Numeracy of Africans, Asians, and Europeans during the early modern period: new evidence from Cape Colony court registers

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The authors would like to thank Gustav Heindrich for valuable research assistance, and NOW ClioInfra and the DFG-SFB 1070 RessourceCultures for background support of data collection.

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Text and footnotes: 9631 words

Please note: This is not the final version of this paper. A later version has been published in the Economic History Review.

ABSTRACT. The lack of accurate measures of human capital formation often constrains investigations into the long-run determinants of growth and comparative economic development, especially in the developing world. Using the reported ages of criminals in the Court of Justice records in the Cape Archives, this paper documents for the first time numeracy levels and trends for inhabitants of the Cape Colony born between the late seventeenth and early nineteenth centuries: the native Khoesan, European settlers, and imported slaves from other African regions and Asia. This variety of origins allows us to compare contemporaneous levels of early modern development across three continents. By isolating those slaves born at the Cape, we also provide a glimpse into the dynamics of human capital transfer in a colonial setting. The Colony's relatively high level of human capital overall had implications for what was later to be the richest country on African soil, but the very unequal attainment of numeracy also foreshadowed extreme income inequality.

Economists agree that human capital formation is an important determinant of long-run economic performance. Hence, the divergence in global incomes over most of the twentieth century must to some extent be the result of different levels of human capital formation during earlier periods. This hypothesis has recently found empirical support via a new measurement technique. Following the pioneering study by Mokyr [1], and using numeracy (calculated using an 'age-heaping' indicator) as a measure of human capital, recent studies found a positive relationship between rates of numeracy and level of development.[2] This close correlation allows us to investigate the root causes of economic development today, even in the absence of reliable measures of early per capita income.

[1] Mokyr, *Why Ireland starved*, p. 245.
[2] A'Hearn et al., 'Quantifying quantitative literacy', p. 791; Crayen and Baten, 'New evidence and new methods', p.452.

While African economic history is receiving greater attention,[3] the scarcity of written records for many African societies from the early modern period has prompted a search for other ways of quantifying development. This study used court records from a unique African society: the Dutch Cape Colony of the seventeenth and eighteenth centuries. The court proceedings document the ages of individuals born over a 135-year period, allowing, for the first time, a thorough investigation of human capital in the early Cape Colony. Further, the diverse nature of Cape society makes it possible to compare the levels of human capital formation of at least seven contemporaneous eighteenth-century population groups: northwestern Europeans, Cape native Khoesan, and East African, Madagascan, Indian, Indonesian, and Chinese slaves. Given the close correlation between numeracy and economic performance, comparing the numeracy levels of these groups provides a snapshot of early modern economic development.

We used a sample of 1,802 individuals documented in the Court of Justice records between 1692 and 1827.[4] As basic numeracy is attained during the first decade of life, we organized the sample into birth cohorts.[5] After taking into account a number of possible biases, we were able to find evidence of the human capital acquisition of Africans, Asians and Europeans. We found that the educational level of most of the non-European population groups did not improve during the first two centuries after contact with Europeans. In contrast, the settlers of Dutch and other European origin already had very high levels of human capital at the start of the eighteenth century, which may also help to explain the rapid increase in inequality between the different groups.

[3] Hopkins, 'The new economic history of Africa'; Schirmer et al., 'The state and scope'; Fenske, 'The causal history of Africa'.
[4] The first official civil and criminal court, the Colony's highest legal body, was established at the Cape of Good Hope in 1656 and was generally known as the Court of Justice.
[5] We note that these birth cohorts could be constructed with error. Given that we assume that ages are reported incorrectly, the implied birth years calculated from these reported ages could also be wrong. However, because we are looking at broad cohort bands, this is unlikely to be a serious problem.

But inequality also existed within the slave society. We found that Cape-born slaves attained higher levels of numeracy than slaves born outside the colony, and we posit reasons for this divergence. Education in the Cape slave lodge may explain part of the difference, but another explanation is that the Cape may have had better childhood nutrition, which is likely to be positively correlated with height and cognitive ability.

Below we provide, for the first time, quantitative evidence of the large disparity between settler and slave human capital levels. This inequality seems to have persisted: South Africa today is one of the most unequal societies in the world, in terms of both education and income. Our research results on Cape Colony numeracy levels suggest a historical explanation for South Africa's education inequality. However, given the higher level of numeracy of Cape-born slaves that we will identify below, we could also imagine an alternative scenario of converging human capital levels between the ethnic groups. In fact, it seems quite likely that political counter-forces during the nineteenth and twentieth centuries restored the educational differences.

