pax’ increased physical security. The

⁹⁵ Sender, ‘Africa’s Economic Performance’.

prohibition of slavery, late though it was in Ashanti and the North, was a precondition of the development of a large-scale, country-wide labour market, in which it was possible for labourers to secure their marginal product.

Arguably, however, the main agents of economic change in colonial Ghana were Africans themselves. It was cocoa growing that became the main motor of economic advance, and it was African farmers who took the economic risks of adopting a new crop, cocoa beans, which was both exotic and required several years before beginning to bear.⁹⁶ Indeed, this African risk-taking led the expansion of cash-crop cultivation to go much faster than the colonial agricultural department wanted.⁹⁷ African producers also out-competed European planters who entered the cocoa industry.⁹⁸

Our findings allow insights into the institutional argument about the determinants of economic growth. In Ghana colonial institutions certainly did not 'prevent' improvements in living standards. The recent institutionalist literature emphasises the importance of property rights and political stability as determinants of long-term economic growth. On property rights, the colonial state upheld the 'customary' indigenous distinction between ownership of the land itself and ownership of farms and buildings created upon it.⁹⁹ On political stability, at Independence in 1957 the colonial government could point to an absence of regime change at Ghana since the assembly of the composite colony. In contrast, there were

⁹⁶ Hill, *Migrant Cocoa-Farmers*.

⁹⁷ Tudhope, *Enquiry*. One academic commentator, mistaking confusion for conspiracy, went so far as to describe this episode as a colonial 'campaign' against the cocoa industry (Kay and Hymer, *Political Economy*).

⁹⁸ Austin, 'Mode'.

⁹⁹ Specifically – and despite the absence of compulsory registration of titles -- the state upheld the right of the individual who planted cocoa trees to the ownership of them, irrespective of the outcome of legal arguments about which chieftaincy owned the soil on which the cocoa trees stood. Austin, *Labour, Land, and Capital*, pp. 270-77, 339-47, 519-21, 531-3.

five military coups between 1966 and 1981 – though various arguments can be put about the contribution of colonial legacies to post-colonial instability.

Ghana was the epitome of the kind of colony where, despite conflicts of various forms, the interests of alien rulers and indigenous economic actors overlapped to an important extent.¹⁰⁰ Despite the anxieties of the agriculture department, the colonial administration stood to gain fiscally from the success of African cocoa production, just as British merchants benefitted commercially. The colonial state did not impose direct taxation until the cocoa industry was already long established.¹⁰¹

Was Ghana therefore a special case? One would expect the Ghana pattern of improving living standards to be most closely paralleled in colonies which shared the fundamental characteristic of continued African ownership of land, as in British West Africa generally, especially where direct taxation was introduced only late, as in southern Nigeria. One would least expect it in the settler economies of Africa, where widespread land alienation was originally intended to squeeze Africans out of the produce market and to force them to sell their labour to European employers.¹⁰² Yet . Moradi found an upward trend for Kenya and Cogneau and Rouanet found the same for Cote d'Ivoire between 1920 and 1980.¹⁰³ In both countries, height increases

¹⁰⁰ Austin, "Reversal of Fortune" and the Compression of History'.

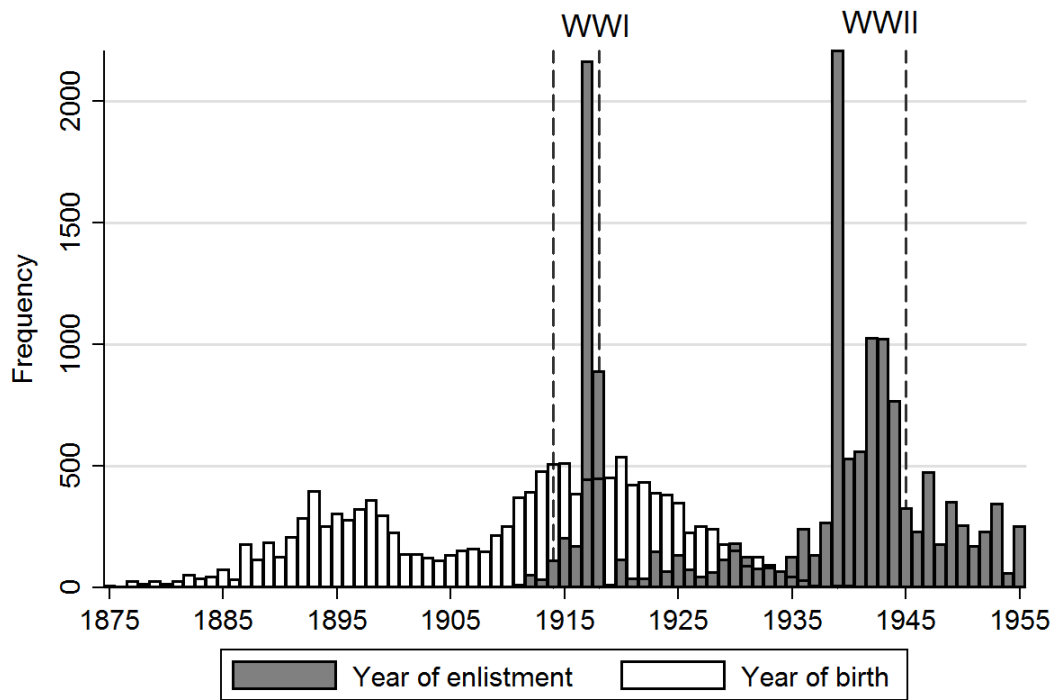
¹⁰¹ Cocoa farmers were first subject to direct taxation in implicit form, with the introduction of a state export marketing board as a wartime expedient (though this was initially intended – in 1939 – to enable the government to subsidise the producer price in case the world price collapsed). Direct taxation began in the labour-exporting region only in 1936, when Native Authorities (chieftaincies) in the Northern Territories were authorised to levy direct taxes.

¹⁰² See Mosley, *Settler Economies*. We know that African real wages tended to rise only later and more slowly in such economies than in at least the more prosperous 'peasant' (or indigenous rural-capitalist) colonies such as Ghana. Bowden, Chiripanhura, and Mosley, 'Measuring and Explaining'; Frankema and Waijenburg, 'Structural impediments'.

¹⁰³ Moradi, 'Nutrition and Health in Colonial Kenya' and Cogneau and Rouanet, 'Living Conditions' on Cote d'Ivoire. A downward trend in height in Sierra Leone is the exception so far.

