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A Curse of ‘Point Source’ Ressources? Cash Crops and Numeracy on the Philippines 19th-20th Century

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Introduction

On the Philippines during the 19th century, a dramatic shift of the agrarian economy from subsistence agriculture to a specialization in cash-crop production occurred. At the same time a modest deindustrialization occurred, as cottage textile production became uncompetitive. Which effects on human capital formation would we expect from such a development in a relatively poor and isolated country such as the Philippines during this period? In general, income and commercialization from cash crop industries should generate a positive trend of human capital formation. Investments in human capital, and in numeracy in particular, should allow to participate in the gains from planting new crops. However, three external effects might reduce or retard the positive effect. Firstly, when cash crop agriculture was introduced in neighboring Indonesia, a strong negative nutrition effect was observed as the agricultural area was not planted with food anymore but rather with exportable cash crop the nutritional status of the poorer part of the population declined (Breman, 1989). Malnutrition has strong adverse effects on human capital formation. Secondly, and related to this, such dramatic changes typically imply shifts in the income distribution with net winners and losers in the

short term. It often takes a certain time lag until the distribution of additional income is beneficial for a broader part of the population recently. For example, during the first phase of the expansion of cash crop production for export landowners and government officials might improve their incomes, whereas the poorer part of the population does not benefit as much. Thirdly, when the specialization in cash-crop production is driven by the demand of world markets, it is sometimes associated with a decline of the cottage industry, especially textile production, due to competition from imported manufactured goods. This happened in particular in Southeast Asia in the second half of the 19th century (Bassino and Williamson 2015). If a country deindustrializes, the reallocation of labor factors within the national economy may be costly, and the major part of the costs is usually incurred by tenants or agricultural wage earners who were previously craftsmen. Specialization in cash crops can therefore result in skill destruction. In such circumstances, a decline in the overall level of human capital accumulation can take place at the country level, particularly if the technology used in the cash crop sector implies a strict division of labor between skilled and unskilled workers, thus preventing the trickling down of know-how to unskilled workers. Additional negative externalities will be discussed below.

Abacá¹, sugar, and tobacco became the three major cash crop export items of the Philippines after the gradual opening of Manila and later other ports to international trade in the late 1840s and early 1850s (Aguilar 1994).²

¹ Abacá (*Musa Textilis*) is a species of banana native from the Philippines that can be processed to obtain a fiber, Manila hemp, which was mainly used for processing ropes (in particular in North America). For the sake of simplicity, we use the term abacá in this paper both for the cultivated species (when discussing issues related to the plantations of cash crops) and for the processed Manila hemp (when referring to export).

²These three crops were already commonly cultivated in the 18th and early 19th century in different parts of the archipelago for domestic demand, mostly for the provincial or regional market, but the later increase was dramatic. In 1818, sugar was only the third most important export items in value (100,835 pesos) after bird's nests and indigo paste (301,568 and 192,000 Pesos, respectively); sugar exports accounted for less than 13% of the total export value of the Philippines (812,495 pesos). The value of abacá exports (4,444 pesos in total for fibers, cables, and rigging) was less than the export value of rattan, ebony wood, or tortoise shell (5,364, 4,567, and 10,850, respectively). Tobacco was not mentioned in the list of export items in 1818 (Yldefonso de Aragon, *Estados que manifiestan la Importacion y Exportacion de esta Ciudad*, Manila 1819; quoted in Corpuz 1997,133).

Their combined share in the Philippines total export increased gradually from 69% in 1846 to 95% in 1873, while total export value was increasing from less than 3 million pesos (Mexican \$) to more than 23 million during the same interval; the combined share of these three items fluctuated thereafter in a range from 71% to 96% between 1873 and 1895 (last year before the nationalist uprising of 1896), while total export value was increasing less rapidly than during the earlier period, reaching a peak of around 36 million pesos in 1893 (Larkin 1993, 49-50).

The share of sugar and abacá in total export value increased from 34% and 13%, respectively, in 1846, to 58% and 22% in 1873. The share of tobacco, however, declined from 19% to 10% during the same period, but in absolute value tobacco exports increased by around 200%. During the period 1873-1895, the shares of sugar and abacá in total export value fluctuated in a range between 30% and 54%, and between 21% and 44% respectively. Tobacco was of lesser importance, fluctuating in a range between 3% and 20%.

We will assess the influence of the rapid expansion of the cultivation of cash crops for export in the mid and late 19th century Philippines on human capital formation. Especially the increase or decline of basic numeracy is assessed in this study. Based on the historiography of the Philippines, we expect the expansion of cash crops to have a negative effect on human capital of the majority of the population during the first phase. #add dramatic cite of the laborer's situation in cash crops region here#. To test this hypothesis, we mobilize a new and large data set based on age statements from parish records which includes 228,853 underlying observations. This is the first quantitative study on numeracy on the Philippines in the long term. We aggregate the individual observations by 41 provinces and the birth decades from the 1800s to the 1930s in order to obtain a large and informative panel (panel observations based on less than 50 underlying age statements are dropped). This allows us to compare the cash crop regions before, during and after the introduction of the three main crops.

We contribute to the substantial literature on economic modernization and its cost. For instance, many economic historians have discussed the externalities of the new factory system during the industrial revolution period in England together with similar industrialization developments in continental Europe (Lindert, 2011, 255-272). The most drastic changes in the developing world were not related to industry, but to the agricultural sphere. The institutional development around the extraction of rents from agricultural products, and cash crops in particular, is a heavily debated issue (Acemoglu et al. 2001, 2002).

Various economic history studies have adopted different views about the welfare effects of introducing new cash-crops. For example, a slightly more positive, but nuanced view of the cash crop developments in African countries was recently articulated by Austin (2016) for the colonial period. Other studies contrast the positive income effect with some more ambivalent inequality externalities during the introduction phase of monoculturally planted cash-crops (Moradi and Baten 2005).

In this study we also contribute to a large literature in development economics that discusses the diffusion of cash crops. Development economists have thought about the effect of plantation economies on economic growth and development. For example, Isham et al. (2005) have argued that not only natural resource exporters, but also plantation economies which are characterized by very narrow geographic specialization on a certain crop are associated with worse institutional frameworks and higher inequality. The authors argue that these so-called “point source” export economies typically cannot easily respond to external shocks. However, flexible responses to changing markets are essential for prosperity. In particular, Isham et al. assess the economic performance during the 1970s and 1980s, comparing countries that were characterized by these “point resource” exports to others. They find that countries depending on banana and sugar producing plantations as well as more traditional natural resource exporting economies perform significantly worse in the wide range of governance and institutional indicators. In contrast, countries with natural resource

exports for which they use the term “diffuse exports” -- such as exports of a wide array of different livestock and agricultural products -- which are often produced on smaller family farms rather than plantations are much more robust against external shocks and more easily able to recover in a difficult situation economically.

1 Methods and data

1.1 Assessing human capital formation with the age-heaping indicator

In both industrial and agricultural economies, numeracy was clearly a core component of human capital. In agricultural societies, individuals making decisions about the timing of activities had to take a number of issues into account, such as the weather, the status of plants and animals, and other similar variables (Baten 2016).

Measuring the production factor “human capital” has never been simple, as advanced forms of skills are difficult to compare. Economists have therefore resorted to using proxy indicators, such as the share of people signing a marriage register. A comparison of different proxy indicators might be the best option for obtaining reliable insights. This is the rationale for using the age-heaping methodology, which is based on the tendency of poorly educated people to round their age erroneously. For example, less-educated people are more likely than people with greater levels of human capital to state their age as “30,” even if they are in fact 29 or 31 years old.

The calculation of the ABCC Index of numeracy is shown here as a derivation of the Whipple Index (Wh):³

³ “ABCC” comes from the authors’ names A’Hearn, Baten and Crayen (2009), plus Greg Clarks, who inspired this simple linear transformation of the Whipple index with a comment. The underlying Whipple Index is the only one that fulfills the desired properties of scale independence and that ranks samples with different degrees of heaping reliably.

$$(1) Wh = \left(\frac{Age25 + Age30 + Age35 + \dots + Age60}{1/5 * (Age23 + Age24 + Age25 + \dots + Age62)} \right) \times 100$$

$$(2) ABCC = \left(1 - \frac{(Wh - 100)}{400} \right) \times 100 \text{ if } Wh \geq 100 ; \text{ else } ABCC = 100$$

The correlation of numeracy and literacy illustrates that the numeracy indicator is informative. Crayen and Baten (2008) found that the relationship between illiteracy and age-heaping for less developed countries after 1950 is very close. They calculated age-heaping and illiteracy rates for no less than 270,000 individuals who were organized into 416 regions, ranging from Latin America to Oceania. Their findings indicated that the correlation coefficient with illiteracy was as high as 0.7 and that the correlation with modern student test results for numerical skills was as high as 0.85. They therefore concluded that the age-heaping measure “Whipple Index” is more strongly correlated with numerical skills. This correlation was reported in many studies (Appendix A has more examples). Crayen and Baten (2010b) also examined a variety of other potential determinants of age-heaping, such as the degree of bureaucracy (proxied by the number of censuses performed for each individual country up to the period under study), birth registration practices, and government interaction with citizens that potentially influenced the likelihood that an individual would know his or her exact age, independent of personal education. Crayen and Baten found that bureaucracy indicators were mostly insignificant, which would suggest that an independent bureaucracy effect was rather weak. In other words, it appears that societies in which a large number of censuses were conducted and where birth registers were introduced early on had a high degree of age awareness. However, those societies also introduced early schooling, and this was the variable that clearly had more explanatory power than the independent bureaucracy effect. They also tested whether the general standard of living had an influence on age-heaping tendencies (using height as well as GDP per capita as welfare indicators) and found a varying influence.

