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BIOLOGICAL WELL-BEING IN LATE 19TH CENTURY PHILIPPINES

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ABSTRACT

This paper investigates the biological standard of living toward the end of Spanish rule. We investigate levels, trends, and determinants of physical stature from the birth cohorts of the 1860s to the 1890s using data on 23,000 Filipino soldiers enlisted by the U.S. military between 1901 and 1913. We use truncated regression technique for estimating average height and use province level information for investigating the determinants of biological wellbeing. The results indicate a decline of more than 1.5 cm cm (0.6 inches) in the height of soldiers born between the early 1870s and the late 1880s. The decline in heights at the end of the 19th century occurred at a time when there was an expansion of commercial activity in cash crop production for export. Heights did not regain the level of the 1870s until the late 1930s and early 1940s. We also find that at 159.3 cm (62.7 inches), the average height of soldiers born in the mid-1870s was very short even for the time. The low biological standard of living in late 19th century was not due to the tropical disease environment alone since taller men were found in the same period in other parts of Asia.

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Biological wellbeing in late 19th century Philippines

Introduction

Living standards in the Philippines in the 19th century are poorly documented although we do know that the transition from Spanish to US colonial rule in 1896-1902 must have been chaotic. it is also well established that during the following three decades economic conditions improved. This paper investigates the biological standard of living at the end of Spanish rule about which there is not much extant evidence.

Information recorded by the US colonial administration indicates that per capita output increased rapidly in agriculture, mining, and manufacturing between 1902 and the late 1920s in a context of steady population growth.[1] According to Maddison (2001, 2010), per capita GDP rose from 673 to 1,403 international USD between 1902 and 1929.[2] The colonial literature of the early 20th century also emphasizes the positive influence of US rule on the functioning of economic institutions (Go 2000, 2007) and the massive public investment in health and education by the new US colonial authorities in the first decades of the 20th century (Alzona 1932, Planta 2008).[3] However, since living standards in 19th century Philippines are poorly documented, it is possible that the steady economic growth of the period 1902-1929 was, to some extent, a recovery after a dramatic collapse at the turn of the century during the chaotic transition from Spanish to US colonial rule, in 1896-1902.

Available information on economic conditions under Spanish rule (e.g. Doeppers 1974; Fenner 1985) indicates that a commercial expansion took place in the last decades of the 19th century, mostly driven by a rising demand for local cash crops.[4] This raises the possibility that the nationalist uprising of 1896 that resulted in the formation of an independent polity controlling most of the country in 1898 (Deady 2005) was not primarily motivated by economic hardship although we know next to nothing about trends in the distribution of income in this period. However, as in the rest of Southeast Asia, major part of the import-competing cottage industry collapsed during the same period, particularly the traditional textile industry (Resnick 1970; Owen 1998; Bassino and Williamson 2015). There were, therefore, winners and losers, with new opportunities in agriculture and in the

[1] Census of the Philippines Islands (various years).
[2] In international US dollars of 1990.
[3] By 1920, mean primary enrolment rates in the Philippines were the highest in Southeast Asia, and catching up with the Japanese levels in the late 1930s (Easterlin 1981; Benavot and Riddle 1988). Using numeracy estimates, Freisen, Baten and Crayon (2012) also find that rapid improvements took place in the first three decades of the 2th century, and that this was associated with a drastic reduction of gender inequality in numeracy.
[4] In particular abaca, sugar, and tobacco, exported to European and North American markets.

commodity-processing industry which mitigated at least to some extent the loss of income resulting for the decline of the traditional textile industry. The dysfunctional character of the Spanish colonial administration, in particular the high degree of corruption (Huetz de Lemps 2006) no doubt contributed to resentment against Spanish rule.

Most of the historiography dealing with socioeconomic condition in late 19th century Philippines is focused on social elites (Cullinane 1982; Fenner 1985; McCoy 1994) or on ethnic Chinese migrants (Wickberg 1964, 1965; Doeppers 1986). Little information is available on the living standards of ordinary Filipinos, except a few studies in historical demography (Smith and Ng 1982; Doeppers and Xenos 1998; Gealogo 2011). The discovery of height data on Filipinos enlisted by the U.S. military between 1901 and 1913 enables us to document levels, trends, and determinants of height, one of the most commonly used measures of biological well-being. The data set includes information for around 23,000 soldiers born in the last four decades of the 19th century. We also use province level information to investigate the determinants of biological well-being.

I. Population growth, commercial expansion, and human capital in late 19th century Philippines

This section relies of national and provincial level population, international trade, agricultural output, and literacy data for a preliminary assessment of long-term trends and regional differences in living standards in 19th century Philippines.

Population density population was extremely low in most of the country, 10 people per km^2 on average around 1850[5] According to the country-level series reported by Maddison (2010), population growth accelerated after 1850. The result was an increase from around 3.6 to 6.4 millions between 1850 and 1890 (Table 1), with a rise in population density from 10.6 to 18.9 persons per km^2 during the same period. The Philippines experienced a demographic growth comparable to that of Indonesia and much higher than in Thailand. The compound population growth rates in the Philippines were 1.7% and 1.2% per year in the periods 1850-1870 and 1870-1890, respectively. Population density almost doubled between 1850 and 1890.

[5] Information reported by Reid (1988; 14) indicates that, circa 1800, population density was below 10 habitants per km^2 in Luzon (the largest northern island) and the Visayas (the central part of the archipelago), and around 2 in Mindanao. The density was also low in most parts of Southeast Asian; the major exceptions were the islands of Java and Bali (38 and 93 per km^2, respectively) and the area of the Red River delta (27 per km^2 on average for northern and central Vietnam). The population estimates reported by Reid indicate that the Philippines had the highest demographic growth between circa 1600 and 1800, on average 0.4% per annum in Luzon and the Visayas, while it was around 0.2% in most other regions and for Southeast Asia as a whole (but only 0.1% in Java and Cambodia, and nil in Laos and Northeast Thailand).

The temporary slowdown experienced between 1890 and 1910, with a compound growth rate of 1.25% per year, seems mostly attributable to war of independence in 1896-1898 and the insurgency again US military occupation between 1898 and 1902 (and to a lesser degree between 1902 and 1913). According to De Bevoise (1995: 13), excess wartime excess mortality in 1899-1903, mostly due to diseases, was "about 755,000 over the number than would have died has no war taken place". He also noted that "(N)o direct statistics exist but a statistical profile of the population in 1918 reveals a deficit of at least 400,000 persons who should have been in the cohort of those born between 1904-1908" (ibid.).[6]

Table 1 around here

The steady demographic growth of the 19th century took place in a context of rapid expansion of in cash crop production, particularly during the last decades of Spanish rule. The specialization of the economy during the second half of the 19th century can be documented using yearly series of international trade for abaca, sugar, and rice. Figure 1 presents export volumes of abaca and sugar, and import volumes of rice relative to total population.

The extent to which an environmental transformation driven by agricultural land reclamation took place in the 19th century the Philippines is poorly documented. Although national average population density was still low at the turn of the 20th century in comparison with the level reached in the mid-20th century, it was not evenly distributed, as evidenced on the map reporting provincial average density in 1903 (Figure 2). A striking contrast is observed between the western and south-eastern parts of the northern island of Luzon and the Visayas (central part of the archipelago)[7] where population density was generally in a range between 50 and 100 inhabitant per square km[8], and the rest of the country where is was well lower, particularly in the large southern island of Mindanao.