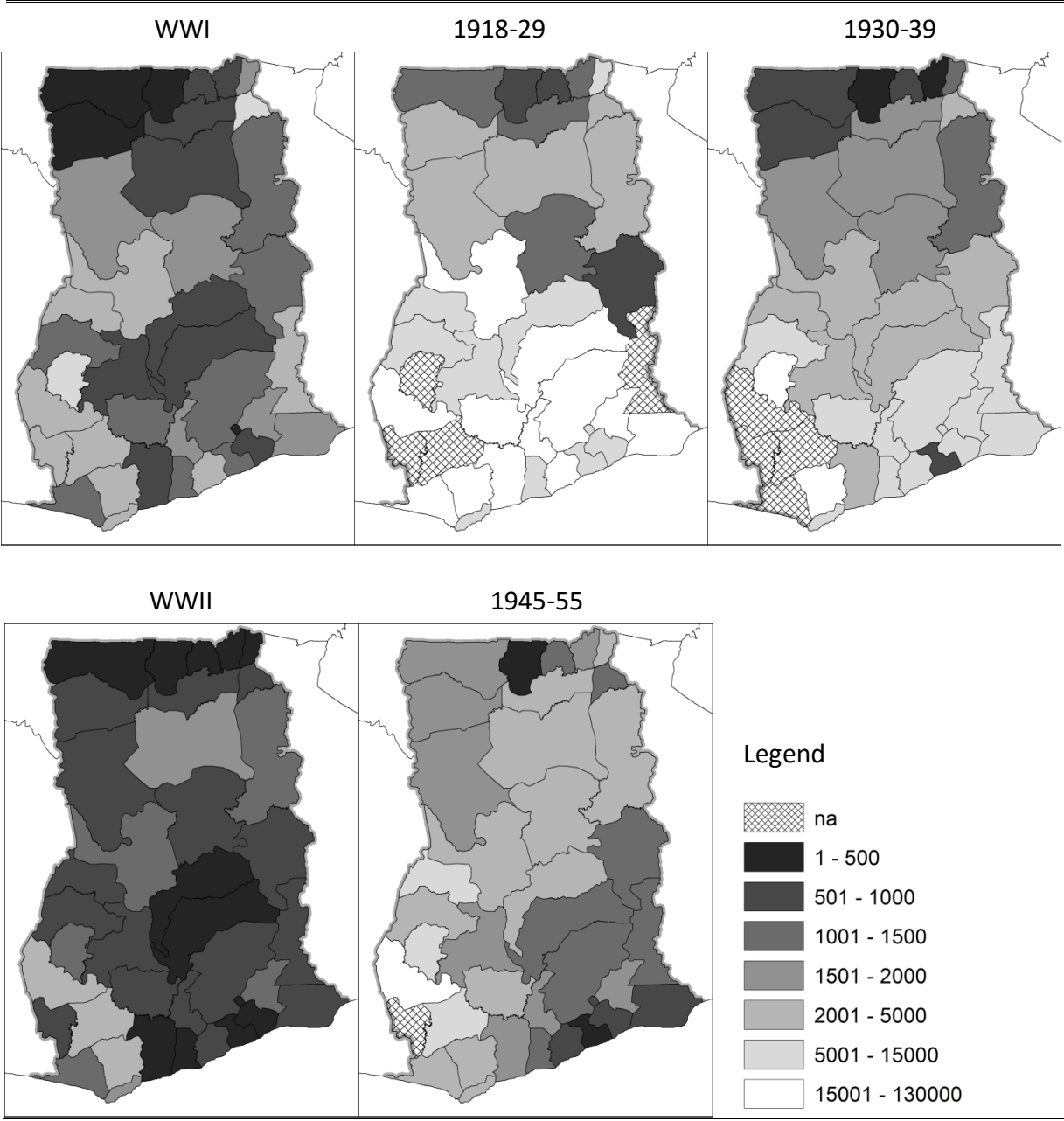
were linked to a African commodity production in the agricultural sector. Thus the issue of where to place the Ghanaian story – Ghana as a whole, and its regions – can be resolved only after further research. Clearly, though, African control of export agriculture was a key element in the Ghanaian case.

Figure 1: Year of enlistment and year of birth (Ghanaian recruits)



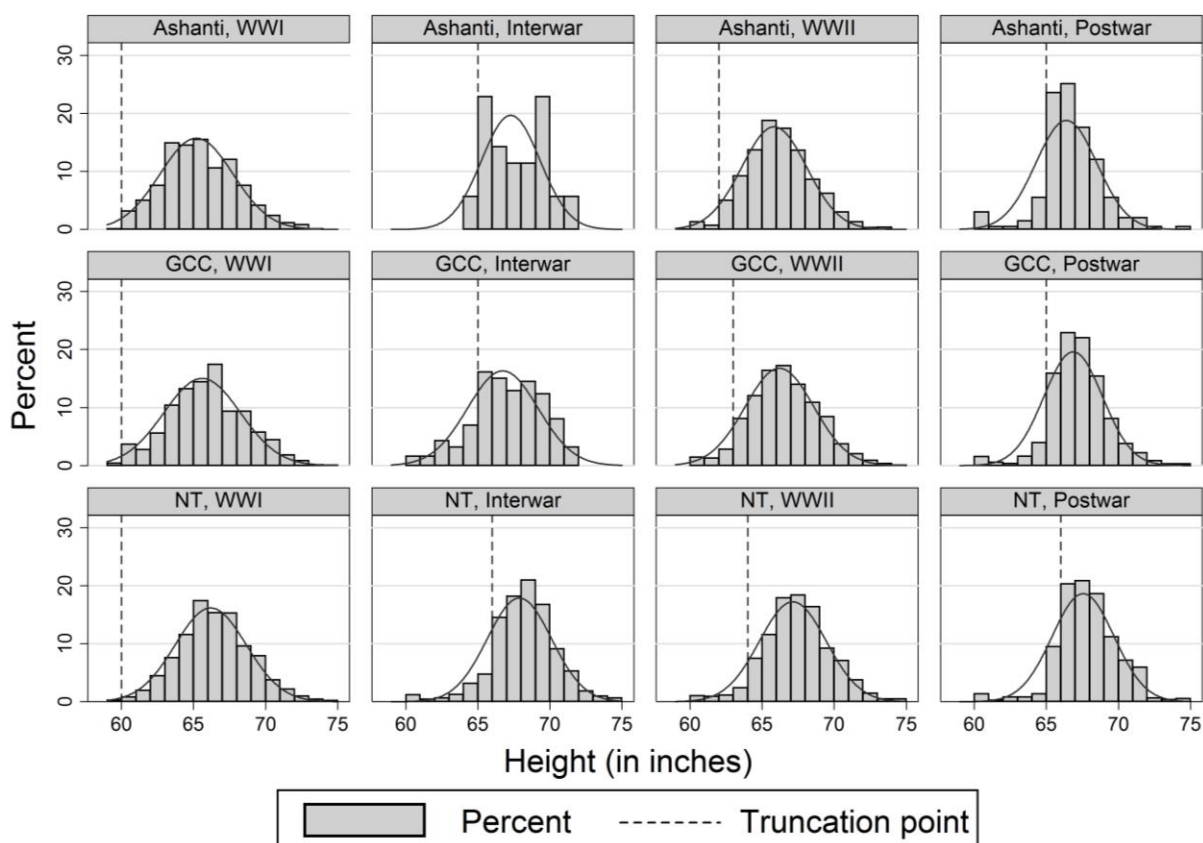
Note: $N(\text{year of enlistment}/\text{year of birth})=14,809/13,514$. Age at enlistment varied between 14 and 50 years; the vast majority 92% of recruits were aged between 18 and 30 years.