In some decades there was a statistically significant correlation, while in others there was none.

We should clarify that the time costs incurred by those parents who let their children acquire basic numeracy are not extremely high. Some amount of explanation of numbers when playing children's games requiring number processing is often enough. Still, the costs were and are too high for many families. Families sometimes sent their children to work instead if it was necessary for family survival, with severe consequences for the children (Appendix B).

In conclusion, the correlation between age-heaping and other human capital indicators is well established, and the "bureaucratic" factor does not invalidate this relationship. One caveat relates to other forms of heaping (apart from the heaping on multiples of five), such as heaping on multiples of two, which was quite widespread among children and teenagers and, to a lesser extent, among young adults in their twenties. However, excluding ages younger than 23 is an easy remedy for this. It also shows that most individuals knew their age as teenagers, but only those in well-educated societies were able to remember or calculate their exact age later in life. We will also exclude those above 72 because a number of distortions could affect groups composed of elderly individuals.

1.2 Data

Our sample consists of parish records from the Philippines provided on the website familysearch.org. made available by the church of Later-Day-Saints (LDS), centered in Salt Lake City. It is mostly used for genealogical studies. However, it is also a rich source of evidence for the field of economic history. Particularly comprehensive for our country of study are the death registers of the Philippines, for which 228,853 age statements from many different regions are available, mostly between birth years in the 1800s and 1939. (Clearly we have no evidence on the Muslims living in South East of the Philippines.)

A Hearn et al. (2009) have already made use of the death registers as a source for numeracy estimation. Recently, this type of source was applied even to the ancient Roman period (Baten and Priwitzer 2015) where the authors carefully and comprehensively checked for potential selectivities and biases. While it is obvious that deceased persons did not report their own age, the literature identified close relatives and friends as the most likely source of age statements. In some cases the deceased herself or himself informed the priest about her or his own age before dying. However, in a number of cases priests probably estimated the age of the dead person, which suggests that numeracy is typically underestimated if death registers are used as a source. Priests sometimes used a rounded age if they did not receive information from the family of the deceased, which is an important caveat to studies based on death registers. However, the fraction of ages guessed by the priests must have been small: Bucher (2014) collected a data set of census and death registers. While the death register-based estimates were always systematically lower, he found a very close correlation between the two sources. In addition, we counter-checked our estimates using alternative sources to make sure that this bias is not a problem (see below).

Looking at the number of cases per birth decade, it is standard to organize all numeracy estimates by birth decade because numeracy is usually acquired in the first decade of life (*Table 1*). We have a substantial amount of data for the 19th and early 20th century. It should be noted that the number of cases is particularly low for the first decade which actually includes also some late 18th century figures. The earliest decade should also be viewed with some skepticism due to this small N. Also in the 1930s the number of observations begins to decline.

1. General trends of numeracy

How did numeracy develop in the Philippines? In *Figure 1* we see numeracy development per birth decade. We distinguish between sugar and non-sugar planting districts which will be

important in the following text. In general, there was a decline between the 1820 birth decade and the 1850s both in sugar and non-sugar planting districts. By the middle of the 19th century values were as low as 45 % points of numeracy. There was a certain recovery in the 1860s and 1870s, but only after the 1880s a steady upward increase did set in. The decline by itself already makes an important contribution to the literature. For example, recently Dennison and Ogilvie (2015) mentioned that numeracy tends to increase if people get in contact with markets, which might suggest that numeracy should not decrease as long as contact with markets is given (or even increases, as in the Philippine case).

As we have a more or less continuous increase in numeracy in many countries of the developing world in the 19th and early 20th century, the Philippine decline of the 19th century is particularly interesting. Hence, we will discuss in the following bias analysis whether this decline is consistent or whether it is a statistical artefact caused by issues like survival bias, regional selectivity or source type biases.

2. Checking Potential Biases

Death register Bias:

One of the potential biases could arise from the source that we are mainly using, which is based on death registers. While death registers in general correlate with evidence that we have obtained from relatively unbiased sources such as census registers, they still could be biased for certain cohorts. For example, one potential bias of death registers is that the person is obviously not able to report the own age after death. We compare the trends of numeracy according to the death registers with statements of ages stemming from other institutional backgrounds. For example, one comparison is possible with a sample of marriage registers for the Philippines. We adjusted both sources for the well-known death and marriage bias as suggested in the notes to *Figure 2*. As a result, both series show a strong decline between the birth decades of the 1800s and the 1840s. There is one major deviation in the 1820s. The

death-based numeracy estimates are higher than the marriage-based estimates. A potential reason for this minor deviation could be the regional composition. The marriage and death registers do not have exactly the same regional composition.⁴ In sum, we can conclude that the decline of the early 19th century was not caused by the characteristics of the source ‘death registers’. Also the level of numeracy estimated based on marriage and death registers is quite similar, if the usual adjustments are made.

The comparison of marriage registers and death registers suggests that individuals were not differently selected into death registers. Probably there was not a social bias, because all social strata were registered by the Catholic Church. On the basis of the census of 1903, it can be estimated that around 90% of Filipinos were baptised Catholics in the late 19th century (although practising various ceremonies in a animist-catholic syncretic way), and the Church presumably kept record of their burials. The native population that remained entirely animist accounted for a small share of the total population, with the possible exception of Mindoro island, of the mountainous areas of Abra and Lepanto-Bontoc provinces in northern Luzon, and the regions with majority Muslim population in the southern island of Mindanao, in Palawan island and in the Jolo archipelago.

In addition, we can compare numeracy and literacy in 1902 in order to assess whether the two measures of human capital display similar regional differences (*Figure 3*). In a regression of literacy (in logs) on numeracy (weighted by the population size of the provinces in 1902), we obtain an R^2 value of 0.43, which is a substantial value (not shown). As is usually the case, the ABCC figures are higher than the literacy estimates – a basic numeracy of, say, 80 percent is achieved earlier than a literacy of 30 percent. The formula to convert numeracy into literacy for the Philippines would be minus 33 (= the constant) plus 0.72 points

⁴ In addition, for the death registers, we estimated two decades jointly, so this might also be a reason for the different estimates of the 1820s. (We decided to estimate the 1810s and 1820s jointly on a regional level, because otherwise for the 1810s and 1820s, the number of observations would have been too small in some cases.)

for each additional ABCC unit if we use linear literacy as the dependent variable. In *Figure 3*, we show literacy (in logs) compared to numeracy values and in general there is a substantial correlation. Districts like Manila had of course high numeracy and high literacy but also more rural regions, such as Tayabas, Paragua Sur, Bataan, Rizal were both among the high numeracy and the high literacy cases, whereas Capiz, Batangas, Antique, Iloilo had both low literacy and low numeracy. The deviations were Negros Oriental on the one hand, with a high numeracy but a very modest literary, and Nueva Vizcaya on the other hand, with a relatively high literacy and a comparatively low numeracy. The correlation coefficient between numeracy and literacy is 0.58 ($p=0.000$).

Survivor Bias:

Was the decline of Philippine numeracy during the early 19th century caused by survivor bias? One could imagine that the average age of those born in the 1800 to 1820 decades was much higher than that of the persons born thereafter. As we have mostly retrospective evidence, we are organizing the evidence by birth decade. Therefore, there might be a different subpopulation surviving up to the year of death in which the information about the age was recorded. However, consideration of those aged 63 to 72 only is a commonly used strategy to assess whether there was survivor bias. If we do this, we observe quite similarly high levels of numeracy in the 1810s and 1820s (1820 as it is called in the figure) and the decline thereafter (*Figure 4*). Only the value of the 1800s differs for those aged 63 to 72 compared to all ages, but actually in the opposite direction: “The-all-age-sample” had a higher estimated numeracy value. In general, for the 1830s to 1890s, the all-age estimate is slightly higher, but the difference is normally not very substantial and the trend is very similar.

Regional Bias

Finally, we want to assess, whether there was regional bias (*Table 3*) For example, church records could have been recorded more often in the regions that were more developed from

the beginning (*Figure 1*), so the decline of numeracy could have been a statistical artefact because of this regional bias.

In terms of regional bias, one strategy is to consider which regions were already included for the early period with sufficient samples. If we compare the numeracy of the 1800 - 1820s with the 1830s - 1850s, we observe a decline in almost all provinces, most pronounced in Leyte and Pangasinan and Batangas. Only in one district, Ilocos Sur, there was a small increase in numeracy, so given that we have 9 provinces with a substantial decline of numeracy, it seems unlikely that the overall decline is caused by regional selectivity. It rather seems to be a widespread phenomenon. It is also interesting to see that the provinces for which evidence is available were quite widespread over the northern and central Philippines.