Figures 1 and 2 around here

Clusters of relatively high density are clearly shown in the map to be related to the production of cash crops: mainly abaca in the southeast of Luzon (Bicol peninsula), sugar in central Luzon and in the central Visayas, and sugar also but increasingly tobacco in the northwest coast of Luzon. However, overall, considering that ecological conditions were almost as favorable for agriculture in some of the low-density provinces than in those with

[6] Demographic growth accelerated further after 1930, with a compound rate of 2.7 in 1930-1950 and 1950-2000. Section 3 provides additional information regarding the military operations during the period 1896-1902.

[7] Luzon is the main northern island. The major islands of the Visayas are Bohol, Cebu, Leyte, Negros, Panay (provinces of Antique, Capiz, and Iloilo), and Samar; see list of early 20th century provinces on figure 2.

[8] The only exceptions were the province of Ilocos Sur, on the northwestern coast of Luzon, and the island of Cebu in central Philippines, with average density of 150 and 130 inhabitants per square km, respectively.

high density, land was abundant in the Philippines in comparison with Japan, Korea, and Taiwan, and remained so until the 1960s (Kikuchi and Hayami 1978).

Birth and mortality rates assessed at the local level using baptism and burial data (e.g. Smith and Ng 1982) are consistent with the figures calculated by Spanish colonial authorities in 1876 and 1885 for the entire population, and in 1886-1897 for certain areas accounting for 45 to 86% of total population.[9] Birth rates were at around 3 to 4% per year and mortality rates at around 2%.[10] The figures are also consistent with mortality rates recorded at the provincial level by the newly established American colonial administration during the 1903 census.

Indicators of morbidity and mortality are particularly relevant because infant mortality is highly correlated with height, and exposure to diseases plays an important role as determinant of adult stature (Eveleth and Tanner 1990; Steckel 1995, 2009). Infant mortality rates in a range between 10% and 60% are observed at the district level (48 provinces or *comandancias* in 1903) with an mean around 30% and a large spatial dispersion (the coefficient of variation (CV) is 0.5). A similar level of regional dispersion is observed for mortality between age 1 and 5.[11] The dispersion is even higher for morbidity rates (CV of 0.78, 0.68, 0.65, 0.54 for cholera, dysentery, malaria, and tuberculosis, respectively).[12]

The data set collected by the Philippines Commission in 1903 enables us to estimate provincial level averages of land to man and livestock to man ratios, yield and output volume per head for the main cash crops (sugar and abaca) and rice, concentration of land ownership, and natural capital stock per head (proxied by forest area per head).[13] To the best of our knowledge, information for the Spanish is unavailable at the provincial level; it is unlikely that these figures changed drastically during the transitions from Spanish to US rule. For all these indicators, a high degree of regional dispersion is observed. For instance, in the case of sugar production, land productivity that was particularly high in a number of provinces with the highest population density. These high levels of land productivity do not seem related to regional differences in mortality, morbidity, primary school enrolments, or literacy. We also notice that the overall level of literacy at the national level was above 30% for males and 10%

[9] Philippines Commission (1905), Census of the Philippines Islands taken under the direction of the Philippines Commission in the year 1903, Volume III, Mortality, Defective Classes, Education, Families, p. 11.
[10] Ibid, pp. 12-16.
[11] Ibid. Table 11, pp. 276-383.
[12] Ibid. Table 5, pp. 139-155.
[13] Philippines Commission (1905), Census of the Philippines Islands taken under the direction of the Philippines Commission in the year 1903, Volume IV, Agriculture, and Industrial and Social Statistics (table 1 pp. 250-252 for land use, including forest areas, Table 17 pp. 314-322 for land distribution, Table 19 pp. 325-328 for acreage and output volumes for the main crops, Table 20 pp. 329-339 for livestock). The regional dataset used in this study, along with maps, that also includes export volumes for abaca, sugar, tobacco, and rice import volumes for the period 1876-1898 (ibid, pp. 11-86) is available upon request.

for females. It appears therefore that the process of human capital accumulation was under way before the implementation of the American policy of transferring to the colony the US model of public education.

II. Insurgency, counterinsurgency, and the recruitment of Filipino soldiers by US authorities

The Filipino nationalist revolt against Spanish rule expanded only gradually between 1896 and 1898, from the provinces of central Luzon to the rest of the country. It is tempting to investigate to what extent the pattern of spatial diffusion of the insurgency is related to regional differences in the biological living standard, literacy, and economic performance. The result indicates that only population density correlated with the insurgency at the regional level. The provinces that remained under Spanish control until 1898 were, with the exception of a few parts of southeastern Luzon, those with the lowest population density.

In their attempt to occupy the country after the treaty of Paris of 1898, the US authorities faced a massive insurgency that quickly expanded to the entire territory. With an estimated military force of 80,000 to 100,000 volunteers, the First Philippine Republic enjoyed initial success against 40,000 US troops in 1898, which were increased to a peak of 74,000 in 1900, one for every 110 residents of the Philippines (Deady 2005, 66). US troops were scattered all across the country in relatively small garrisons but the counterinsurgency policy focused first on central Luzon, particularly the Tagalog speaking areas of central Luzon that were the stronghold of the nationalist movement (Deady 205, 55). US military operations were extended to northern and southern Luzon, the Visayas and Mindanao only in 1900.[14]

US military losses were limited to around 4,000. On the Filipino side about 16,000 soldiers died and civilian casualties numbered around 200,000, including those due to diseases, starvation, and maltreatment by both sides (Deady 2005, 64), accounting for more than 2% of total population of the archipelago. One of the major causes of the high civilian death toll was the American "pacification" policy that relied on concentrating civilians in camps modeled on Indian reservations where poor nutrition and health conditions prevailed.[15] The nationalist uprising ended in 1902 with the fall of the Philippines Republic and the U.S. occupation of the entire archipelago.

[14] Among the various descriptions of military operations, Barrows (1905), LeRoy (1914), Deady (2005), and Angeles (2013) are the most detailed.
[15] It is estimated that 300,000 civilians were in concentration camps in southern Luzon during the campaign of 1901 (Deady 2005).

The US authorities quickly realized that, in order to effectively control and rule the country, they had to rely on Filipino auxiliary troops. In 1901, they decided to recruit 15,000 soldiers who became increasingly involved in counterinsurgency (Linn 2000, 128). By 1903, US troops were reduced to 15,000 (Deady 2005). In total, around 23,000 Filipino soldiers were recruited between 1901 and 1913; our data set includes all of their heights individuals. Roughly one percent of Filipino male adults (i.e. above age 20) were recruited.[16]

Individual information regarding these soldiers[17] provides a data set of exceptional size for early 20th century Southeast Asia. In addition to individual height in inches, information related to these individuals includes year of recruitment, age in years and months, and for a majority of observations, occupation and place of birth (province and/or city or district). After excluding individuals born before 1866, due to concern over the effect of age shrinkage on height, and after 1890, since they were not fully grown adults, 77% of the records (17,479 out of a total of 22,793) are available for analysis.

Table 2 summarizes the number of observations by birth cohort and year of enlistment. The size of the subsamples appears sufficient for conducting quantitative analysis, except for the first sub-period 1866-70. As can be expected in a population with relatively low levels of literacy, some heaping is observed in the height distribution, with a strong preference for measures rounded in inches or half-inch rather than quarter of inch. The distribution in quarter inch intervals (figure 3) exhibits a normal pattern with a leptokurtic tendency.