Figure 2: Ratio of total population in 1931 to the number of Ghanaian recruits enlisted in WWI, 1918-29, ... 1945-55



Note: N(WWI)=3,378; N(1918-29)=833; N(1930-39)=1,710; N(WWII)=5,910; N(1945-55)=2,523. N(Census population 1931)=3,160,376.

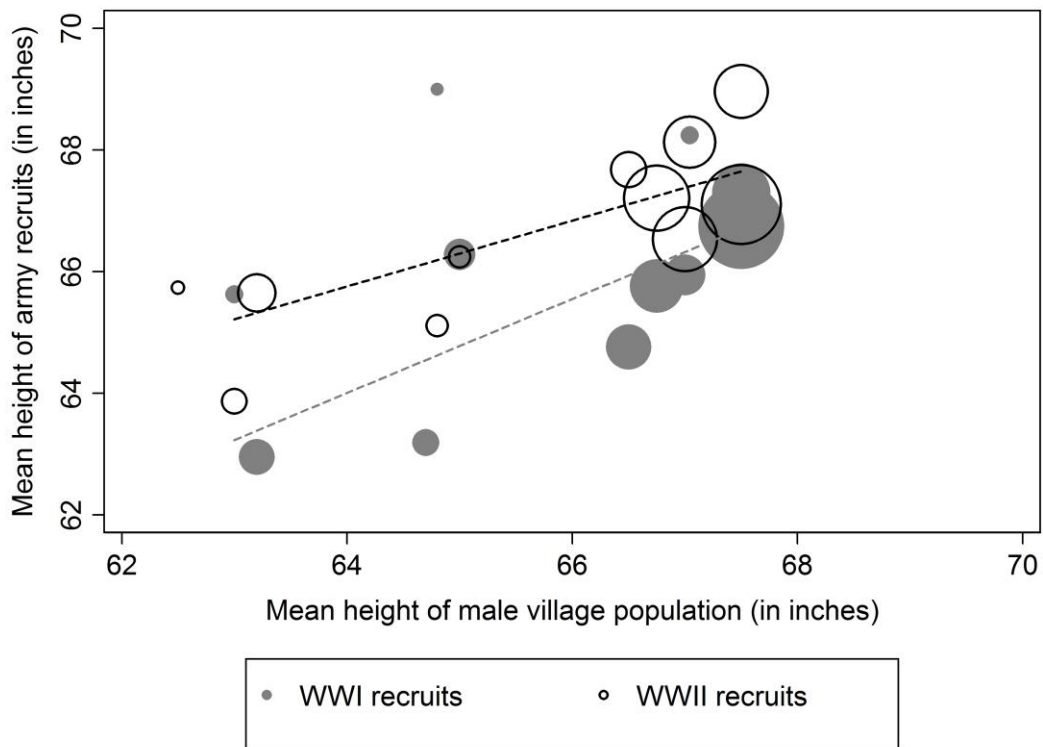
Figure 3: Height distributions by recruitment regime and region



Note: MHRs differed by ethnic group rather than birth region. Mimicking this we grouped individuals by their ethnicity, e.g. Akwapim, Fante, Ga-Adangbe were assigned to Gold Coast Colony (GCC), Builsa, Dagomba, Mamprusi, Kusasi were assigned to Northern Territories (NT). Heights lower than 59 inches are not shown (N=79).

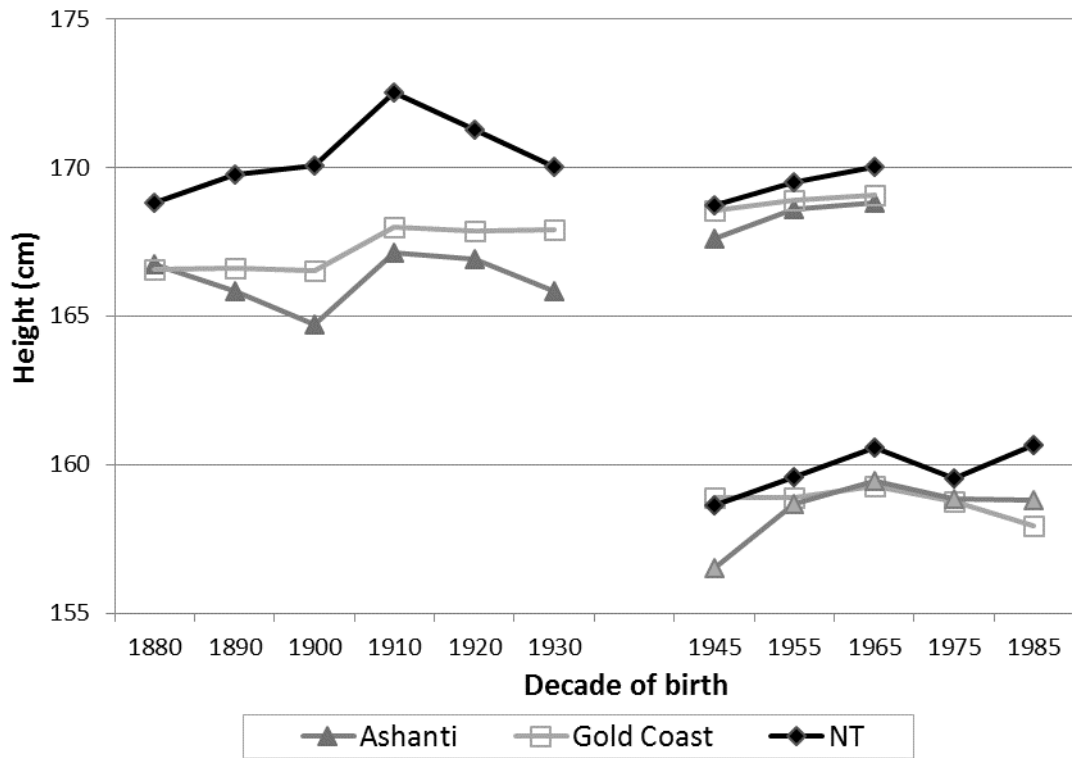
Truncation points are set as follows: 60 inches for all World War One enlistments; 64, 65 and 66 inches for Asante, GCC and NT interwar recruits respectively; 62, 63 and 64 for World War Two recruits respectively; 65 inches for Ashanti and GCC and 66 for NT post World War Two enlistments respectively.