3. Regional economic structure and development of the Philippines during the 19th C

The regional specialisation in different types of cash crop cultivation, mainly abacá, sugar, and tobacco, in different socio-economic and environmental setting enables us to consider the role of institutions, exposure to diseases, seasonal migration, and income volatility. In the case of abacá, the Bicol peninsula (the southeast of Luzon: provinces 2, 3 and 43 in Figure 6) became the most important cash crop producing region in the mid-19th century. The population grew at a very rapid pace in the first half of the 19th century, 1.5% per annum on average, from less than 150,000 in 1794 to almost 400,000 in 1862. In spite of a series of epidemics, demographic growth remained close to 1% in the last four decades of the 19th century. The population exceeded 600,000 in 1903, and it increased further in the early 20th century, reaching 1.164 million at the time of the 1938 census (Owen 1984, 116). Abacá requires only limited labor input, as opposed to wet-rice cultivation. As the cultivation calendars of rice and abacá do not overlap much, these two crops were not competing in terms of time allocation. Abacá was well suited for cultivation on non-irrigated land and does not compete with wet-rice cultivation (rice was also cultivated in rain-fed fields in the early 19th

century). Abacá and rice therefore existed side by side in most districts; the expansion of abacá cultivation did not require massive seasonal migration. Rice remained the main agricultural activity of the subsistence economy, and although rice was mostly self consumed, it was an essential albeit secondary source of cash income for most workers involved in abacá (ibid 121) and the region remained self-sufficient in rice until the mid-19th century (ibid. 130). The institutional arrangements and size of land estates were not much different for both main crops, with a combination of cultivation by smallholders as well as in relatively large land estates owned by the church or members of the social elite. The economy of Bicol peninsula gradually evolved from labor scarcity in the early 19th to land scarcity in the early 20th century. As a result, other provinces with relatively low population density, such as Leyte in the Visayas and Misamis in northern Mindanao, became significant abacá producers in the late 19th century.

Sugar from sugarcane has traditionally been part of the standard diet in most provinces of the Philippines, although in moderate quantities. In the 19th century, it became an important cash crop supplementing agricultural income from rice in around one third of provinces, mostly in central Luzon and in the Visayas (provinces 12, 20, 32, 33, 14, 9, 26 and 41 in Figure 6). In contrast to abacá, sugarcane cultivation required high labor inputs for both plantation work and harvest. In provinces that already had a relatively high population density and where little uncultivated land of high natural fertility was available, in particular in Ilocos Norte and Ilocos Sur provinces, sugar competed with rice for both land and labor. But in most provinces, sugar plantations were established in areas that were not previously under permanent cultivation, such as slash and burn areas occupied by Negrito animist populations in Pampanga province (Larkin 1972). This implies land reclamation and therefore eventual exposure to severe strains of tropical diseases. In addition, in the main two producing provinces, Pampanga in central Luzon and Negros Occidental in the Visayas, sugar cultivation required migration. In Pampanga, sugar plantations were established in the western

part of the province, as an almost exclusive monoculture, while rice remained the predominant crop in the central part of the province (Larkin 1972, 6, 8, 67). Although the distance between the two areas is compatible with seasonal migration, the development of sugar plantations resulted in a rapid demographic growth in the municipalities of the sugar zone (ibid. 68) and land concentration, mostly in the hand of the new mestizo social elite. In Negros Occidental, where population density was low and virgin land abundant, most of the labor force had to come from other provinces of the Visayas. The population of Negros Occidental increased rapidly, from around 35,000 around 1845 to 154,000 around 1886, and 303,000 around 1903; during the same period, sugar output jumped from 3,000 piculs to 575,000, and then 1,384,000 (Larkin 1993, 61).

The expansion of abacá and sugar cultivation mostly took place in newly reclaimed land tracks, with land titles granted in arbitrary fashion by the colonial administration to members of the local elites of mestizos resulting of intermarriages between offspring of Chinese immigrants and of traditional chieftains or village heads (Owen 1984; Larkin 1974, 1993). Huetz de Lemps (2006) argues that both the local and the central colonial administrations were plagued by corruption.

Tobacco too was also cultivated in most provinces of the 18th and 19th century Philippines. The public monopoly established in 1766 restricted the cultivation for commercial purpose to a small area, the *Gapan colección*, a group of municipalities including Gapan, in Nueva Ecija province, and of the *Gagayan colección*, a group of municipalities in the Cagayan valley, but small scale production for self consumption was tolerated in all other areas.⁵ Neither in Gapan nor in Cagayan did tobacco cultivation compete with other crops for

⁵ The area of the *Gapan colección* covered the southern part of Nueva Ecija province, as well as in the northern part of Bulacan and eastern part of Tarlac province; De Jesus 1980, p. 36). Total output was around 30,000 *fardos* (one *fardo*: 4000 tobacco leaves) per year and declined somehow thereafter (ibid., p. 207). The municipalities of the *Gagayan colección* were located in the central part of the provinces of Cagayan and Isabela; ibid. p. 108). Tobacco production expanded in these areas mostly from the 1850s: 10,000 to 20,000

land, but it did for labor. This was not a problem in the area of the *Gapan colección* that had already a relatively high population density, by the standards of the Philippines, in the early 19th century. The area of the *Gagayan colección*, however, was a land frontier attracting immigrants from the relatively high population density provinces of central Luzon and the northwestern coast. Apart from hostility of local rural animist communities, which remained out of control of the Church and the colonial authorities until second half of the 19th century, tobacco producers were facing three main difficulties: risk of exposure to diseases related to land reclamation, delays in the payment for the sales of tobacco leaves by the monopoly, and the shortage of staples as locally produced corn was not sufficient for local food consumption. Rice had to be imported from the high population density provinces of central Luzon and the northwestern coast that had some surplus in normal years. Tobacco producers were therefore exposed to the fluctuation of relative prices (rice/tobacco and maize/tobacco). In these events, their difficulties were amplified by the irregularity of payments to producers by the monopoly and resulted in a long term trend of land concentration.

4. Regression analysis

In the following, we will assess whether it was really the introduction of cash crops which had adverse effects on human capital formation.

Simon Kuznets' idea of rising inequality during industrial development might apply to agricultural innovations as well. In the first stages of the cash crop boom only some social group benefit while in later stages of development, broader segments of the population might eventually obtain their share of the additional income generated by this new crop. However, the evaluation of the shift to a cash crop economy is often associated with the first phase – if

fardos in the 1820s, 47,412 in 1850, 253,360 in 1860, 303,162, 462,419 (ibid. p. 209; no data for 1831-1849, 1851-1859, and 1861-1864; continuous series for 1865-1874, around 400,000 per year).

this introductory phase was accompanied by large social problems, the overall effect of the introduction is perceived to be negative.

Three additional negative externalities were commonly observed in other countries and periods during the initial phase of expansion of cash crop production: disease exposure, migration, and price/income volatility. Land reclamation in forest areas, particularly in tropical countries, increases the exposure to severe strains of diseases, directly affecting the health component of human capital and indirectly leading to a decrease in its cognitive component. As cash crop plantations are usually established at some distance from the main settlements, seasonal work undertaken by unskilled workers results in temporary migration that disrupts subsistence agricultural production as well as family life and social relations at the village level. These temporary migrations generate additional cash income but also sometimes enhance the demand for child labor at home (because one or both of the parents are absent) and therefore adversely affect the accumulation of cognitive skills by children. Plantation wage earners and tenants are exposed to cash crop price and income volatility, with adverse effect on the nutritional status of household members, particularly children. When cash crop cultivation expands in remote areas with low population density, it is usually the sole crop and plantation workers rely on supply from other regions for their staple food consumption. Although the absolute price of staples could be high in plantation areas due to transportation costs, the revenues from cash crops are sufficient to cover these additional costs in normal circumstances, making the local production of staples uneconomical in a situation of relative labor scarcity.

These externalities would imply that in the introduction or expansion phase of cash-crops, the human capital investment might have been lower. But was this really the case on the Philippines?

We perform regressions of numeracy for the 19th century in which our main explanatory variables are indicating whether a certain cash crop was cultivated in a certain region (*Table*

4). For example, for sugar, we use those regions which had substantial sugar production. The literature identified the main sugar production regions (Larkin 1984, 1992; Census 1903). We included one dummy variable for the introductory phase (1850s-1870s) for all these provinces of sugar production. We also included dummy variables for 1800-1850 for the regions that would become later sugar-producers in order to identify potential characteristics that were not caused by sugar. Finally, we included a dummy for the ‘maturity’ phase of the 1880s and the 1890s. The end of this maturity phase was also characterized by military conflicts.⁶

Abacá production, was most important in the three provinces of Albay, Ambos Camarines, and Sorsogon. However, other provinces also planted this cash-crop in substantial amount (*Table 5*). For tobacco, we included Ilocos Norte, Ilocos Sur, La Union, and Pangasinan as central provinces for this crop, but again assigned all provinces with tobacco with a dummy variable.

In addition, we included in a following regressions a variable for urbanization which represents the provinces that contained the largest cities of the country during the 19th century. We included also a binary variable for natural disaster based on the regional history provided in the 1918 census. We include a variable for large immigration into a province. Similarly, we control for population density in 1800 with a dummy based on Reid (1988) that separates the higher population densities on Luzon and the Visayas from lower density provinces of Mindanao. Finally, we also control for the number of inhabitants per priest as the priest density might have implications for setting up Sunday schools.

In the first column of our regression, we tested the most parsimonious model using only the different interaction terms of provinces of Philippines, that have introduced cash crops, such as sugar, abacá or tobacco.

⁶ The nationalist uprising against Spanish rule in 1896-1898, and the military operation between nationalist troops and the U.S. expeditionary corps that gradual occupied the Archipelago in 1898-1903, resulted in an almost entire collapse of cash crop production.