Table 2 and Figure 3 around here

The place of birth is reported for all individuals. A few provinces of northern Luzon had a disproportionately high number of recruits (Figure 4).[18] This is explained by the fact that most of the leaders of the nationalist movements were member of the local elite of the Tagalog provinces of central Luzon. Very low levels of recruitment in the US auxiliary troops are observed in Tagalog speaking provinces such as Bataan, Bulacan, Manila, Rizal, and La Laguna. (Nonetheless, the level was relatively high in two Tagalog speaking provinces, Cavite and Mindoro). The provinces with high soldiers to population ratios of northern Luzon

[16] The Census of 1903 indicated a balanced sex ratio, with half of the population below 20 (Philippines Commission 1905, volume II, p. 60. Total population of around 8 millions ca. 1900.

[17] National Archives and Records Administration. 7th and Pennsylvania Ave., NW, Washington, DC 20408-0001. Microfilm ID M233. Record Group 094. Register of Enlistments in the U.S. Army, 1798-1914. U.S. Army 72, Volumes 134 and 135.

[18] We used a procedure based on Damerau-Levenshtein distance (Damerau 1964, Levenshtein 1966) for correcting erroneous information[18] and obtained information related to place of birth (name of province, town or district). The sub-sample does not appear to be biased in terms of height distribution, nor in comparison with the share of recruits by year of birth cohort or year of recruitment, in comparison with the total sample.

correspond mostly to Iloko[19] speaking areas. Several other provinces where the predominant language was neither Tagalog nor Iloko had a relatively high participation in the US auxiliary troops, in particular Pampanga (in central Luzon) and Zamboanga (in the western part of Mindanao island), while the contribution was close to the median in the Visayas islands (Iliolo, Leyte and Samar provinces). Considering the diversity of environmental conditions in the different provinces, the overall sample is probably not a perfectly geographically representative sample.

Figure 4 around here

III. Estimation of average height levels, trends, and regional patterns

We estimate average height controlling for year of birth, occupation, region of provenance, some characteristics of province of birth, as well as probable minimal height requirement (MHR). On the basis of these results, we also estimate trends by 5-year cohorts in the period 1866-1890.

No explicit mention of MHR was found in US military records but an examination of the data set suggested that informal MHR existed (albeit not very strict since a few short individuals, below 145 or even 140 cm, were also recruited). The level of MHR identified were at 61.9 inches (157.22 cm) for all recruitment years except 1907 for which it was identified as 62.9 inches (159.77 cm). We also set an upper limit at 70.1 inches (178.05 cm) in the truncated regression.

We use truncated maximum likelihood estimator in order to account for the MHR insofar as one would obtain biased results using an OLS estimator (A'Hearn 2004; Komlos 2004).[20] The independent variables used include *Birth cohort* dummy variables equal to one if the individual was born during the specific 5-year cohort and 0 otherwise, *Young*, a dummy variable equal to one if the individual was 20 or 21 years old and 0 otherwise, the occupation of the individuals represented by *Musician*, *Police* or *Sailor*, dummy variables equal to one for the corresponding occupation of each individual and 0 otherwise.

We excluded from the estimation the individuals born after 1890 or before 1866. This leaves us with a sample of 17,479 observations. Information regarding occupation prior to recruitment is reported for a subsample of 62% the soldiers (14,080 individuals out of a total of 22,793). In order to control for local conditions, the provincial level (48 provinces or

[19] Also designed as Ilocano.
[20] Similar results were obtained with OLS or Tobit estimator (estimation results with these specifications are available upon request).

comandancias) socio-economic variables for 1903 are introduced in the regression[21] Although output volume of cash crops declined, we can assume that the regional variance in disease environment, population density, land and livestock to man ratios, yields of main crops, land distribution, or literacy did not change dramatically between the end of the Spanish colonial period and the first decade of American rule.

Table 3 presents the results of this regression, with four specifications. The first one uses information available at the individual level only. The second and third ones include provincial characteristics in the analysis as provincial clusters. The fourth one includes province level fixed effects. The results are almost identical for the coefficient for the birth cohorts in the four specifications, and for the three occupations for which significant coefficients are obtained in specifications 1, 3, and 4, the same signs and similar magnitudes are observed. Moreover, we find that the characteristics of the place of birth did not have a major influence on heights insofar as significant coefficients are obtained only with two provincial level variables: the percentage of farms of less than 2 hectares and the prevalence of dysentery (see appendix, table A1, for detailed information). The coefficients for provincial fixed effects were significant with specification 4.

Table 3 around here

The results indicate that height declined significantly among the birth cohorts of the 1880s (Table 3), by about 0.6 inches (1.5 cm). As expected, a negative and significant coefficient is observed for young individuals (aged 20 or 21). Undernourished populations tend to grow for a longer period of time than well-nourished ones. Among the prior occupations of these soldiers, significant coefficients are obtained only for musicians, policemen, and sailors, which indicate selectivity into these occupations.

The coefficients obtained in table 3 with the two preferred specifications (columns 2 and 3) are used to estimate the national trend of heights for 5-year cohorts. The two results are virtually identical and show that average height declined by 0.63 inches (1.5 cm) between 1866-1870 and 1886-1890 (Table 4).

Table 4 around here

Although the number of observations is relatively small in about half of the provinces (below 200 individuals), it is also possible to provide an overview of regional differences in height adjusted fixed effects coefficients in the truncated regression (specification 4). Figure 5

[21] All data were obtained from the 4 volumes of the Philippines Commission (1905), Census of the Philippines Islands. To the best of our knowledge, the equivalent provincial level information for the late 19th century is unavailable in Spanish colonial records.

presents differences in soldiers' mean height relative to the national average in percentage. The provinces with less than 50 observations were omitted. The provinces with comparatively high biological wellbeing do not have homogenous characteristics. Height was greater in some of the Tagalog speaking areas of central Luzon, (Bulacan and Cavite provinces), in the central Visayas (Cebu and Negros Oriental), and in part of the Bicol peninsula, in southeast of Luzon (provinces of Ambos Camarines and Sorsogon), which were regions with high population density. But recruits were also relatively tall from some areas of low density such as Palawan Island (province of Paragua) and in northeastern Luzon (provinces of Cagayan and Isabela), and in Dapitan province (in western Mindanao). Furthermore, there is no evident relationship between the number of soldiers relative to the population presented in Figure 3 and mean provincial heights. In particular, height appears to be below the national average in the three of the four Iloko speaking provinces of northwestern Luzon that were major contributors to the auxiliary troops.

In order to ascertain that there was a downward trend in stature in the entire country, we use the specification of the truncated regression presented in column 3 of table 3 with a regional breakdown. Because sample sizes are too small to estimate the trend in each province, we combine provinces on the basis of present-day borders of administrative regions in order to obtain 3 macro-regions.[22] Due to the small number of observations for 1866-1870, this cohort is excluded from the regional estimations (Table 5).

Table 5 around here

Region 1 corresponds approximately the present-day Ilocos administrative region,[23] region 2 covers the rest of Luzon,[24] and region 3 includes the other islands.[25] The reason for merging the provinces in this manner is the following: Ilocos is specific as it has been a region of massive emigration to the rest of Luzon in the 19th century (and to other island, the USA, and the rest of the world in the 20th century). The rest of Luzon (region 2) combines province of emigration and immigration with flows of temporary or permanent migrants using mostly land routes in the 19th century. The rest of the country is an archipelago; region 3

[22] See the interactive map of the Library of Congress; http://www.loc.gov/resource/g8061f.ct001416/

[23] In our case, six provinces of the administrative map of 1903: the four original Iloko speaking provinces of Ilocos Norte, Ilocos Sur, La Union, and Pangasinàn, and two mountainous provinces of 1903 Abra and Lepanto-Bontoc, mostly colonized by Iloko speakers in the 20th century.