Figure 4: Heights in 1940 survey villages and recruits born in the same villages



Note: Circles are weighted by the number of army recruits. Larger circles mean more height measurements implying a lower standard error. Surveyed 'forest villages' include Edubiase (62.5 inches), Abenasi (63), Kpandu (63), Buamang (63.2), Akokoaso (64.7); surveyed 'savanna villages' include Nakon (64.8), Tumu (65), Bongo (66.5), Tongo (66.8), Lawra (67), Chaana (67) and Sandema (67.5). N(WWI/WWII recruits)=156/155.

Figure 5: Height trends of adult men and women in Ghana, birth cohorts 1880-1985



Note: The 1880-1930 series is based on recruits of the GCR and derived from col. (4), Table 2. The 1945-1965 series was derived from the Ghana Living Standard Measurement Study surveys 1988/89 (N=2,598) (World Bank). The 1955-1985 series on the bottom right are women from the Ghana Demographic and Health Surveys 2003 and 2008 (N=8,195).

Figure 5: Railways, cocoa cultivation, cities and health ca. 1900 and 1930

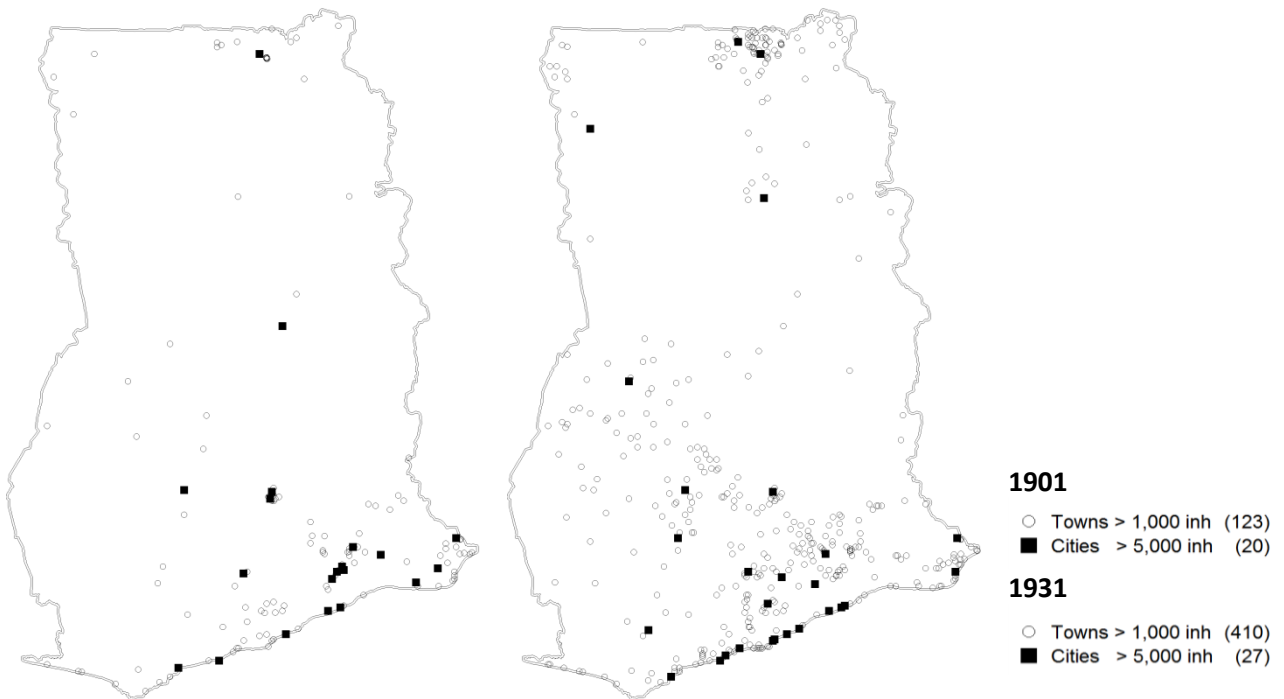
Panel A: Railways & Cocoa 1900

Railways & Cocoa 1927



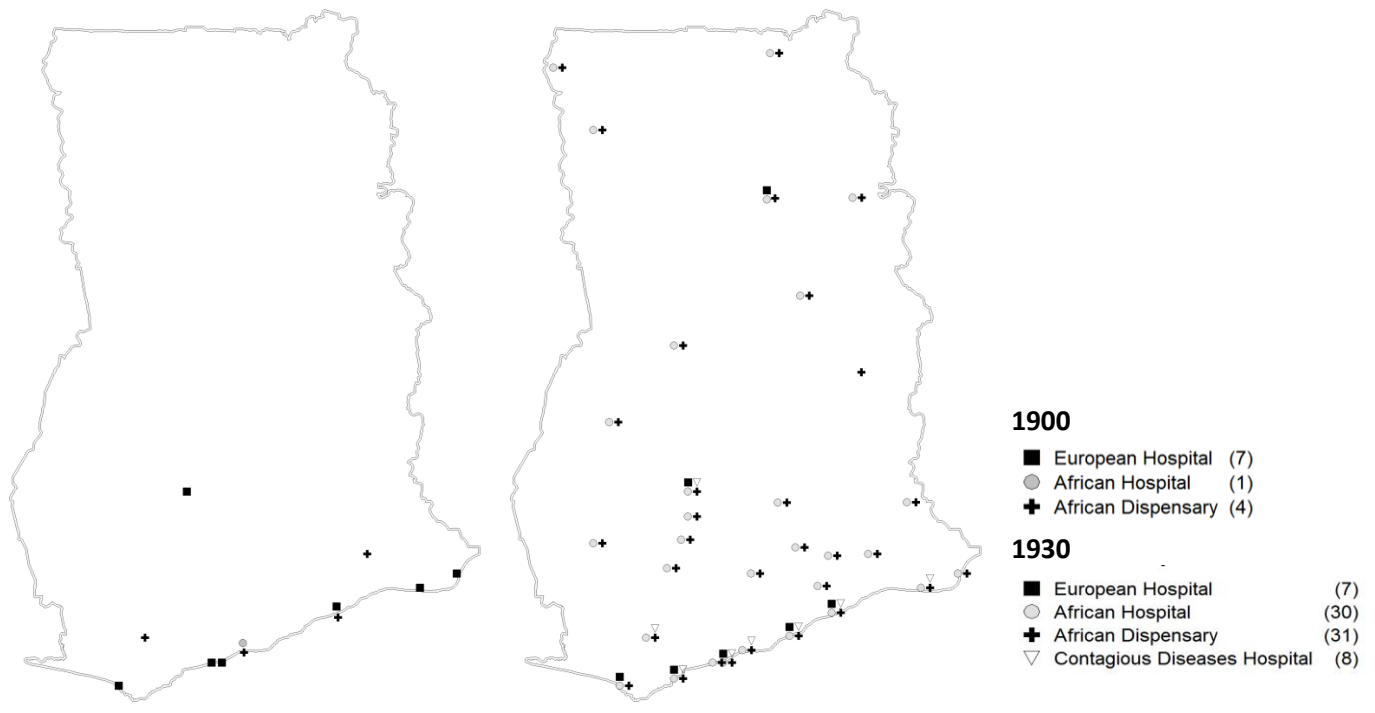
Panel B: Urbanization 1901

Urbanization 1931



Panel C: Health facilities 1902

Health facilities 1930



Notes: Present day boundaries of Ghana including the part of German Togoland which became a British mandate after WWI. Frequencies in parentheses in legend.

Sources: **Cocoa** cultivation area of 1927 from the 'Annual Report' of the Gold Coast Agricultural Department. We lack a map of cocoa cultivation in 1900 which was limited to the immediate hinterland ca. 80 km north of Accra, see Jedwab and Moradi 'Colonial Investments' for a profitability analysis. In 1900, however, cocoa exports were negligible at just 500 tons, as compared to 225,000 tons in 1927, see Gold Coast 'Blue Books'.

Population size of towns from the 1901 and 1931 Population Census of Gold Coast. No Census data exists for Togo before 1921; population data for 1901 was back-extrapolated. The data was kindly provided by Jedwab 'Why Is Africa So Urbanized?'. We labeled places with a population greater than 1000 and 5000 as towns and cities respectively.