As can be observed in the first column, in the pre-1850s the districts which have later the highest output per capita of the cash crop of sugar had already a substantially lower numeracy (-10 %), when compared to those which have never introduced any significant amount of cash crop (the constant; Table 5, see also Figure). In the introductory phase (1850-1879), the negative numeracy gap of these regions had declined, i.e. the numeracy in the sugar provinces improved. Yet, the sugar districts could still not reach the other agricultural districts represented by the constant during mid-century. In the final phase, the effect in sugar provinces was insignificant.

For the second most important cash crop - abacá - according to our regressions, the impact during all the sub-periods was found to be insignificant. As for tobacco, its estimated effect was positive and significant relative to the constant in the pre-cash-crop phase. However, in the main phase of rapid tobacco expansion (1850s - 70s) the coefficient became insignificant. Relative to the large positive coefficient of the pre-expansion phase, this suggests a substantial drop. What can explain the negative development in the tobacco districts? Studies of the development of cash crop production in 19th century Philippines suggest that specific institutions played a negative role. The tobacco public monopoly, established in 1766 and abolished in 1880, performed very badly during most of the period of operation and deprived producers of their income. Tobacco...#rephrasethe following sentence a bit:# Tobacco producers were therefore exposed to the fluctuation of relative prices (rice/tobacco and maize/tobacco). In these events, their difficulties were amplified by the irregularity of payments to producers by the monopoly and resulted in a long term trend of land concentration.

In sum, the hypothesis that the introduction of the cash crop sugar led to lower numeracy cannot be confirmed. The low level existed before 1850 already, i.e. during the initial phase of land reclamation for the establishment of sugar plantations, particularly in the provinces of Pampanga and Negros occidental. During that phase, output and export volumes

remained small in comparison with the phase of rapid expansion of the 1850s and 1860s. It seems likely that the cash-crops plantations were founded in provinces that happened to have low numeracy and immigration of workers from other provinces did not result in changing these ratios. However, the income from sugar was also not sufficient to generate a substantial increase of human capital investment. At least it was not large enough to reach “normal” Philippine level. Only towards the end of the 19th century the cash-crop regions converged to the ‘other’ agricultural regions. The regions in which tobacco was introduced suffered from difficult situation during the cash crop introduction face (1850 – 1879) relative to before and after.

Finally, we were curious how the effect of the most important cash crop, sugar, developed in the early 20th century. In particular, we assess whether it might have been not sugar *per se* which had a potentially negative effect but whether there might have been an interaction with land inequality. We can measure this variable for the early 20th century (but unfortunately not for earlier periods). We took the land inequality values by calculating the share of the farms which had at least 30 ha. We use the censuses of 1903 for the birth decades of the 1900s and 1910s and the land inequality in the census of 1918 to assess the effect on numeracy of the birth decades of the 1920s and 1930s. We calculated the area share of the larger farms by province (and took logs of this variable). In order to assess potential non-linearities, we also added a dummy variable for high land inequality which covers those districts which have 40% and more area farmed by the large land owners. As an effect, we still find a small negative correlation between numeracy and sugar in the 1900 and the 1910s numeracy regression. But we find that this was probably not caused by land inequality, because we actually have a positive yet insignificant effect for land inequality (*Table 6*). If we assign the dummy variable to the high land inequality cases, we even have a positive numeracy effect which might have been caused by a higher productivity in these high land inequality regions or by other factors. Secondly, if we regress the numeracy of the 1920s and

1930s on sugar production kg/capita and include also the ‘high land inequality’ dummy variable, we find no effect of sugar for this later period, but a positive effect of land inequality. In this regression, we control for time fixed effects using a dummy variable for one of the birth decades. In general, we see that it was probably not land inequality that was behind the cash-crop effect, although we can assess this only for the 20th century. Any potential effect of sugar disappeared in the early 20th century.

5. International Comparisons

The changes in numeracy levels observed in the Philippines since the early 19th century invite to further investigate the historical trend in human capital levels in other Southeast Asian countries. The estimates of numeracy generated by Crayen and Baten (2010) using census data show an upward trend in the late 19th century in Southeast Asian countries, with absolute levels well above those of India and Middle Eastern countries, but much lower than in East Asia (China, Japan, and Korea, were close to the top World level).

High levels of numeracy are observed in the different regions of coastal China in the 19th century (Baten et al. 2005), including in the Fujian province, which was the region of origin of most Chinese immigrants in the Philippines. This suggest that ethnic Chinese communities in the Philippines, broadly defined as to include also the mestizo communities which were more involved in cash crop agricultural production that recent Chinese immigrants, had brought some skills from China and had a comparative advantage related to their numeracy level. The upward trend in numeracy starting in the mid-19th century could be interpreted as the consequence of their high numeracy skills trickling down towards the entire population. But since the Chinese were already present in the early 19th century, this cannot explain the high initial level, the downward trend and the specific role of sugar cultivation in this process.

Conclusion

In this first quantitative study on the numeracy development of the Philippines, we find a high numeracy level at the beginning of the 19th century. Qualitative information on literacy collected but Reid (1988) suggests that a large part of the rural male and female population of Southeast Asian countries was able to read and write poetry well before the arrival of Westerners. In Luzon and in the Visayas local syllabic scripts derived from Brahmi scripts of India (introduced via present-day Indonesia and Malaysia), in particular *baybayin* (Scott 1984), remained in use until the 19th century. The most common mode of knowledge transmission was informal at the family or village level. Since numeracy is usually strongly correlated with literacy, the high numeracy of early 19th century Philippines can be regarded as a legacy of the pre-colonial past. The disruption of family life and of the social life in village communities that resulted from massive seasonal migrations during the initial period of expansion of sugar plantations appears therefore as a plausible explanation for the decline of numeracy observed in the early 19th century. A partial explanation for the stagnation might have been the deindustrialization (even if cottage textile was limited in size #or not? If not, please correct#).

The results presented above indicate that the Philippines experienced a decline in the level of human capital, as measured by numeracy, in the initial phase of expansion of cash crop cultivation in the mid-19 century. This was a temporary phenomenon. Numeracy fully recovered the initial level of the early 19th century only during the first decades of the 20th century. The fact that the same upward trend is observed before the national uprising of 1896 and after the imposition of the US colonial rule in 1898 suggests that local forces were at play in this process before the possible additional effect of mass primary education introduced by the US colonial authorities. Land inequality does not seem to play an important role as explanatory variable of differences in numeracy levels across provinces. Therefore, the upward trend in numeracy in the late 19th century could be considered as evidence of the long

term gains of the shift to cash crop production, as opposed to the heavy cost burden for the birth cohorts of the 1830s to 1880s, or at least of an adaptation of rural population to the new environment in which the return on investment to the numeracy component of human capital was increasing.

In a panel regression analysis of the Philippine provinces and birth decades, we studied whether it was really the cash-crop expansion that was the culprit. Based on the earlier literature, we expected sugar plantation provinces to be responsible for the decline in numeracy. However, the result was a very differentiated picture. In the (later) “sugar provinces”, the coefficient changed from very large and negative during the pre-expansion phase to only large and negative in the expansion phase (relative to other rural districts without substantial cash-crop expansion). Abacá provinces were never much different from the constant. It seems that these two cash-crops did not cause the decline of numeracy directly. However, an indirect effect could be imagined, as the population structure of the Philippines changed substantially: the sugar provinces experienced massive immigration and population growth. Hence a smaller part of the decline could have been caused by the increase of the population share in low-numeracy sugar provinces. Unfortunately, population statistics are not precise enough to calculate the size of this effect. A second result is that the expansion of tobacco probably had a negative effect. This development was partially caused by a very negative institutional setting in the tobacco cash-crop economies. As a conclusion, the hypothesis that there was a “curse of point-source resources” needs to be qualified for the Philippines in the 19th century. In general the method of age-heaping based numeracy analysis allows to study the specific effects for individual cash-crops and different institutional

settings, which is an important strategy to understand development processes in poorer countries.⁷

⁷ It is, however, worth noting that this rise in capabilities related to numeracy did not materialize as improvement in biological standard of living but, quite to the opposite, took place in a context of declining height (Bassino, Dosis and Komlos 2015). This indicates that the shift from subsistence agriculture to cash crop specialization resulted in a decline in the biological standard of living in the Philippines. A similar downward trend of height occurred in lower Burma, where rice was the main cash crop, during the expansion of paddy cultivation for export in the second half of the 19th century (Bassino and Coclanis 2008). Often a decline in numeracy is followed by a decline in living standards one generation later. This was also the case in China where numeracy declined in the 1840s and 1850s (height as a measure of living standards in the later 19th century, see Baten et al. 2010). Also in England this was the case around 1800 (height declined in the 1830s and 40s, see Komlos#).