Our historical study also helps to explain why the country's income and development level is higher than most other countries in Africa and in south and south-eastern Asia, and why its GDP today is situated between the richer and the poorer parts of the world.

I

Hanushek and Woessmann[6] identify three ways that education may promote long-term economic growth: it increases the human capital component of the workforce, thus increasing labour productivity;[7] it encourages the development of knowledge and information about new technologies and products; and it improves people's ability to implement new technologies.[8] Recent studies have found not only that an improvement in the quantity of education

[6] Hanushek and Woessman, 'The role of education quality', p. 20.
[7] See also Barro, 'Human capital'; Barro and Lee, 'International data'.
[8] See also Nelson and Phelps, 'Investment in humans'.

increases economic growth, but also that if education quality is taken into account as a variable in a regression analysis of economic growth, then the effect of number of years of schooling, i.e. quantity of education, diminishes.[9] These effects are robust across countries and periods.[10]

These seminal contributions focus on the recent past, but less is known about pre-twentieth-century education and long-run development.[11] The scarcity of available historical data means that researchers often rely on proxies for human capital formation, rather than direct measurements of inputs or outputs. Van Leeuwen and Földvári[12] list three such proxies for human development: whether a person was able to sign a document (often used to measure historical literacy rates); the number of published books (book publishing as a proxy for human capital provides even more explanatory power than basic literacy in analysing economic growth);[13] and the proxy used here, age-heaping as an indicator of numeracy.

A person's ability to report his or her true age can be used as a proxy for cognitive ability. 'Age-heaping' is the tendency to report one's age in round numbers. A'Hearn et al. find a significant relationship between age-heaping and literacy not only for European countries but also for less developed countries from the 1950s onwards.[14] Crayen and Baten also find significant negative correlations between primary education enrolment and age-heaping for 70 different countries between the 1880s and 1940s.[15] These estimates, measured across a wide range of countries and birth periods, support the conjecture that age-heaping is an appropriate proxy for the various measures of human capital quality highlighted by Hanushek and Woessman.[16]

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[9] Ibid.
[10] Coulombe and Tremblay, 'Literacy and growth'.
[11] Mokyr and Voth, 'Understanding growth in Europe', p.31.
[12] Van Leeuwen and Földvári, 'An estimation of human capital stock'.
[13] Baten and Van Zanden, 'Book production', p.218.
[14] A'Hearn et al., 'Quantifying quantitative literacy', p.791.
[15] Crayen and Baten, 'New evidence and new methods', p.452.
[16] Hanushek and Woessman, 'The role of education quality'. We also note that educational attainment (using indicators such as 'per cent having finished primary school') may not be similar to education quality across all

Basic numeracy is estimated using the Whipple index. This index is denoted mathematically in equation (1), and a linear transformation of the index is made in equation (2), yielding the ABCC index.[17] The ABCC index reports a numeracy score between 0 and 100, with 100 representing a fully numerate society. In other words, the ABCC index estimates the share of the population able to report their own age to the exact year.

$$W = \frac{\sum (n_{25} + n_{30} ... + n_{65} + n_{70})}{\frac{1}{5}\sum_{i=23}^{72} n_i} \times 100 \quad (1)$$

$$ABCC = (1 - \frac{(WI - 100)}{400}) \times 100 \quad (2)$$

Age-heaping is used to indicate not only the relationship between human capital and growth but also the role of human capital inequality in a country's development trajectory. Assessing gender inequality in the Netherlands, de Moor and van Zanden found that women had a relatively high level of education, which brought about positive demographic changes and increased women's involvement in the labour market.[18] Baten et al. investigated the impact of malnutrition on cognitive abilities and the subsequent impact on earnings capability for England from 1780 to 1850, and found a large, negative relationship.[19] Using age-heaping, Crayen and Baten determined human capital inequality during the seventeenth and nineteenth centuries in France and the United States.[20] Evidence for the Great Divergence, the rise in per capita incomes in the West relative to the rest, is also borne out by age-heaping

dimensions; in fact, one could imagine a trade-off between educational attainment and quality. We consider age heaping a measure of human capital quality, because basic numeracy could be taught even outside of school, by parents for example (although this was not common).

[17] The ABCC stands for the authors A'Hearn, Baten, and Crayen, who developed the index in their 2009 paper, and Gregory Clark, who suggested this in a comment on their paper.