Health centers from the 'Annual Reports' of the Gold Coast Medical and Sanitary Department for the year 1902 and 1929/30. No data for Togo in 1902.

Table 1: Occupation before joining the GCR (in %)

	Pre-WWI	WWI	1919-29	1930-39	WWII	Post-WWII
Farmer	88.0%	68.3%	76.9%	55.4%	32.2%	19.3%
Unskilled	3.0%	4.7%	13.9%	19.3%	12.5%	8.0%
Semi-skilled	1.2%	7.3%	2.8%	5.9%	25.0%	11.7%
Skilled	1.8%	12.8%	2.8%	13.6%	20.7%	30.4%
Semi-professional	6.0%	5.8%	3.1%	5.4%	9.0%	24.3%
Professional	0.0%	1.2%	0.5%	0.5%	0.7%	6.3%
N Total	167	3,292	818	1,652	5,772	2,412

Note: Classification follows Armstrong, *Nineteenth-century Society*. Unskilled occupations include carriers, herdsmen, laborer, servants, washmen, messenger, miners. Ghanaian recruits only.

Table 2: Height discontinuity with the start of wartime recruitment in August 1939

Region	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline		With controls		Excluding re-enlistments and recruits older than 25	
	GC	NT	GC	NT	GC	NT
WW2 recruitment	0.112 (0.244)	-0.657*** (-2.885)	0.110 (0.184)	-0.718*** (-2.917)	0.252 (0.257)	-0.835*** (-3.039)
Occupational class FE			Yes	Yes	Yes	Yes
Age FE			Yes	Yes	Yes	Yes
Ethnic Group FE			Yes	Yes	Yes	Yes
N(before/after Aug 39)	57/530	207/919	54/490	197/904	29/257	158/524

Notes: Sample consists of enlistments 24 months before and 12 months after August 1939. Restricted MLE estimator with σ of 6.86 cm (2.701 inches). z-statistics in parentheses. Ashanti was excluded due to a small pre-WWII sample size (N=11 only).

Table 3: Mean height and selection during World War Two

	(1)	(2)
Enlistment period	1939-41	WWII
Proportion of quota met by registrations	-0.042 (-0.66)	-0.046 (-1.15)
Proportion rejected	-1.052 (-1.43)	-1.374*** (-2.94)
Constant	67.087	66.966
N(states/heights)	50/767	56/1998

Notes: Restrict MLE estimator, z-statistics in parentheses. Gold Coast Colony only excluding Accra region and Tarkwa state.