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Tables and FiguresTable 1: Number of underlying cases by birth decade

bdec	Underlying cases
1760s-1800s	132
1810s-1820s	1248
1830	3884
1840	6196
1850	20653
1860	27013
1870	31479
1880	42116
1890	42596
1900	27181
1910	18174
1920	6126
1930	2055
<u>Total</u>	<u>228853</u>

Table 3: Regional bias

Was there regional bias, because the earlier provinces might have been a selective sample of Philippine provinces? This seems unlikely, because in all provinces except one for which we have sufficient cases both in 1800-1820 and 1830-50, there is a decline in numeracy, except one (Ilocos Sur):

prov	bdec18001820	bdec18201850	diffbdec18001820_18301850
Leyte	78.1	32.4	-45.7
Pangasinan	77.7	39.9	-37.8
Batangas	92.3	60.8	-31.4
La Union	88.8	58.8	-30.0
Tarlac	92.7	69.4	-23.3
Pampanga	71.9	52.2	-19.7
Manila	72.7	58.3	-14.3
Cebu	57.7	46.2	-11.5
Iloilo	50.9	42.4	-8.6
Ilocos Sur	54.3	64.9	10.6

Table 4: Regressions of numeracy during the 19th Century

	(1)	(2)	(3)	(4)	(5)	(6)
sugar1_pre1850	-10.31*	-10.42*	-10.42*	-10.40*	-10.05	-5.64
	(0.062)	(0.082)	(0.082)	(0.087)	(0.107)	(0.159)
sugar1_185070	-6.12*	-5.92*	-5.92*	-5.90*	-5.32*	-3.39
	(0.076)	(0.053)	(0.055)	(0.061)	(0.097)	(0.252)
sugar1_post1880	-2.51	-2.29	-2.29	-2.28	-1.67	0.31
	(0.490)	(0.479)	(0.483)	(0.496)	(0.621)	(0.929)
abaca1_pre1850	-1.05	1.08	1.08	1.08	1.28	0.85
	(0.815)	(0.829)	(0.830)	(0.829)	(0.799)	(0.815)
abaca1_185070	-2.78	-0.41	-0.41	-0.40	-0.31	0.71
	(0.496)	(0.909)	(0.910)	(0.912)	(0.931)	(0.824)
abaca1_post1880	0.42	2.82	2.82	2.83	2.94	3.96
	(0.923)	(0.470)	(0.476)	(0.477)	(0.460)	(0.287)
tobacco1_pre1850	24.91**	27.83**	27.83**	27.82**	29.97**	28.55***
	(0.024)	(0.014)	(0.015)	(0.015)	(0.016)	(0.008)

tobacco1_185070	-1.65	1.13	1.13	1.14	1.87	3.24
	(0.732)	(0.787)	(0.788)	(0.787)	(0.677)	(0.390)
tobacco1_post1880	1.07	3.84	3.84	3.85	4.52	6.00*
	(0.812)	(0.309)	(0.311)	(0.314)	(0.268)	(0.076)
urban		6.17	6.17	6.14	6.42	-1.94
		(0.200)	(0.201)	(0.223)	(0.203)	(0.441)
popdenshigh1800			0.02	0.02	0.21	-0.49
			(0.995)	(0.996)	(0.947)	(0.873)
naturaldisaster				0.62	0.40	
				(0.912)	(0.943)	
immigration					-3.05	-1.24
					(0.452)	(0.737)
Souls per priest						0.00
						(0.217)
Constant	61.81***	58.98***	58.97***	58.95***	58.70***	54.45***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	375	375	375	375	375	370
Adj. R-squared	0.0823	0.117	0.114	0.112	0.117	0.101

Table 5: Number of cases by ever planted cash-crop

Period	sugar	abacá	tob	no sugar
1800-49	6372	4431	2256	5088
1850-79	40228	45203	22730	38894
1880-99	42906	47899	22877	41786
1900-39	26344	27776	12761	27186
<u>Total</u>	<u>115850</u>	<u>125309</u>	<u>60624</u>	<u>112954</u>

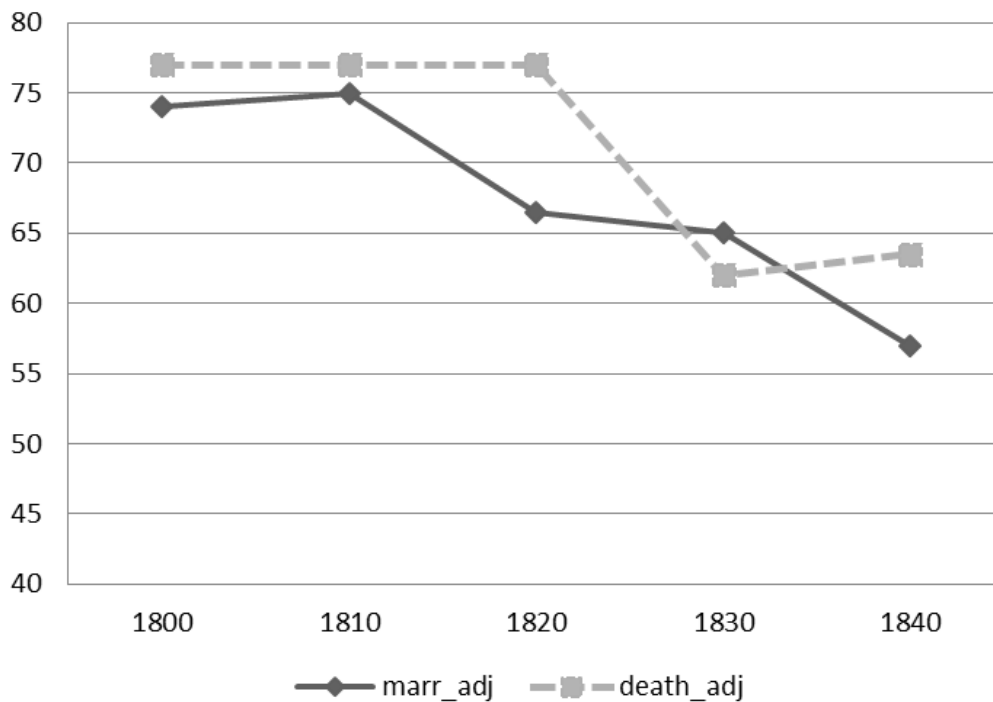
Table 6: Regressions of numeracy during the 20th Century

	(1)	(2)
Period	1900s/1910s	1920s/1930s
Sugar (kg p.c.)	-0.05***	-0.00
	(0.003)	(0.978)
Land ineq	0.66	3.05**
	(0.727)	(0.029)
High land ineq	7.84**	1.98
	(0.047)	(0.819)
Time FE	Yes	Yes
Constant	80.80***	95.93***
	(0.000)	(0.000)
Observations	115	82
R-squared	0.0436	0.203

Figure 1: Numeracy by Sugar and Non-sugar planting districts



Figure 2: Numeracy according to death and marriage registers

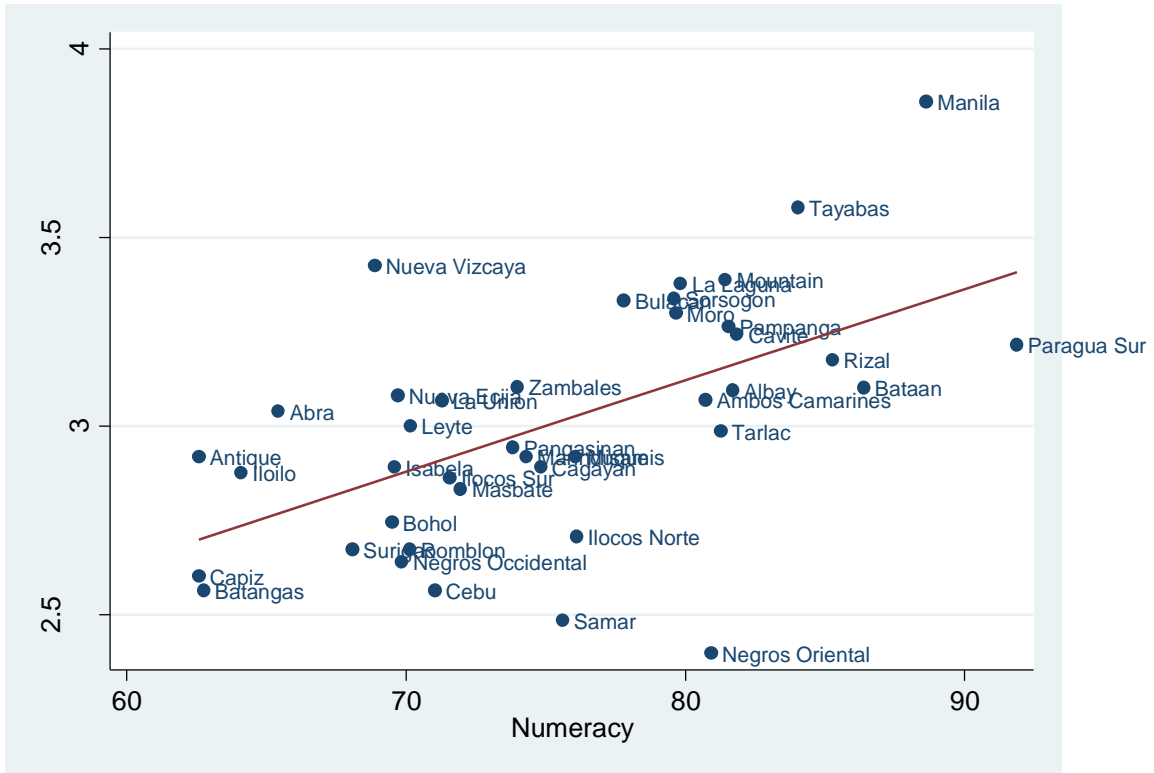


Comparing the trends of numeracy according to death and marriage registers (both sources adjusted for death/marriage bias). Death register: one value for 1810s/1820s. Both marriage and death register sources suggest a decline. The only deviation is caused that we could estimate only one value for the 1810s and 1820s jointly