[24] Corresponding to the administrative regions of Cordillera, National Capital, Cagayan, Central Luzon, Calabarzon, and Bicol

[25] The administrative regions of Mimaropa, Western Visayas, Central Visayas, Eastern Visaya, and Mindanao

combines province of emigration and immigration with flows of temporary or permanent migrants using mostly sea routes in the 19th century.[26]

Although several of the coefficients in the regional regressions are not significant anymore, particularly for occupations in region 1 and birth cohorts in region 3, the results are overall consistent with those presented in Table 3 for the country as a whole. The coefficients are used to generate estimates of mean height by cohort for the three regions. The results confirm the downward trend in height that is particularly steep in region 1 (Ilocos) for the cohort 1886-1890, for which the coefficient is significant (Figure 6).

Figure 6 around here

IV. International comparison and interpretation of the decline in biological wellbeing in the Philippines

How do late 19th century levels and trends in average height of male adults in the Philippines compare with contemporary estimates for other Asian countries, and other countries with tropical conditions? In terms of levels, Filipino men were among the shortest in the world in the late 19th century,[27] although in 1870s at 159 cm, they were still 2 cm taller than Japanese conscripts. However, the Filipino men lost that advantage by the late 1880s.[28] Filipino men were also much shorter than Southern Chinese males whose height was 162 cm in the 1890s (Baten et al. 2010, 252) and their Korean counterparts whose average height was around 164 cm (Choi and Schwekendiek 2009, 260). Average height of East Asian and South Asian men was around 163 to 164 cm, and it was above 166 in Sub-Saharan Africa and Latin America; (Baten and Blum 2012). In Southeast Asia, average height lower than in Philippines can be identified for the late 19th and early 20th century only among Kinh (ethnic Vietnamese) populations of southern Vietnam, albeit with small sample sizes (Bassino and Coclanis 2008, Appendix A1).

[26] Particularly from Cebu island to Samar, Leyte, and Mindanao islands, and from Iloilo island to Negros island.

[27] The low stature of Filipino soldiers, and more generally of the Philippines population, cannot be attributed to unidentified characteristics in the genetic pools. The characteristics of genetic pool of the population are mostly explained by relatively recent Austronesian migrations (the last 6,000 years), with a sizable but much more recent inflow of migrants from southern China. The genetic pool is therefore fairly close to that of populations who settled in other regions of Southeast Asia and the Pacific (Melton et al., 1995). Some of these populations, in particular the Maori of New Zealand were almost as tall in the late 19th century as New Zealanders of European origin (Inwood, Oxley, Roberts 2010).

[28] An upward trend is observed in Japan using conscription data covering almost the entire cohorts from the 1870s, both with national averages and for all prefectures. Prefecture level data (47 districts) are in a range between 155 and 158 in the early 1870s and between 157 and 159 in the late 1880s, with the exception of Okinawa, whose average went up from 152 to 154 cm (Bassino 2006).

In terms of trend, average male height was following in the Philippines the same pattern as in several other Asian countries during the last decades of the 19th century in stark contrast to European heights which were increasing in this period. For instance, male height declined in southern China from 164 to 162 cm (Morgan 2008), and in Taiwan from 164 to 163 cm (Olds 2003). The same trend is also identified among Chinese migrants to Australia, Canada, and the US (Baten et al. 2010), but with much higher initial levels and a north-south gap of around 3 cm (Morgan 2004). In lower Burma too, a decline in stature occurred between the 1860s and the 1880s, but increased in upper Burma during the same period (Bassino and Coclanis 2008). A downward trend is also identified for Indonesia in the 1860s, from above 160 to 158 cm, but with a partial recovery to 159 cm in the late 1880s that marks the start of an upward trend only temporarily interrupted in the 1930s and during WWII (Baten, Stegl, and van der Eng, 2013). This general pattern of decline of average stature in late 19th century Southeast and East Asian countries (with the notable exception of Japan) suggests that the first globalization, in particular the rise of intra-Asia and international trade, resulted generally in a degradation of the biological wellbeing in this region of the globe. The fact that height was shrinking in a growing economy echoes the observation made for mid-19th century Britain and the United States (Komlos 1998).

In investigating the determinants of height, significant coefficients were obtained for only two provincial variables, the prevalence of dysentery and the share of farms of less than 2 hectares. This suggests that the factors of decline in stature were similar all over the country, although we cannot rule out that the downward trend was amplified in several provinces by the rapid rise in the production of cash crops, in particular abaca and sugar. Three main explanatory factors could be envisioned in our attempt at identification of the main drivers of the decline in biological well-being: an increase in the exposure to diseases, a rise in inequality, and the effects of rapid population growth in a context of poor nutritional status.

The significant coefficient obtained for the provincial level prevalence of dysentery should be considered tentative, because part of the variance may reflect the impact of the military operations in 1896-1902 rather than local conditions in earlier decades. De Bevoise (1995) describes a link between commercial expansion and the increase in the prevalence of the diseases that affected the Philippines in the last decades of the 19th century. Although his study is mostly qualitative, it contains useful insights on the cause of the rise in prevalence of beriberi, resulting directly from the specialization in cash crops and therefore the import of rice processed in steam mills (De Bevoise 1995, 118-141); but beriberi was mostly restricted to the lower income households of Manila and sugar plantation areas such as in the province

of Negros Occidental. The major cause of rise in the disease claims on calories and protein intake was the rise of severity and frequency of malaria, a consequence of land reclamation in the highlands with seasonal migration bringing a severe strain of disease to the villages of origins in the lowlands. Additional claims were due to the increase in the diffusion and periodicity of smallpox and cholera epidemics resulting from market integration in a context of failure of the colonial health care system (De Bevoise, 1995, 94-117, 164-184).

The negative and significant coefficient obtained for the share of small farms suggests that the decline in stature could have been due to a rise in inequality. The studies on the development of cash crop productions such as abaca and sugar highlight the tendency toward land concentration and the formation of large-scale haciendas (Owen 1988; Larkin 1995). In addition, the traditional textile cottage industry declined rapidly from the 1870s due to the massive import of British cotton yarns and fabrics (Resnick 1970). The calculation of the coefficient of variation of individual height by 5-year birth cohorts indicates however that this measure of inequality declined over time from 3.4% for the cohort 1871-1875, to 3.1% for the cohort 1886-1890. As van Zanden et al. (2014) identify a positive and significant relationship between height CV and income Gini, we can use the linear formula they estimated to generate proxies of income CV. [29] The implied Gini coefficients obtained are: 38.8 for the cohort 1871-1875, to 36.2 for the cohort 1886-1890.

A more plausible explanation of the decline in biological well-being could lie in the extremely rapid demographic growth resulting in a high dependency ratio. Population increased between 1870 and 1890 at an annual rate of 1.2% in the Philippines, higher than in Indonesia, and well above the population growth rate of Thailand (around 1.07% and 0.72% respectively).[30] Using individual data for mid-20th century Philippines "finds only limited support for the idea that parents were concerned about average child quality, since the results show that there are strong birth order effects on nutritional status" (Horton 1988), and a negative link between family size and children height is also identified in late 19th and early 20th century Britain (Hatton and Martin 2010).

V. Conclusion

The results obtained on the basis of the height Filipino soldiers enlisted by the US military imply that during the last decades of the Spanish rule the average height of the native

[29] The formula that we regard as the most appropriate is that obtained with model (5) FE 1820-1929 Appendix 2 (Table 3, p. 33). In this specification, $Gini_{it} = 9.19 + 8.71*CV_{it}$;

[30] Calculation based on figures reported by Maddison (2010).

population was low by the international standards. It also appears that few socio-economic characteristics of the province of birth had a significant influence on individual height.