Table 3: Trend estimates of heights (inches) in Ghana, 1885-1934

	(1)	(2)	(3)	(4)	(5)
	OLS Unadjusted	Truncated ML	Truncated ML	Weighted by ethnic group	Weighted by district of birth
Panel A: Gold Coast Colony					
Birth decade					
1885-94	-0.369 (-1.366)	-0.205 (-0.762)	-0.174 (-0.627)	0.419 (1.255)	0.031 (0.094)
1895-04	-0.218 (-0.771)	-0.302 (-1.050)	-0.320 (-1.069)	-0.112 (-0.303)	-0.014 (-0.038)
1905-14	0.382 (1.447)	0.328 (1.235)	0.235 (0.840)	0.635 (1.909)*	0.574 (1.568)
1915-24	0.374 (1.449)	0.236 (0.903)	0.164 (0.585)	0.501 (1.520)	0.520 (1.515)
1925-34	1.005 (3.748)***	0.346 (1.206)	0.148 (0.446)	0.628 (1.752)*	0.536 (1.427)
Constant	66.193	66.299	66.054	65.421	65.570
Sigma		2.445	2.415	2.447	2.545
N	5,067	4,737	4,563	4,215	4,676
Panel B: Ashanti					
Birth decade					
1885-94	0.182 (0.505)	-0.110 (-0.350)	-0.137 (-0.428)	-0.192 (-0.585)	-0.343 (-0.821)
1895-04	0.016 (0.040)	-0.293 (-0.830)	-0.435 (-1.208)	-0.500 (-1.207)	-0.796 (-1.727)*
1905-14	0.823 (2.310)**	0.453 (1.470)	0.340 (1.033)	0.334 (0.942)	0.155 (0.367)
1915-24	0.816 (2.318)**	0.428 (1.400)	0.317 (0.978)	0.444 (1.103)	0.077 (0.177)
1925-34	1.246 (3.252)***	0.207 (0.540)	-0.272 (-0.631)	-0.176 (-0.359)	-0.345 (-0.665)
Constant	65.425	65.777	65.781	65.797	65.638
Sigma		2.347	2.328	2.303	2.352
N	2207	2170	1837	1427	1427
Panel C: Northern Territories					
Birth decade					
1885-94	-0.190 (-0.690)	-0.408 (-1.601)	-0.270 (-0.987)	0.315 (0.877)	0.371 (0.825)
1895-04	-0.039 (-0.144)	-0.353 (-1.370)	-0.284 (-1.028)	0.588 (1.663)*	0.490 (1.133)
1905-14	0.924 (3.417)***	0.631 (2.535)**	0.597 (2.196)**	1.455 (4.176)***	1.469 (3.475)***
1915-24	0.330 (1.212)	0.138 (0.546)	0.405 (1.482)	0.910 (2.586)***	0.975 (2.268)**
1925-34	0.720 (2.576)**	0.097 (0.343)	0.370 (1.016)	1.257 (3.607)***	0.473 (1.076)
Constant	67.079	67.306	67.029	66.446	66.458
Sigma		2.395	2.265	2.318	2.380
N	6,886	6,459	6,250	5,744	4,437
Controls (Panel A-C)					

Age FE	Yes	Yes	Yes	Yes	Yes
Former occupation FE			Yes	Yes	Yes
Recruitment regimes FE			Yes		

Note: The dependent variable is height in inches. One inch is 2.54 cm. Reference category is a farmer, 23-50 year old, Robust t-statistics in parentheses.

Table 4: Covariates of changes in heights in Ghana, 1890 and 1930

	(1)	(2)	(3)	(4)	(5)
Infrastructure					
Railway station 1930	0.274 (1.173)	-0.023 (-0.092)	-0.445* (-1.664)	-0.326 (-1.170)	-0.326 (-1.161)
*WWII	-0.222 (-0.843)	0.143 (0.511)	0.386 (1.284)	0.278 (0.881)	0.278 (0.965)
Distance to nearest railway station 1930<10km	-0.391** (-2.102)	-0.085 (-0.419)	-0.032 (-0.158)	-0.133 (-0.598)	-0.133 (-0.840)
*WWII	0.302 (1.494)	-0.049 (-0.218)	-0.088 (-0.388)	0.006 (0.026)	0.006 (0.032)
Cocoa production					
Cocoa production in 2km radius 1927 (in 100 tons)		-0.298** (-2.435)	-0.292** (-2.376)	-0.270** (-2.179)	-0.270** (-2.538)
*WWII		0.408*** (3.000)	0.407*** (2.981)	0.413*** (2.990)	0.413*** (3.456)
Cocoa production in 2-5km radius 1927 (in 100 tons)		-0.037 (-1.605)	-0.031 (-1.338)	-0.048* (-1.958)	-0.048** (-2.295)
*WWII		0.016 (0.643)	0.014 (0.563)	0.032 (1.163)	0.032 (1.414)
Urbanization					
City in 1930 (>5,000 inh=1)			0.788*** (4.981)	0.348 (1.606)	0.348 (1.458)
*WWII			-0.367** (-1.976)	0.142 (0.552)	0.142 (0.716)
Town in 1930 (1,000-5,000 inh=1)			0.213** (2.034)	0.157 (1.455)	0.157 (1.138)
*WWII			-0.113 (-0.905)	-0.041 (-0.317)	-0.041 (-0.239)
Health facilities					
Health facility in 1930<10km				0.160 (1.097)	0.160 (0.817)
*WWII				-0.114 (-0.656)	-0.114 (-0.521)
Churches					
Church in 1930				0.044** (2.076)	0.044** (2.381)
WWII				-0.038 (-1.640)	-0.038 (-1.930)
Recruit is Christian (1=yes)				0.272* (1.808)	0.272 (1.229)
*WWII				-0.455*** (-2.818)	-0.455* (-2.004)
WWII recruit (1=yes)	0.733*** (11.273)	0.646*** (9.306)	0.744*** (7.721)	0.915*** (8.929)	0.915*** (8.196)
Age FE	Yes	Yes	Yes	Yes	Yes
Ethnic Group FE	Yes	Yes	Yes	Yes	Yes
Clustered Standard errors					Yes

N	8,909	8,909	8,909	8,469	8,469
---	-------	-------	-------	-------	-------

Note: Difference-in-Differences specification. Interactions with the “WWII” dummy represent the difference between First World War and Second World War recruits. All regressions include a constant. Ghanaian recruits only. Standard errors clustered by administrative districts 1931 (N=31); t-statistics in parentheses.