Note: Death register: one value for 1810s/1820s. These first estimates were performed by Julia Plötz and Tobias Bucher (Human

Capital Trends in Central America and the Caribbean from the 18th to the 20th Century; Regionale Humankapitalentwicklung in England während der Industriellen Revolution: können Indikatoren auf Basis von Sterberegistern gebildet werden?). They compared numeracy estimates for countries and birth decades for which we have both census data (usually relatively unbiased), and marriage (upwardly biased) and death registers (downwardly biased). The idea of the figures is that you can look up the observed level of numeracy of marriage registers on the horizontal axis. The adjustment factor can then be read from the vertical axis. Alternatively, you can use the formula: Adjustment factor (negative!) = $-5.51 + 0.264 * \text{observed_numeracy_in_marriage_register}$. For example, an observed marriage register numeracy of 40 would then be adjusted downward by $(40 * 0.264) - 5.51 = 10.56 - 5.51 = 5.05$. The observed numeracy of 40 is upwardly biased (because most marriages take place in the early 20s, hence there are many more aged 23 than 30), and the estimate of unbiased numeracy would be $40 - 5.05 = 34.95$ then. The whole formula would be $ABCC_adj = -5.51 + 0.736 * ABCCobs$, but it should be only applied to cases substantially below 100% numeracy (the values entering the regression were below 80%, so only for cases below 80% the formula should be used). The same can be done for death registers, but here we have usually a downward bias (as some persons died without having close relatives who usually informed the priest, and the single/widowed persons also did not tell the priest their age before dying, so that priest estimated the age in some cases, usually using a round number). Here the formula would be $ABCC_adj = 19.38 + 1.202 * \text{observed_numeracy_in_death_register}$. For example, an observed death register numeracy of 40 would then be adjusted upward by 11.3, hence the estimate of unbiased numeracy would be 51.3 then. $ABCC_adj = 19.38 + 1.202 * ABCCobs$

Figure 3: Literacy and Numeracy



Correlation coefficient between numeracy and literacy 0.58 (p=0.000)

Figure 4: Survivor bias



Figure 5, Panel A: Numeracy in “Sugar” Provinces (Coefficients of Model 5 in Table 4)

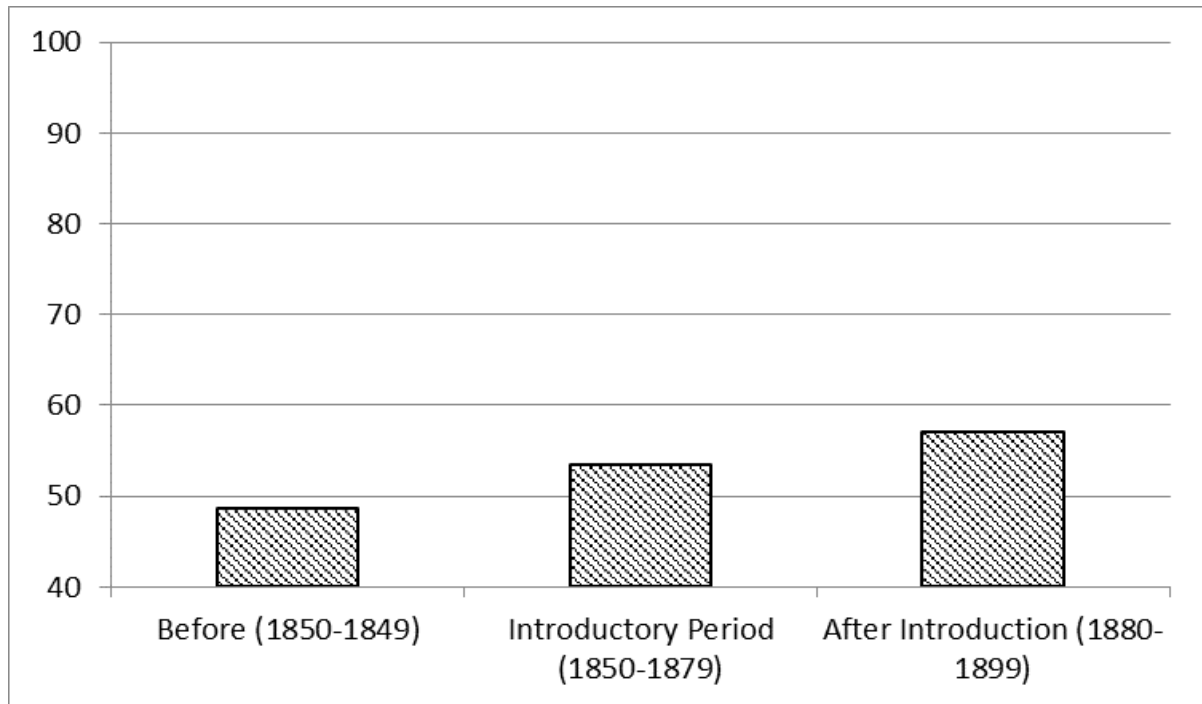


Figure 5, Panel B: Numeracy in “Abaca” Provinces (Coefficients of Model 5 in Table 4)

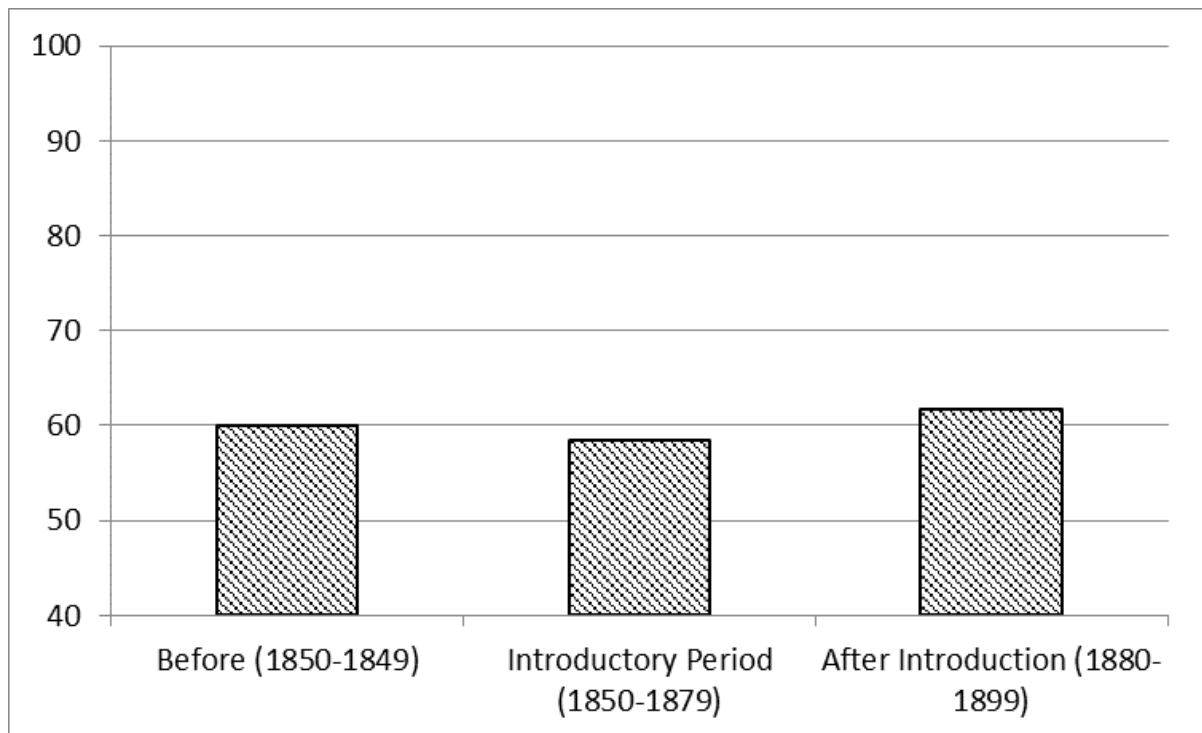


Figure 5. Panel A: Numeracy in “Tobacco” Provinces (Coefficients of Model 5 in Table 4)