The low biological standard of living observed in late 19th century Philippines cannot be explained exclusively by the tropical disease environment since greater average heights were recorded for the same period in other parts of Asia. Furthermore, and just as importantly, average heights declined in the Philippines at the end of the 19th century in spite of an expansion of commercial activity, in particular the expansion of cash crop production for export. The onset of commercialization has been found to coincide with a decline in the biological well being in other contexts as well (Komlos 1998). A decline in nutritional status indicates that the population was suffering and this could have been one of the causes of the independence movement. After all, a decline in nutritional status also preceded the French Revolution (Komlos et al. 2004). Finally, although per capita GDP was well above subsistence level in 1902, more than doubled between 1902 and 1929, and remained fairly stable until 1940 (Maddison 2001, 2010) average height barely recovered to the level of the early 1870s by the 1930s. This raises the possibility that the rapid economic growth between 1902 and 1929 was to a large extent a period of recovery from the collapse of the economy during the chaotic transition from Spanish to American rule in 1896-1902.

Average height in late 19th century Philippines can be compared also to more recent data in order to assess to what extent improvements in biological living standards took place under American rule in the first half of the 20th century, and more recently. To the best of our knowledge, there is no large-size sample available for the mid- or late-20th century, which could be compared to our results. However, The Food and Nutrition Research Institute (Department of Science and Technology, 2003) reported heights of 163.5, 162,6, and 159.7 cm, on average, for men aged 20-39, 40-59, and above 60, respectively.[31] Assuming that these samples are representative, and allowing for shrinkage due to old age, this would imply that average male stature of the cohort born in the 1930s and early 1940s was only slightly above the level recorded for the birth cohort of the early 1870s.

[31] FNRI (2003, part II, Table 33). The figures for female cohorts were 151.76, 151.11, and 147.96, respectively. Standard deviations and sample sizes are not reported, but the FNRI report states: "the 2003 Master Sample (MS) that was developed by the National Statistics Office (NSO) was used for the 6th National Nutrition Survey. The 2003 MS three-stage stratified sampling design had the province as the stratum, barangay or contiguous barangays with at least 500 households as the primary sampling unit (PSU)." For the younger cohort, the figure is consistent with information, reported by De Cao (2010) from the Cebu Longitudinal Health and Nutrition Survey (CLHNS), a cohort of Filipino children followed from conception, in 1983-84, to 2005. Average height of the male population at age 20 was slightly above 160 cm. The comparatively low level of stature in the early 21st century could be explained to a large extent by high level of malnutrition among children aged 0-5, 30% and in 2003 (FNRI 2003, Part II, figures 9), with a similar percentage of under-height in the height for age measurement (ibid., Table 28).

We can also observe an unexplained mismatch between biological and economic indicators of well-being, both in terms of levels and trends. With an average male stature around 159 cm and per capita GDP close to 1500 USD (of 1990) in the 1930s, the Philippines is one of the main outliers in Asia, along with Japan, in the overall relationship between per capita GDP and stature identified by Steckel (1995).[32] A similar mismatch is also observed between the two main components of human capital, education and health.

Although rising education levels and increase in per capita income translated into a rapid secular trend in stature in late 19th and early 20th century Japan, spectacular improvements in education levels in the Philippines were not associated with proportionate improvements in biological well-being. In terms of enrolment rates in primary education (relative to total population) Philippines was well ahead of Burma, Thailand, Indonesia, China, and even Korea in the 1920s and 1930s, and even close to the Japanese level in the late 1930s (Easterlin 1981, 9, Figure 1). In spite of this impressive human capital accumulation, the Philippines did not experience the same economic growth performance as the East Asian miracle economies; one may wonder: "where has all the education gone?" (Pritchett 2001). A large part of the explanation, both on the lack of return to education and on the low biological wellbeing, could well lie in the other legacy of the Spanish colonial period, the sub-optimal institutions that fuelled the insurgency of 1896-98 and that the US colonial authorities failed to ameliorate in the 1920s and 1930s.

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[32] The predicted value for average male height at 1500 USD per head is 165 cm.

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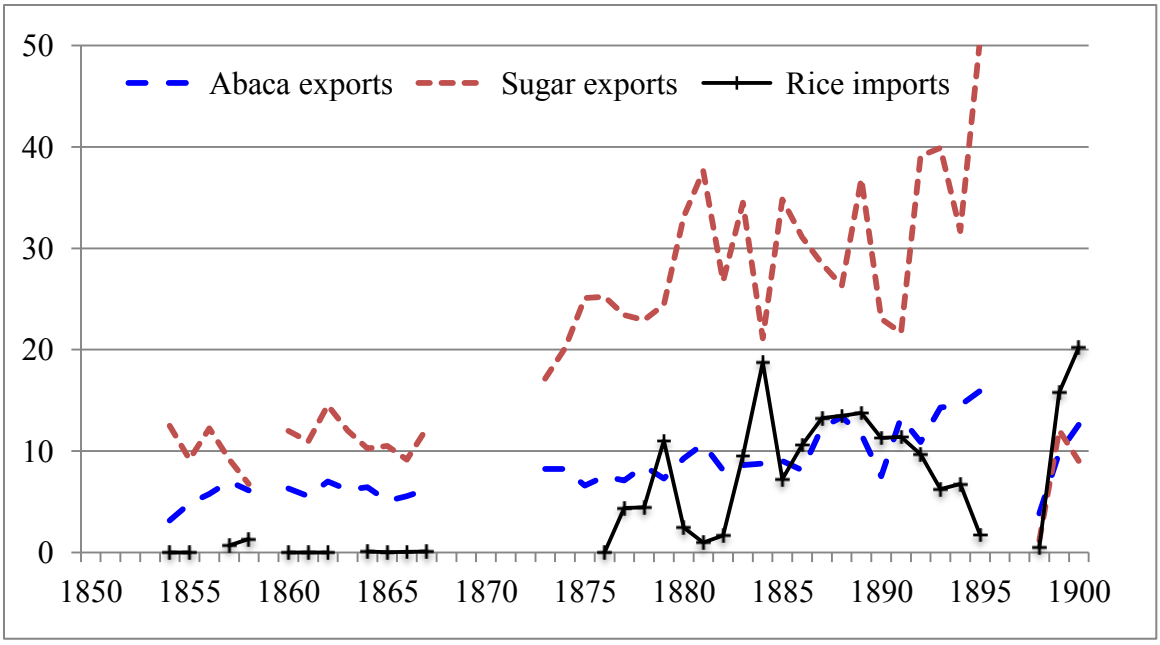

Figure 1. Abaca and sugar exports and rice imports of the Philippines (kg per capita).

Sources: *Censo des las Islas Filipinas* 1903, volume IV for international trade volumes in tons (pp. 17, 28-29, and 96 for abaca, sugar, and rice, respectively); population series interpolated on the basis of data for the benchmark years 1850 and 1900 reported by Maddison (2010), assuming a constant growth rate (1.4% per annum).