[18] De Moor and Van Zanden, 'Girl power', p.23.

[19] Baten et al., 'Numeracy and the impact of high food prices', pp.20-21.

[20] Crayen and Baten, 'New evidence and new methods', p.452.

estimates, although existing estimates of developing countries remain rudimentary and fragmented.[21] Evidence on numeracy development outside of Europe will be crucial for understanding the divergence in modern economic growth.[22] Countries of medium-level income such as South Africa provide even deeper insights, because they show more variation in the economic growth rate.

The fact that unequal human capital can lead to unequal development in the long term gives us a further motive for investigating the Cape Colony. South Africa's extreme human capital and income inequality has been mentioned above. Spaull shows that, 18 years after the end of apartheid, South Africa is still a 'tale of two schools': one functional, wealthy, and able to educate children; the other dysfunctional, poor, and unable to equip them with primary school numeracy and literacy.[23] The following sections attempt to explain the roots of this bifurcation in human capital levels– within South Africa, and between developing countries.

II

The establishment of a trade and refreshment station at the southern tip of Africa by the *Vereenigde Oost-Indische Compagnie* (Dutch East India Company) in April 1652 brought European settlement and administration to southern Africa. The first European arrivals built a fort at the Cape, meeting with only modest resistance from the nomadic, pastoral Khoe and hunter-gatherer San (collectively known as the Khoesan). The community that developed around the fort in what later became known as Cape Town gradually evolved into a thriving cosmopolitan society, ruled and administered by the Company. And since the Cape station served the interests of the Dutch merchant fleets travelling between their colonial empire in

[21] Except perhaps those of Latin America; Manzel et al., 'Convergence and divergence of numeracy', p. 957.
[22] Mokyr and Voth, 'Understanding growth in Europe', p.31.
[23] Spaull, 'Poverty and privilege', p. 444.

the Dutch East Indies and the Netherlands, the Cape became a de facto mercantilist society. All its inhabitants were subjected to the rule of law imposed by the colonizers.

The Cape of the eighteenth century was made up of colonial administrators, European merchants, sailors, traders, and (in the interior) farmers who supplied the foodstuffs and provisions demanded by the Company for their ships. The population also included indigenous peoples such as the Khoesan and several thousand slaves from various regions. Inhabitants of European descent were labelled 'white', 'European', 'colonist', or 'Christian' and included sailors, workmen, or servants of the Company.

The first slaves arrived in 1658 but relatively few were brought to the Colony during the seventeenth century. At the beginning of the eighteenth century, however, the increasing labour demand by the European farmers, particularly the wheat and wine farmers to the west of the first mountain ranges, obliged the Company to become more involved in the slave trade. Slaves soon permeated every aspect of colonial society; Ross notes that slaves cost the Company less than European wage labour and Worden reports the pervasiveness of slaves even in the poorer farm households.[24]

[FIGURE 1 AND TABLE 1 HERE]

Shell was the first to construct a comprehensive taxonomy of the origins of Cape slaves.[25] He calculated that more than 60,000 slaves were brought to the Cape between 1652 and 1808, from four areas: Africa (including the west coast of modern-day Angola and the east coast from Mombasa to Port Natal, now Durban, and including the Cape Verde islands, 26.4 per cent), Madagascar (and Mauritius, 25.1 per cent), India (and Ceylon, 25.9 per cent) and the south-east Asian islands (including modern-day Indonesia, Malaysia, Timor and

[24] Worden, *Slavery in Dutch South Africa*; Ross, *Status and respectability*.
[25] Shell, *Children of bondage*.

Taiwan, 22.7 per cent). Figure 1 shows the origins of the slaves in our data set. Our percentages below the place names should be compared to Shell's. Our sample does not entirely reflect the Shell estimates, which may introduce some bias (see Table 1). In particular, Madagascar and Mauritius are under-reported in our sample (15.5 per cent). This discrepancy may be partly due to different definitions of 'origin': when the Dutch first arrived in Mauritius, it had not yet been permanently settled. The slaves brought to the Cape from Mauritius were originally of East African, and later south Asian, origin, and these areas might sometimes have been noted as their ethnic origin although they had been born in Mauritius. Similarly, India and Ceylon are slightly underrepresented (-4 per cent), whereas the south-east Asian slaves in our sample (+9.8 per cent) and the Africans (+5.3 per cent) are over-represented.[26] This is a strong caveat that we have to acknowledge.