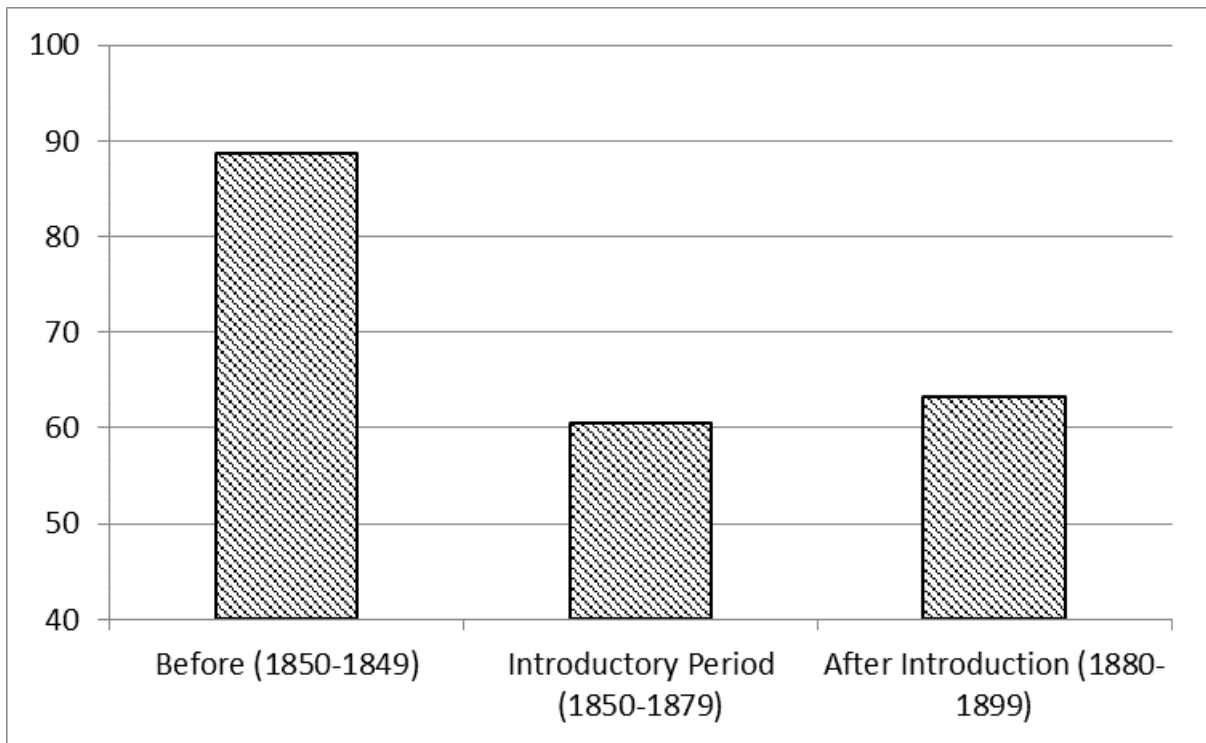


Figure 6a: Numeracy of birth cohort 1860-69

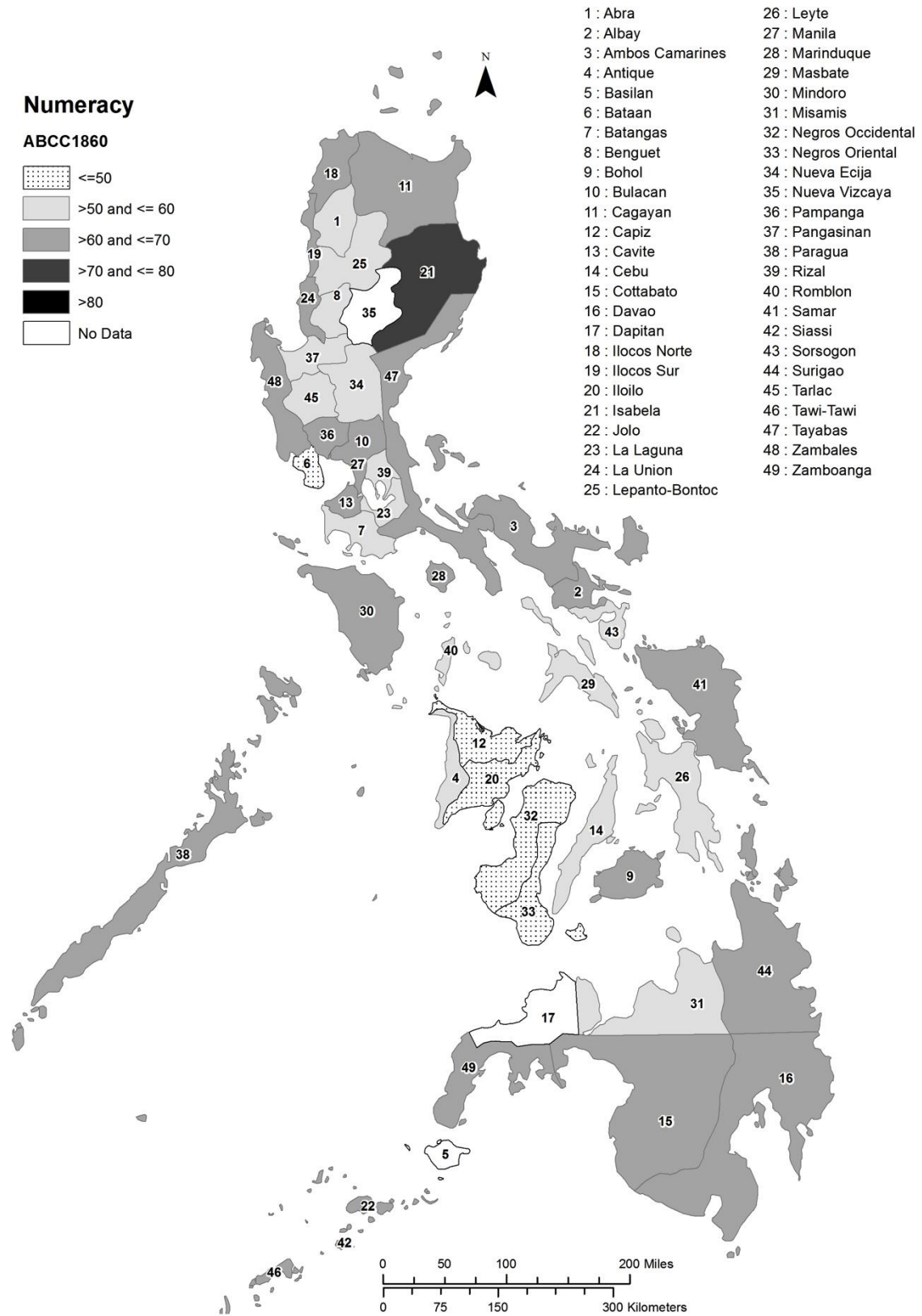


Figure 6b: Numeracy of birth cohort 1880-89

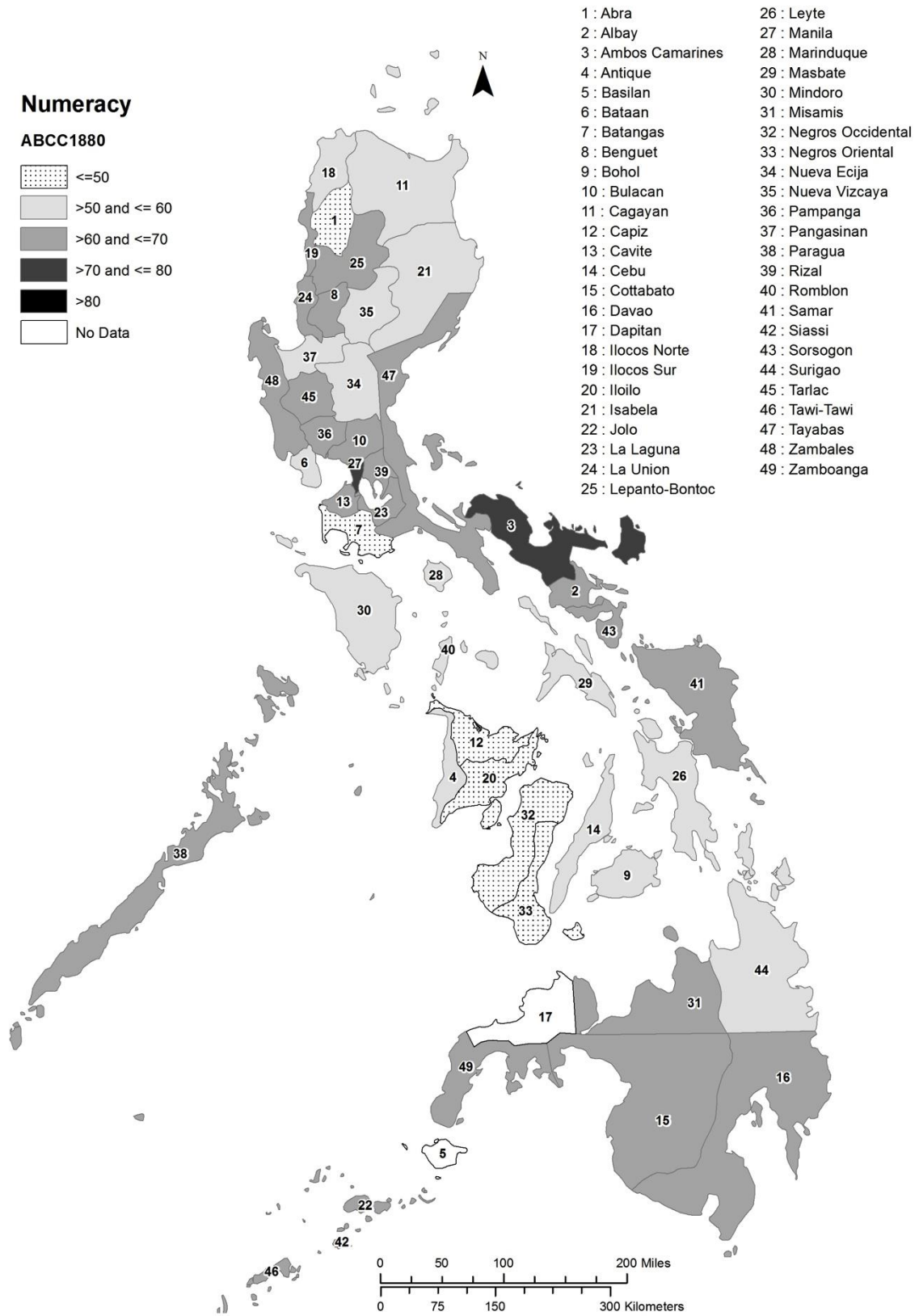
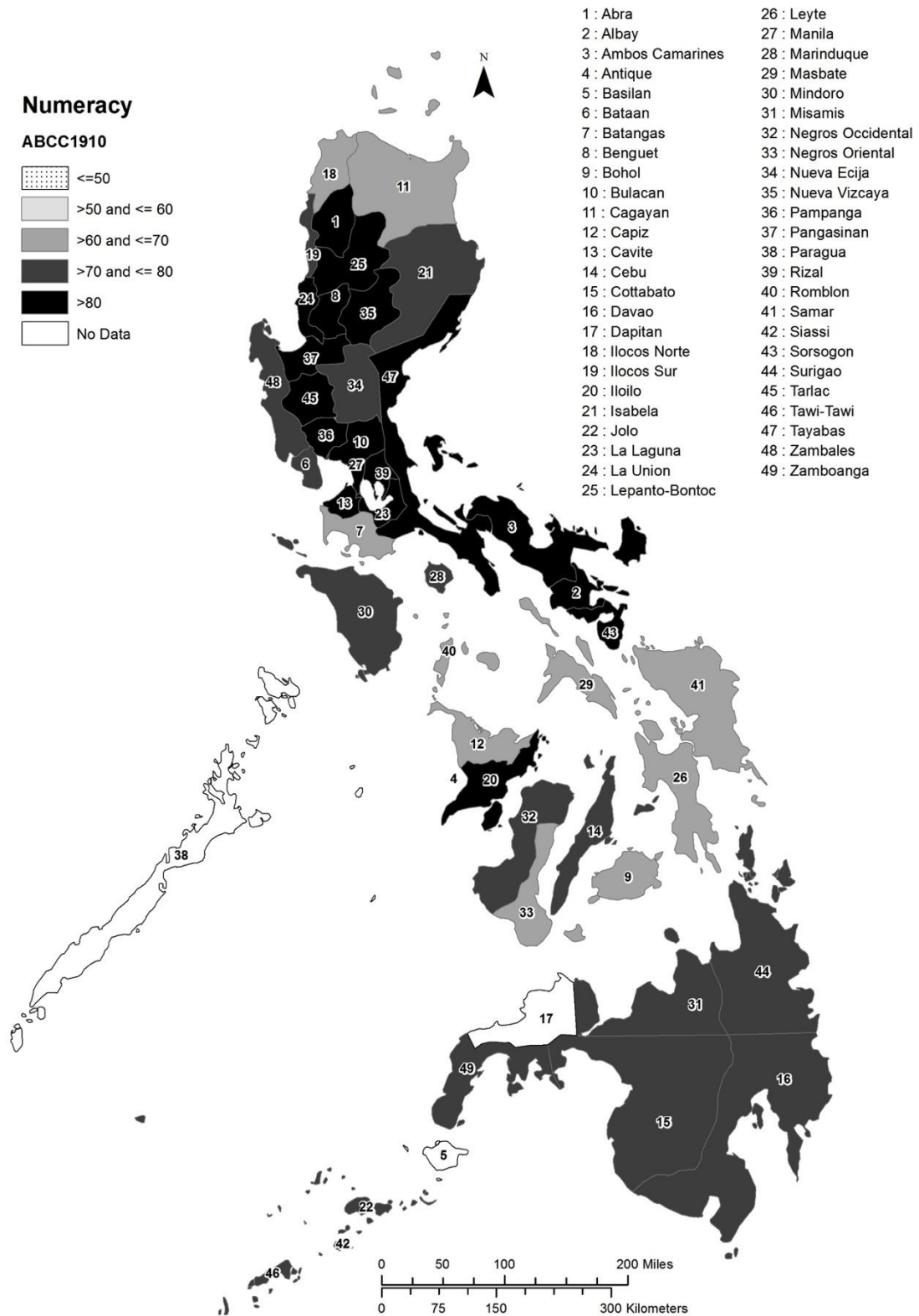