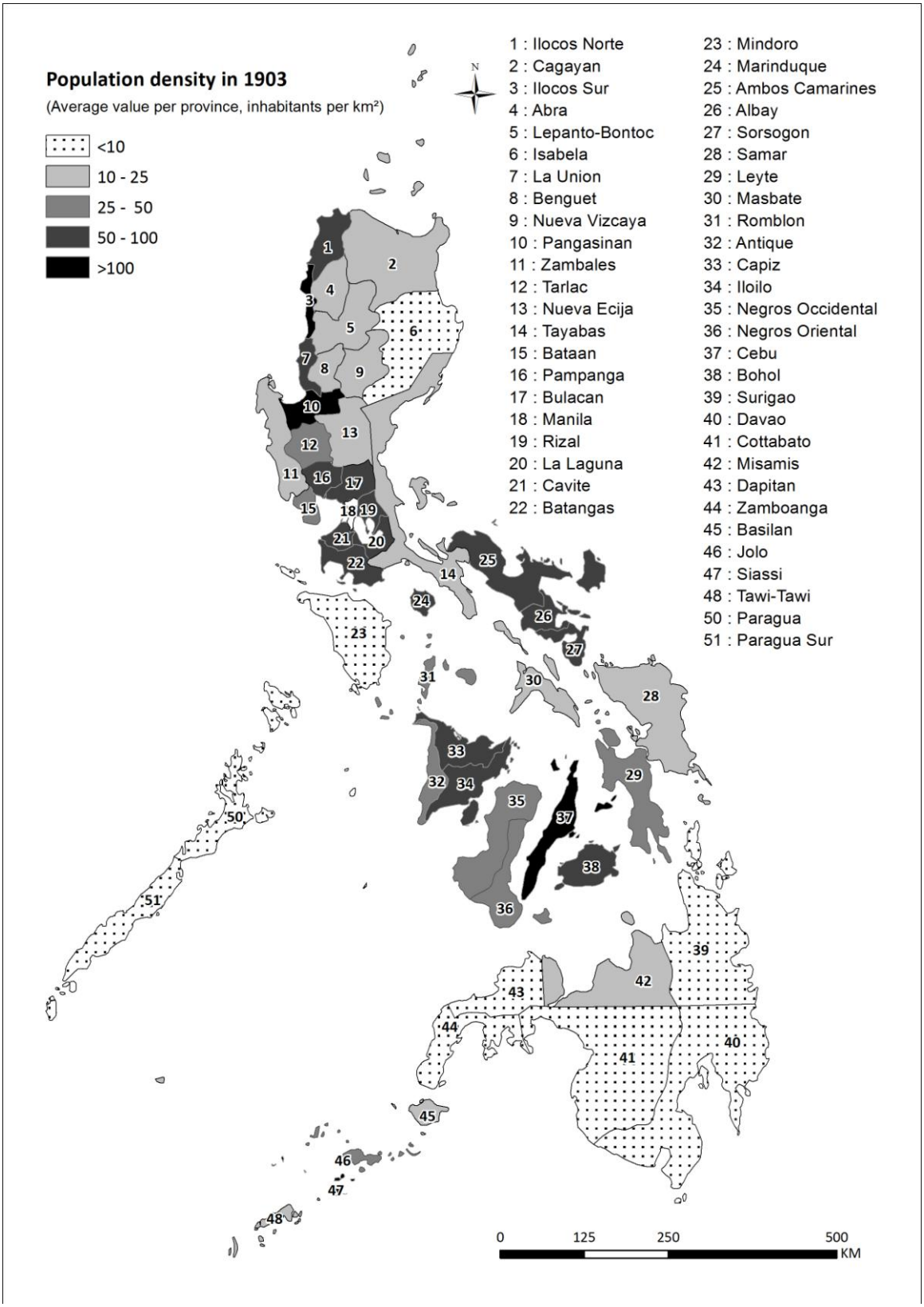

Figure 2. Population density by province of the Philippines in 1903

Source: Philippines Commission (1905), Census of the Philippines Islands in 1903, Volume II, Population, p. 48.

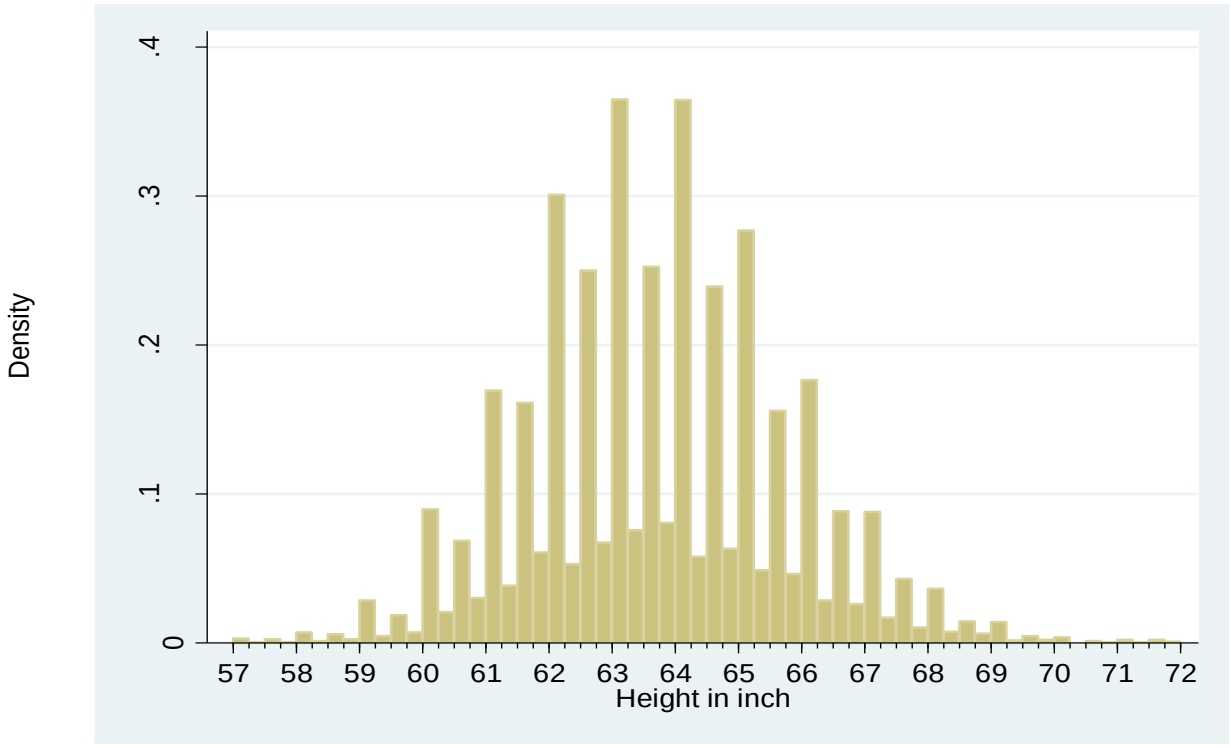

Figure 3. Height distribution in quarter inch intervals (0.635 cm)