III

The Company made a distinction between the slaves on the one hand and the Khoe and the San on the other: the indigenous inhabitants were never to be enslaved.[27] However, as Green observes, Khoesan labour constituted a significant proportion of farm labour, a labour type that has been ignored simply because of data unavailability.[28] The Court of Justice records were the first data source to systematically include the Khoesan, and can thus be used as a proxy for their participation in the colonial economy.[29]

The records include a wealth of qualitative information mostly pertaining to the crime of the accused. In general, the records suggest that the decline in the economic culture of the

[26] What are potential implications? For example, as slaves from Africa have a lower numeracy than those from India, this would lead to a downward bias for the Cape average, if all slaves were aggregrated into a single number.
[27] Dooling, *Law and community*, p. 63.
[28] Green, 'The economics of slavery'.
[29] Fourie and Van Zanden, 'GDP in the Dutch Cape Colony'.

Khoe and the diminishing resources for the San hunter-gatherers were among the main reasons for crime during the eighteenth century. Having lost their independence and a considerable part of their livestock, the Khoe turned to stock theft for survival, and this became one of the most widespread crimes. Crimes related to adultery or miscegenation were fairly common, as a constant influx of European sailors and soldiers interacted freely with the local population. The Court of Justice records show a number of crimes such as forgery, theft or desertion from their ships.[30] In some cases where sailors or soldiers were convicted of a crime, the chances were good that the accused would have left the Cape shortly after the crime, thus evading the law.

We were specifically interested in how the ages of the accused were recorded. From the end of the seventeenth century, the secretary of the Court of Justice had to report on all matters related to criminal and civil cases and keep an inventory describing the cases and the respondents.[31] The following two articles from an 1819 guide to procedure[32] give us an idea of how this was done:

> Art.36: And in order, in the administration of Justice in Criminal proceedings, to give equal facility to all and every accused Person, the tenor of the said Act of indictment, shall be communicated to all Persons in custody, accused of having committed a Crime, without exception; and, consequently, to all Hottentots [i.e., Khoesan], Free-Blacks, and Slaves, to whom, in case of their not being able to read, the same shall be read and explained – in Cape Town, by one of the sworn Clerks, belonging to the Court of Justice; or, if need be, by an Interpreter; and in the Country, by the Clerk of the District, or the Person acting as Secretary to the Board of the Landdrost and Heemraden.

[30] Heese, *Reg en onreg*, p. 57–59.
[31] Visagie, *Regspleging en reg*, p. 48. See app. C.
[32] National Library of South Africa Special Collections, *Crown trial, or mode of proceeding*, p. 9.

> Art. 39: On the day of the trial, after the Court has been opened, with the usual ceremonies, and the Accused, whether a Prisoner, or Person summoned to personal appearance, the Prosecutor is to exhibit the Act of indictment, subscribed by him, together with all the preparatory information, collected by him, and a specific list of all the witnesses, in favour of, and against, the Accused, to the best of his knowledge: together with the interrogatories, on which he considers the Prisoner, or Defendant, should be examined.

The 'examination' included a question about age. Frequently, the accused would merely guess their ages. In the Dutch transcripts of legal cases, mention was made of *naar gissing* (guessing), which means that either the defendant was guessing or the person recording the events assumed the defendant was guessing. There is no indication that any attempt was made to ascertain or counter-check the age of the accused before trial. Although such information could be available from baptism records for slaves born at the Cape or from slave sale deeds, no specific mention was made of age at the commencement of a court case, probably because it was not considered very important.[33]

We can see the possibility of bias here. Could it be that some groups were less likely to be questioned about their age? The articles quoted above show no discernible bias in favour of any group. Our calculations show that the naar gissing variable is closely correlated with slave and Khoesan defendants, but not exclusively so, which suggests that legal representatives did in fact question defendants from all groups about their age. Several European settlers, for example, also register a naar gissing.