References

- A'Hearn, B. 'A Restricted Maximum Likelihood Estimator for Truncated Height Samples', *Economics & Human Biology* 2, no. 1 (2004), pp. 5-19.
- Abdulai, A. 'International Migration and Agricultural Development in Ghana', *Scandinavian Journal of Development Alternatives* 18, no. 1 (1999), pp. 61-74.
- Acemoglu, D., Johnson, S. and Robinson, J. A. 'Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution', *Quarterly Journal Of Economics* 117, no. 4 (2002), pp. 1231-1294.
- Addae, S. K., *History of Western Medicine in Ghana 1880-1960* (Edinburgh, 1997).
- Akresh, R., Bhalotra, S. R., Leone, M. and Osili, U. O. O. 'War and Stature: Growing up During the Nigerian Civil War', *American Economic Review (Papers & Proceedings)* (2012).
- Akurang-Parry, K. O. 'African Agency and Cultural Initiatives in the British Imperial Military and Labor Recruitment Drives in the Gold Coast (Colonial Ghana) During the First World War', *African Identities* 4, no. 2 (2006), pp. 213-234.
- Allman, J. M. and Parker, J., *Tongnaab: The History of a West African God* (Bloomington, Ind., 2005).
- Amin, S., *Modern Migrations in West Africa*. Edited by S. Amin (London, 1974).
- Armstrong, W. A. 'The Use of Information About Occupation', in E. A. Wrigley ed., *Nineteenth-Century Society: Essays in the Use of Quantitative Methods for the Study of Social Data*, (Cambridge, 1972), pp. 191-310.
- Austin, G. 'Mode of Production or Mode of Cultivation: Explaining the Failure of European Cocoa Planters in Competition with African Farmers in Colonial Ghana', in W. G. Clarence-Smith ed., *Cocoa Pioneer Fronts: The Role of Smallholders, Planters and Merchants*, (Basingstoke, 1996), pp. 154-175.
- . 'No Elders Were Present': Commoners and Private Ownership in Asante, 1807-96', *Journal of African History* 37, no. 1 (1996), pp. 1-30.
- . 'African Rural Capitalism, Cocoa Farming and Economic Growth in Colonial Ghana', in T. Falola ed., *Ghana in Africa and the World : Essays in Honor of Adu Boahen*, (Trenton, NJ, 2003), pp. 437-453.
- , *Labour, Land, and Capital in Ghana: From Slavery to Free Labour in Asante, 1807-1956*, *Rochester Studies in African History and the Diaspora*, [V. 18] (Rochester, NY, 2005).
- . 'The Political Economy of the Natural Environment in West African History: Asante and Its Savanna Neighbors in the Nineteenth and Twentieth Centuries', in R. Kuba and C. Lentz eds., *Land and the Politics of Belonging in West Africa*, (Leiden, 2006), pp. 187-212.
- . 'Labour and Land in Ghana, 1879-1939: A Shifting Ratio and an Institutional Revolution', *Australian Economic History Review* 47, no. 1 (2007), pp. 95-120.
- . 'The 'Reversal of Fortune' Thesis and the Compression of History: Perspectives from African and Comparative Economic History', *Journal of International Development* 20 (2008), pp. 996-1027.
- Austin, G., Baten, J. and van Leeuwen, B. 'The Biological Standard of Living in Early Nineteenth-Century West Africa: New Anthropometric Evidence for Northern Ghana and Burkina Faso', *Economic History Review* 65, no. 4 (2012), pp. 1280-1302.

- Baten, J. 'Height and Real Wages: An International Comparison', *Jahrbuch für Wirtschaftsgeschichte* 2000-1 (2000), pp. 17-32.
- Billewicz, W. Z. and McGregor, I. A. 'A Birth-to-Maturity Longitudinal Study of Heights and Weights in Two West African (Gambian) Villages 1951-1975', *Annals of Human Biology* 9, no. 4 (1982), pp. 309-320.
- Bodenhorn, H., Guinnane, T. W. and Mroz, T. A. 'Sample-Selection Bias in the Historical Heights Literature', *Working Paper* (2012).
- Bogin, B., *Patterns of Human Growth, Cambridge Studies in Biological and Evolutionary Anthropology*; 23. (Cambridge, 2nd edn, 1999).
- Bossuroy, T. and Cogneau, D. 'Social Mobility in Five African Countries', *Review of Income and Wealth* (forthcoming).
- Bowden, S., Chiripanhura, B. and Mosley, P. 'Measuring and Explaining Poverty in Six African Countries: A Long-Period Approach', *Journal of International Development* 20 (2008), pp. 1049–1079.
- Bowdich, T. E., *Mission from Cape Coast Castle to Ashantee* (London, 1819).
- Cardinall, A. W., *The Gold Coast, 1931: A Review of Conditions in the Gold Coast in 1931 as Compared with Those of 1921, Based on Figures and Facts Collected by the Chief Census Officer of 1931* (Government Printer, 1932).
- Cogneau, D. and Rouanet, L. 'Living Conditions in Côte d'Ivoire and Ghana 1925-1985: What Do Survey Data on Height Stature Tell Us?', *Economic History of Developing Regions* 26, no. 2 (2011), pp. 55-82.
- Curtin, P. D., *Death by Migration: Europe's Encounter with the Tropical World in the Nineteenth Century* (Cambridge, 1989).
- Deshler, W. 'Cattle in Africa: Distribution, Types and Problems', *Geographical Review* 53, no. 1 (1963), pp. 52-58.
- Destombes, J. 'From Long-Term Patterns of Seasonal Hunger to Changing Experiences of Everyday Poverty: Northeastern Ghana C. 1930-2000', *Journal of African History* 47, no. 2 (2006), pp. 181-205.
- Eveleth, P. B. and Tanner, J. M., *Worldwide Variation in Human Growth* (Cambridge, 2nd edn, 1990).
- Fiawoo, D. K. 'Physical Growth and the School Environment: A West African Example', in W. A. Stini ed., *Physiological and Morphological Adaptation and Evolution*, (The Hague, 1979), pp. 301-314.
- Frankema, E. and Waijenburg, M. v. 'Structural Impediments to African Growth? New Evidence from Real Wages in British Africa, 1880-1965', *Working Papers 0024, Utrecht University, Centre for Global Economic History* (2011).
- Gifford, P. and Weiskel, T. C. 'African Education in a Colonial Context: French and British Styles', in P. Gifford and W. R. Louis eds., *France and Britain in Africa: Imperial Rivalry and Colonial Rule*, (New Haven, 1971), pp. 663-711.
- Gillespie, W. H., *The Gold Coast Police 1844-1938* (Accra, 1955).
- Gold Coast, *Annual Report on Ashanti for 1907-8* (Accra, 1908).
- , *Annual Report of the Department of Agriculture* (Accra, 1928).
- , *Gold Coast Report for 1929-30, Colonial Reports Annual* (London, 1930).
- , *Report on the Medical and Sanitary Department* (Accra, various years).
- Great Britain, *Annual Report on the Social and Economic Progress of the People of the Gold Coast, 1935-1936* (London, 1936).