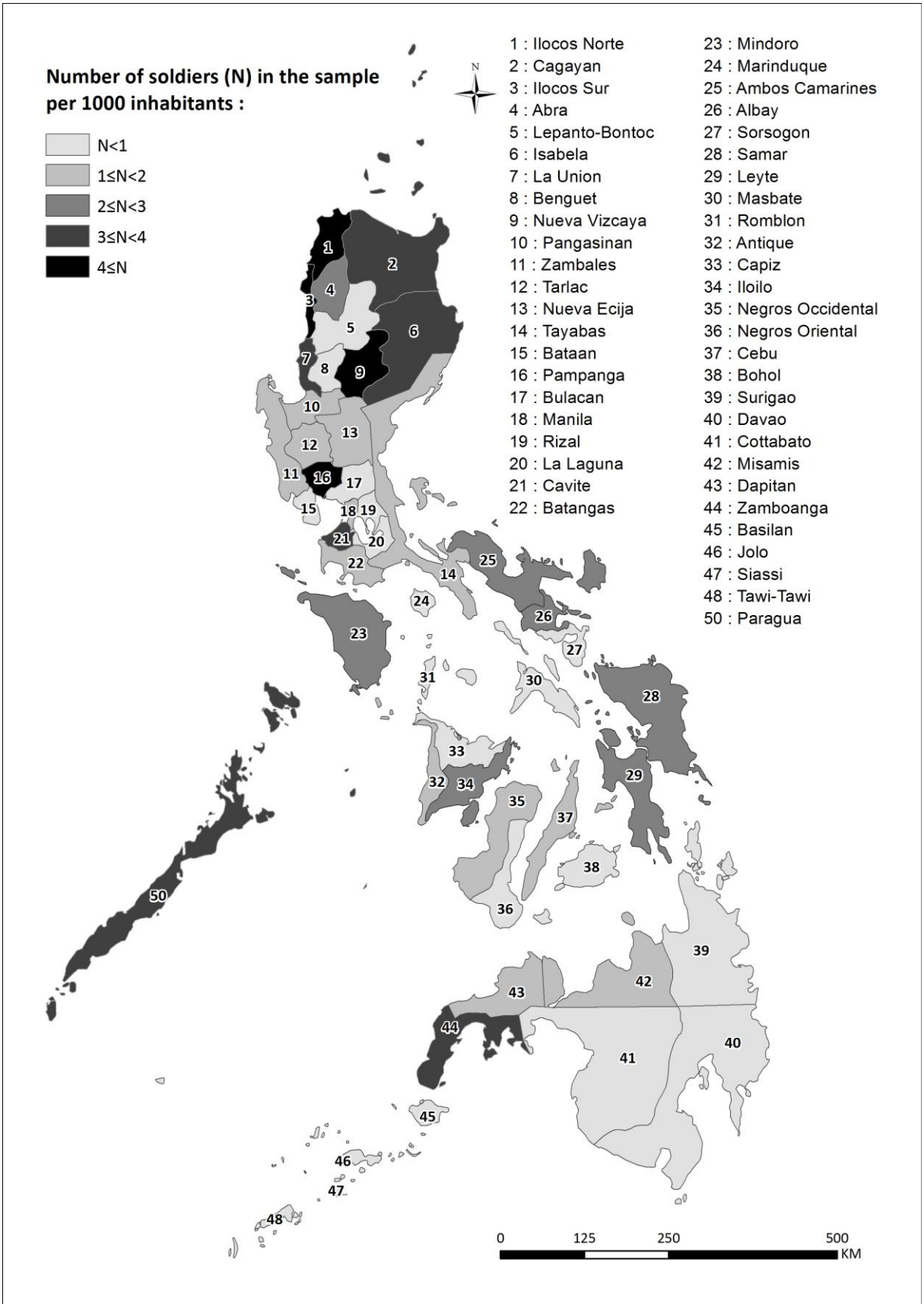

Figure 4. Number of soldiers relative to total population by province

Source: see figure 2 for population data.

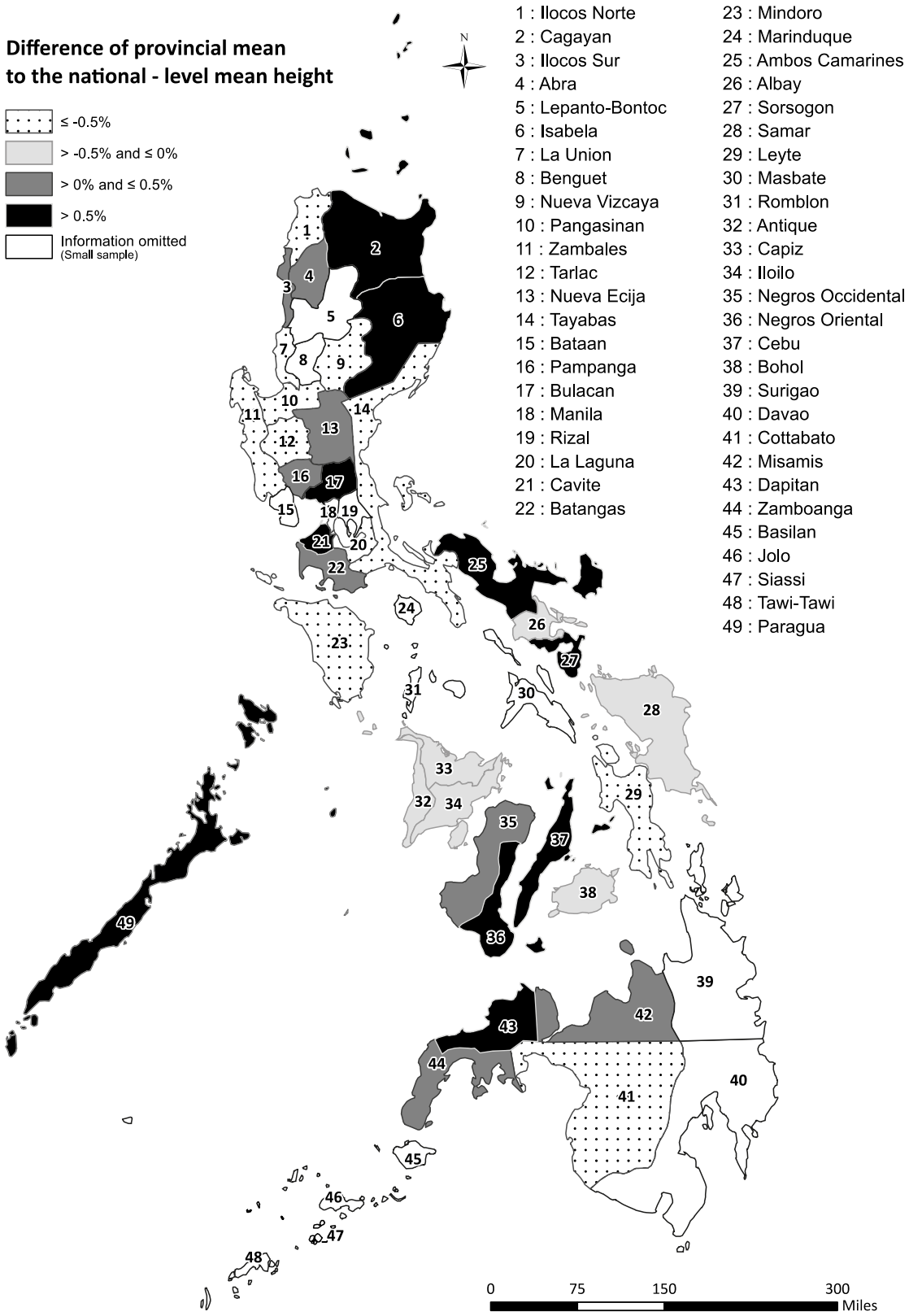

Figure 5. Soldiers' estimated mean height by province relative to national average

Source: see text.

Notes: provinces with less than 50 observations were omitted.