Figure 6a: Numeracy of birth cohort 1910-19



Appendix

Appendix A

More details on the age-heaping method

Many young males and females married in their early twenties or late teens, when they also had to register as voters, military conscripts, etc. On such occasions, they were sometimes subject to minimum age requirements, a condition that gave rise to increased age awareness. Moreover, individuals in this age group were physically growing, which made it easier to determine their age with a relatively high degree of accuracy. All these factors contributed to a reduction in age-heaping among children and young adults relative to levels observed among older adults. Because the age-heaping patterns of very old individuals were subject to upward as well as downward bias for the reasons mentioned above, the very old should also be excluded.

A question that needs careful study is whether the age-heaping found in the sources reflects the numeracy of the responding individual or, rather, the diligence of the reporting personnel who wrote down the statements (e.g., Szołtysek 2011, 2014). The age data of the relevant age groups of 23-72 were normally derived from statements from the person himself or herself. However, it is possible that a second party, especially the household head, the father, or the husband, may have made or influenced the age statement. It is even possible that the enumerator estimated the age without asking the individual (especially for lodgers, inmates, or other temporary household members such as unrelated servants). In such cases, we would not be able to measure the numeracy of the person interviewed. By contrast, if the enumerator asked the person for his or her age and obtained no response, a round age estimated by the enumerator would still measure basic numeracy correctly. A large body of literature has investigated the issue of how to handle cases in which individuals did not report their own information. In the early modern period and the nineteenth century, marriage was

often associated with higher educational and social status, as a number of studies have found (for example, Baten and Murray 1998). Our comparison of male and female numeracy in our sample indicated that women were sometimes more numerate than men, which would support the hypothesis that the accuracy of age reporting may have been higher among women than among men. Friesen et al. (2011) recently systematically compared the evidence of a gender gap in numeracy and in literacy for the late nineteenth and early twentieth centuries and found a strong correlation. They argued that there is no reason why the misreporting of literacy and age should have yielded exactly the same gap between genders. A more likely explanation is that the well-known correlation between numeracy and literacy also applies to gender differences.

Moreover, there is sometimes direct evidence in the sources that the wives themselves were asked. Manzel et al. (2011) reported finding sources on Latin American Indio women in which statements such as the following were included: “She says that she is 30, but she looks more like 40.” Even for black female (and male) slaves in the Cape Colony in South Africa who were accused of crimes, the legal personnel created a separate column that indicated whether the person was guessing her age or whether she actually knew it. We can speculate that if these Indio and African women—who probably were not shown much respect by colonial officers—were asked to report their age, then European women—who were likely treated with a greater level of respect—might also have been asked to report their age. For our study, the question of whether the women answered themselves is slightly less important because we only seek to estimate average numeracy.

The problem of different enumerators influencing the quality of age statements has also been studied in a twentieth century context. While a large part of age misreporting indeed arises because the respondents do not know their exact age, this problem is likely to be exacerbated by differences in the quality of the performance of the enumerators, as some of them may have taken their duties more seriously than others (United Nations 1952, 59).

Referring to the notorious hardships encountered in the surveying processes in contemporary developing countries, Ewbank observed: “In particular, the training of interviewers, their level of education, and their ability to understand and pursue the interests of the researcher will significantly affect the quality of data [on age]” (Ewbank 1981, 15). However, the difference between the behavior of twentieth century enumerators and the priests and officials of the seventeenth to nineteenth centuries is that the former had much easier access to sources that would enable them to cross-check age statements. Priests of the eighteenth century could have looked up birth years in birth registers, but because the registers were usually chronologically sorted, the cross-checking of ages would have required a substantial investment of time. However, as some of the existing sources were clearly cross-checked (yielding ABCC values of approximately 100 very early), we used a historian’s judgment in excluding them. In addition, Szoltysek (2011, 2014 – Appendix 2) found that differences in the age-heaping patterns in historical Poland-Lithuania might be partly attributable to differences in the organizing principles of the enumeration process that are inherent to different types of listings and not to differences in the capabilities of the individuals being surveyed.

Of course, a potential bias always exists if more than one person is involved in the creation of a historical source. For example, if literacy is measured by analyzing the share of signatures in marriage contracts, there might have been priests who were more or less interested in obtaining real signatures as opposed to just crosses or other symbols. We are reassured in our assumptions by the findings of previous studies, which generally indicate that age-heaping was much more prevalent (and numeracy levels were lower) among members of the lower social strata and among the half of the sample population who had lower anthropometric values (Baten and Mumme 2010). Moreover, studies have shown that the regional differences in the prevalence of age-heaping were similar to the regional differences in illiteracy. We can therefore conclude that the method of age-heaping is a useful and innovative tool for assessing human capital.

A'Hearn, Baten, and Crayen (2009) used a large U.S. census sample to perform a very detailed analysis, and they confirmed a significant relationship. It is also remarkable that the coefficients were found to be relatively stable between samples; i.e., a unit change in age-heaping was associated with similar changes in literacy across the various tests.

To assess the robustness of those U.S. census results and the similar conclusions that could be drawn from the less-developed countries of the late twentieth century, A'Hearn et al. (2009) also assessed age-heaping and literacy in 16 different European countries between the middle ages and the early nineteenth century. Again, they found a positive correlation between age-heaping and literacy.

The widest geographical sample studied so far was created by Crayen and Baten (2010b). This sample included 70 countries for which both age-heaping and schooling data (as well as other explanatory variables) were available. They found in a series of cross-sections between the 1880s and 1940s that primary schooling and age-heaping were closely correlated, with R-squares between 0.55 and 0.76 (including other control variables, see below). Again, the coefficients were shown to be relatively stable over time.

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