- Grier, B. 'Underdevelopment, Modes of Production, and the State in Colonial Ghana', *African Studies Review* 24, no. 1 (1981), pp. 21-47.
- Gunnarsson, C., *The Gold Coast Cocoa Industry 1900-1939: Production, Prices and Structural Change* (Lund, 1978).
- Habicht, J.-P., Yarbrough, C., Martorell, R., Malina, R. M. and Klein, R. E. 'Height and Weight Standards for Preschool Children: How Relevant Are Ethnic Differences?', *Lancet* 303, no. 7858 (1974), pp. 611-615.
- Haines, M. R. 'Growing Incomes, Shrinking People - Can Economic Development Be Hazardous to Your Health? Historical Evidence for the United States, England, and the Netherlands in the Nineteenth Century ', *Social Science History* 28, no. 2 (2004), pp. 249-270.
- Hauspie, R. C., Das, S. R., Preece, M. A. and Tanner, J. M. 'A Longitudinal Study of the Growth in Height of Boys and Girls of West Bengal (India) Aged Six Months to 20 Years', *Annals of Human Biology* 7, no. 5 (1980), pp. 429-441.
- Hill, P., *The Migrant Cocoa-Farmers of Southern Ghana: A Study in Rural Capitalism* (Cambridge, 1963).
- Hopkins, A. G., *An Economic History of West Africa* (London, 1973).
- Howard-Hassmann, R. E., *Colonialism and Underdevelopment in Ghana* (London, 1978).
- Hunter, J. M. 'Geographical Patterns of Guinea Worm Infestation in Ghana: An Historical Contribution', *Social Science & Medicine* 44, no. 1 (1997), pp. 103-122.
- Jacobs, J., Katur, T. and Tassenaar, V. 'On the Efficiency of Estimators in Truncated Height Samples', *Mimeo* (2004).
- Jedwab, R. 'Why Is Africa So Urbanized? Evidence from Resource Exports in Ghana and Ivory Coast', *Unpublished manuscript, Department of Economics, Paris School of Economics and London School of Economics* (2011).
- Jedwab, R. and Moradi, A. 'Transportation Technology and Economic Change: The Impact of Colonial Railroads on City Growth in Africa', *Working Paper* (2013).
- Jerven, M. 'Future Challenges in Measuring Africa's Past: Lessons from Estimating GDP for the Gold Coast, 1891-1954', *AEHN Working Paper No. 3/2012* (2012).
- Kay, G. and Hymer, S., *The Political Economy of Colonialism in Ghana : A Collection of Documents and Statistics, 1900-1960* (Cambridge, 1972).
- Killingray, D. 'The Colonial Army in the Gold Coast: Official Policy and Local Response 1890-1947', University of London, 1982).
- Komlos, J. 'How to (and How Not to) Analyze Deficient Height Samples: An Introduction', *Historical Methods* 37, no. 4 (2004), pp. 160-173.
- Kuczmariski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., Wie, R., Curtin, L. R., Roche, A. F. and Johnson, C. L. '2000 CDC Growth Charts for the United States: Methods and Development', *Vital and Health Statistics* 11, no. 246 (2002), pp. 1-190.
- Kuczynski, R. R., *Demographic Survey of the British Colonial Empire*. Edited by R. R. Kuczynski. Vol. 1. West Africa, *Demographic Survey of the British Colonial Empire* (London, 1948).
- Lee, D. S. and Lemieux, T. 'Regression Discontinuity Designs in Economics', *Journal of Economic Literature* 48, no. 2 (2010), pp. 281-355.

- Maddison, A. 2010. Historical Statistics of the World Economy: 1-2008 AD. In, <http://www.ggdc.net/maddison/>. (accessed 6 Nov, 2012).
- Martorell, R. and Habicht, J.-P. 'Growth in Early Childhood in Developing Countries', in F. Falkner and J. M. Tanner eds., *Human Growth: A Comprehensive Treatise*, (New York, 1986), pp. 241-262.
- McCaskie, T. C., *State and Society in Pre-Colonial Asante, African Studies Series ; 79* (Cambridge, 1995).
- Meillassoux, C. 'From Reproduction to Production: A Marxist Approach to Economic Anthropology', *Economy and Society* 1, no. 1 (1972), pp. 93-105.
- Moradi, A. 'Towards an Objective Account of Nutrition and Health in Colonial Kenya: A Study of Stature in African Army Recruits and Civilians, 1880-1980', *Journal of Economic History* 69, no. 3 (2009), pp. 720-755.
- . 'Nutritional Status and Economic Development in sub-Saharan Africa, 1950-1980', *Economics & Human Biology* 8, no. 1 (2010), pp. 16-29.
- . 'Selective Mortality or Growth after Childhood? What Really Is Key to Understand the Puzzlingly Tall Adult Heights in sub-Saharan Africa', *CSAE Working Paper 2010-17* (2010).
- Moradi, A. and Baten, J. 'Inequality in sub-Saharan Africa: New Data and New Insights from Anthropometric Estimates', *World Development* 33, no. 8 (2005), pp. 1233-1265.
- Mosley, P., *The Settler Economies: Studies in the Economic History of Kenya and Southern Rhodesia 1900-1963* (Cambridge, 1983).
- Patterson, K. D. 'Health in Urban Ghana: The Case of Accra 1900-1940', *Social Science & Medicine. Part B: Medical Anthropology* 13, no. 4 (1979), pp. 251-268.
- . 'The Veterinary Department and the Animal Industry in the Gold Coast, 1909-1955', *International Journal of African Historical Studies* 13, no. 3 (1980), pp. 457-491.
- . 'The Influenza Epidemic of 1918-19 in the Gold Coast', *Journal of African History* 24, no. 4 (1983), pp. 485-502.
- Purcell, F. M. 'Final Report on Nutrition Surveys in the Gold Coast 1940', in, 1940).
- Rouch, J. 'Migrations au Ghana', *Journal de la Société des Africanistes* 24 (1957), pp. 33-196.
- Scott, D., *Epidemic Disease in Ghana, 1901-1960, Oxford Medical Publications* (London, 1965).
- Sender, J. 'Africa's Economic Performance: Limitations of the Current Consensus', *Journal of Economic Perspectives* 13, no. 3 (1999), pp. 89-114.
- Steckel, R. H. 'Stature and the Standard of Living', *Journal of Economic Literature* 33, no. 4 (1995), pp. 1903-1940.
- . 'Heights and Human Welfare: Recent Developments and New Directions', *Explorations in Economic History* 46, no. 1 (2009), pp. 1-23.
- Szerezewski, R., *Structural Changes in the Economy of Ghana, 1891-1911* (London, 1965).
- Teal, F. 'Export Growth and Trade Policy in Ghana in the Twentieth Century', *World Economy* 25, no. 9 (2002), pp. 1319-1337.
- Tsey, K. and Short, S. D. 'From Headloading to the Iron Horse: The Unequal Health Consequences of Railway Construction and Expansion in the Gold Coast, 1898-1929', *Social Science & Medicine* 40, no. 5 (1995), pp. 613-621.

- Tudhope, W., *Enquiry into the Gold Coast Cocoa Industry: Interim Report and Final Report* (Accra, 1919).
- Van Hear, N. 'Northern Labour and the Development of Capitalist Agriculture in Ghana', University of Birmingham, 1982).
- Wilks, I., *Asante in the Nineteenth Century: The Structure and Evolution of a Political Order, African Studies Series ; 13* (Cambridge, 1st paperback edn, 1989).
- World Bank. Living Standard Measurement Study. In, <http://www.worldbank.org/lsms/>. (accessed May, 2006).