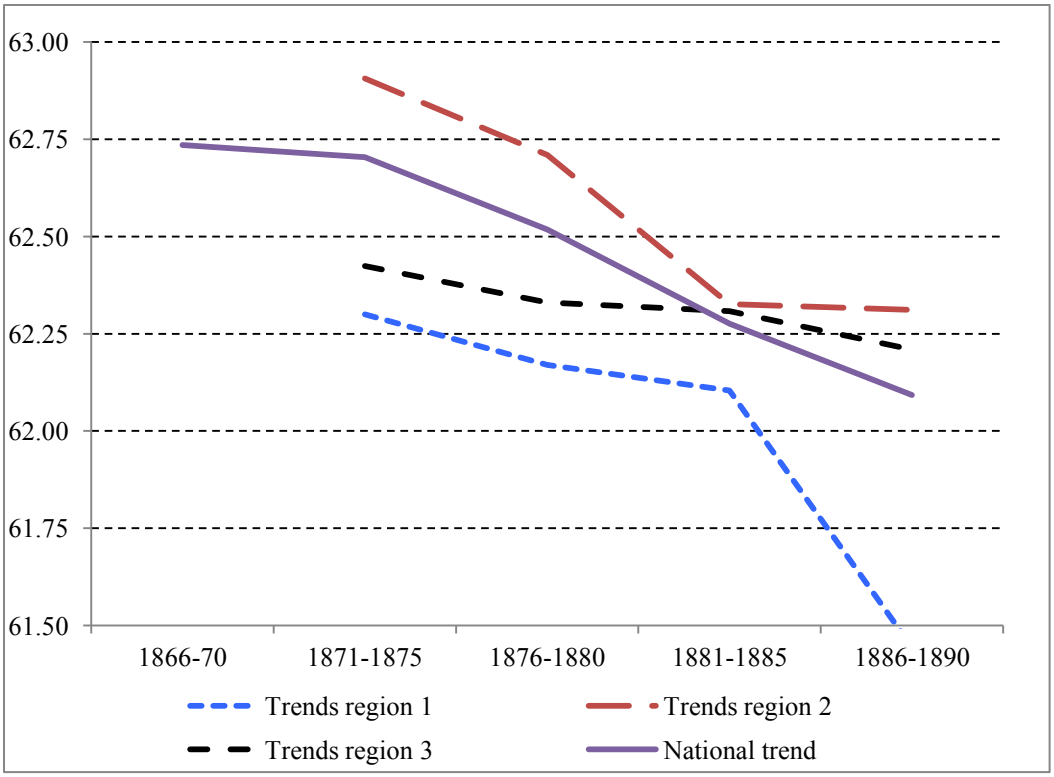

Figure 6. National and regional trends (in inches)

Sources: national trend reported in table 4; see text for regional trends.

Table 1. Total population and density in the Philippines, Indonesia, and Thailand 1850-1950

	Population (millions)			Population density (per km^2)		
	Philippines	Indonesia	Thailand	Philippines	Indonesia	Thailand
1850	3,612	22,977	5,230	10.6	12.1	10.2
1870	5,063	32,743	5,775	14.8	17.2	11.3
1890	6,476	40,532	6,670	18.9	21.3	13.0
1910	8,861	50,034	8,305	25.9	26.3	16.2
1930	13,194	61,805	12,392	38.5	32.5	24.2
1950	21,131	82,612	20,042	61.7	43.4	39.1

Sources: World Bank for land area (http://data.worldbank.org/indicator/AG.LND.TOTL.K2); Maddison (2010, *Historical Statistics of the World Economy: 1-2008 AD*) for population.

Table 2 – Number of observations (N) by cohort and year of measurement

Birth cohorts		*Years of recruitment*					
Cohort	N	*Year*	N	Year	N	Year	N
1866-1870	596	1901	3044	1906	403	1911	2063
1871-1875	1500	1902	431	1907	2028	1912	529
1876-1880	5148	1903	200	1908	2019	1913	43
1881-1885	6907	1904	3060	1909	624		
1886-1890	3328	1905	1071	1910	1964		

Note: 17,479 observations in total after excluding individuals born before 1866 and after 1890.

Table 3 – Height (inches) estimated with truncated regressions

	(1)		(2)		(3)		(4)	
Childhood macro environment – birth cohort:								
1866-1870	0.017	(0.20)	0.019	(0.25)	0.030	(0.25)	0.019	(0.24)
1871-1875	*Reference*		*Reference*		*Reference*		*Reference*	
1876-1880	-0.11	(0.12)	-0.17	(0.13)	-0.18	(0.13)	-0.22	(0.14)
1881-1885	-0.36***	(0.12)	-0.42***	(0.13)	-0.42***	(0.13)	-0.43***	(0.14)
1886-1890	-0.57***	(0.14)	-0.61***	(0.16)	-0.61***	(0.16)	-0.58***	(0.16)
Young	-0.44***	(0.09)	-0.40***	(0.11)	-0.40***	(0.11)	-0.45***	(0.11)
Occupation:								
Musician	-0.90***	(0.29)			-0.77**	(0.38)	-0.61	(0.37)
Police	0.92***	(0.22)			0.80***	(0.27)	0.77***	(0.22)
Sailor	-0.99**	(0.40)			-1.05**	(0.43)	-1.10***	(0.41)
Constant	62.78***	(0.17)	62.79***	(0.16)	62.80***	(0.16)	62.83***	(0.11)
Province FE	No		No		No		Yes	
Observations	14,080		17,479		14,080		14,080	

Notes: standard errors are in parenthesis clustered by province in column (2 and (3). * Significant at 10%, ** at 5%; *** at 1%. Young stands for age 20 or 21 (3,546 individuals out of 17,479 in column (2); 2,880 individuals out of 14,080 in columns (1), (3) and (4); reference values are, for birth cohort, 1866-1870; for occupation, other than musician, sailor, or policeman (200, 82, and 194 individuals, respectively). Other major occupations (more than 20 individuals were bakers (32), carpenters (57), clerks (114), cooks (61), farmers (759), fishermen (147), laborers (5095), merchants (176), scouts (970), servants (107), soldiers (5328), students (208), and tailors (52).

Table 4 - Estimated Height trends (inches)

Birth cohort	Trend (regression column 2)	Trend (regression column 3)
1866-1870	62.72	62.73
1871-1875	62.70	62.70
1876-1880	62.53	62.51
1881-1885	62.28	62.27
1886-1890	62.09	62.09

Note: Means are calculated at the mean of the independent variables.

Table 5. Height (inches) estimated with truncated regressions by region

	Region 1 (Ilocos)		Region 2 (Rest of Luzon)		Region 3 (Other islands)	
Childhood macro environment – birth cohort:						
1871-1875	0.13	(0.30)	0.19	(0.18)	0.09	(0.30)
1876-1880	*Reference*		*Reference*		*Reference*	
1881-1885	-0.06	(0.10)	-0.38***	(0.06)	-0.02	(0.34)
1886-1890	-0.72**	(0.34)	-0.39***	(0.13)	-0.12	(0.29)
Young	-0.24	(0.22)	-0.65***	(0.10)	-0.18	(0.20)
Occupation:						
Musician	-0.34	(0.93)	-0.87	(0.56)	-1.17*	(0.66)
Police	0.21	(0.73)	0.62**	(0.28)	1.20***	(0.36)
Sailor	-0.16	(1.47)	-0.70	(0.70)	-1.26**	(0.52)
Constant	62.50***	(0.18)	63.02***	(0.17)	62.74***	(0.23)
Observations	2,702		6,962		4,161	

Notes: same as table 3.

Appendix

Table A1. Estimates of the influence of characteristics of the province of birth on height

Dependent variable: height		
Female literacy rate	-1.99	(1.41)
% of farms of less than 2 ha	-0.84***	(0.30)
Sugar yield per ha	-0.22	(0.15)
Share of forest as % of area	0.71	(0.65)
Population density	0.02	(0.09)
Death rate of children less than 5	-0.50	(1.07)
Livestock to man ratio	-0.03	(0.14)
Dysentery rate	-0.09**	(0.03)
Population growth (1876-1895)	-0.20	(-0.18)

Source: see text.

Notes: Standard errors in parentheses; each line is a separate regression. Standard errors are in parenthesis clustered by province. * denotes coefficients significant at 10%, ** at 5%; *** at 1%. Each line is a separate regression. All estimations include dummy variables for birth cohorts, young, musician, police, and sailor. *Livestock* stand for the total number of buffaloes, cattle, and horses at the provincial level. All data are for 1903, (except the population growth rate).