The Court of Justice in the colony started to record criminal cases at the end of the seventeenth century and continued to do so consistently well into the nineteenth century. The

[33] Mason, *Social death and resurrection*, p. 181–182.

ages of 392 Europeans, 368 Khoesan and 1,026 slaves of African and Asian origin are included in our overall sample of 1,802 individuals.[34] The years recorded are from 1692 to 1827, but as most people acquire the basic human capital necessary to report an exact age in the first decade of life, we were able to include sufficient cases from birth cohorts from the 1670s to the 1790s. Our Court of Justice sample consisted of 1,096 individuals aged 23 to 32, 488 aged 33 to 42, 176 aged 43 to 52, 37 aged 53 to 62 and 6 aged 63 to 72.[35] Table 2 shows details of these by birth decade. The number of cases was quite substantial after the 1670s, although the European share was slightly higher in the first two well-documented decades of the 1670s and 1680s. The average age did not change dramatically (except for some exceptional values at the beginning). The share of those 'not guessing' was high in the first four decades, considerably lower in the next five and slightly higher in the final seven. This does not correlate perfectly with ABCC (numeracy) development over time, which was declining in general. It reached a low level for the birth cohort from the 1750s to the 1780s but increased for the 1790s cohort. This discrepancy between the trends in numeracy and age-guessing may have something to do with the prejudices of the white penitentiary officers, who assumed that people of African and Asian origin would guess their ages, whereas Europeans would not (the correlation between 'not guessing' and 'European' is very high, 0.85, p=0.000). This finding confirmed that we should calculate numeracy by ethnic group.

[TABLE 2 HERE]

We might imagine sample selection bias if some groups were more likely to evade the law than others. For example, Europeans might have been less likely to be prosecuted for petty crimes than slaves. If poorer individuals are associated with petty crimes, then

[34] We retained only observations with values for age and where the reported age of the individual was between 23 and 72.
[35] See also app. B.

neglecting to include them in the analysis would bias our estimates for Europeans upwards. We used three strategies to assess the extent of this possible bias. First, as explained below, we controlled for the severity of crimes in our regression estimates. This had the effect of giving a lower weight to those parts of the distribution that were less prevalent in the other groups (but does not fully cope with possible censoring, of course). Second, to obtain partial evidence of possible censoring, we chose only two types of crime, theft and murder, and compared the different groups. If the results were similar to the general model, there would be less reason to suspect that this bias significantly distorts differences between groups. We found that non-Europeans who committed theft had an ABCC of 26.7 whereas Europeans had 88.3 (see Table 3). The corresponding figures for murder were 31.8 and 96.7. We concluded therefore that there was a small downward bias of both ethnic groups for theft if we assume murder to be relatively undistorted (15 per cent for non-Europeans and 8 per cent for Europeans). The difference between the ethnic groups was more than 60 per cent in both cases. However, since the extent of this bias might have been influenced by temporal composition effects, we then performed a regression analysis, as described in the following section.

[TABLE 3 AND 4 HERE]

Our third strategy, to assess the possibility of bias more closely, was to consider whether a social gradient of crime types existed. The fact that this gradient exists today does not necessarily mean it existed in early modern times, and in the eighteenth-century Cape Colony in particular. To study this, we ran regressions of the probability that an accused person stated an exact age rather than a rounded approximation (see Table 4). We distinguished four types of crime: ‘minor’, meaning small crimes below the level of theft,

such as not reporting someone else's theft to the authorities, 'theft' that did not involve violence, 'violence', and 'murder'. We also included time and world region fixed effects in order to exclude composition effects. As a result, we found that only the numeracy of those committing minor crimes was significantly different from the constant, which refers to those who committed theft. But minor crime accounted for only for a small minority of cases. Those who committed murder were around 4 to 5 per cent more numerate than those who committed theft, but the coefficient was insignificant. Violent crimes rated between theft and murder in terms of numeracy.

[FIGURE 2 AND 3 HERE]

The severity of crimes and punishments over time may also influence selection. We assessed the extent of severe crimes and punishments by calculating the share of severe crimes (such as violence and murder) and the share of severe punishment (hanging and other harsh sentences). Both series trended slightly downward over time (see Figures 2 and 3). For both Europeans and non-Europeans, the share was around 30 to 35 per cent for the early birth cohort, and then declined to 20 to 25 for the later cohorts. Moreover, we observed that punishment was much more severe for non-European offenders in the first birth cohort, whereas for later cohorts the severity of punishments was similar. The overall decline in the severity of punishments would suggest that there might be a downward bias for the later cohorts because a larger number of minor criminals were included in the sample. The question is, how large was this bias? Less severe crimes accounted for around 65 to 70 per cent in the first birth cohort and 75 to 80 per cent in the later cohorts. If we use a rough estimate of 5 per cent less numeracy for the petty crimes like theft and minor offences, the ABCC levels in our sample should be upwardly adjusted by around 3 to 4 per cent for the

early cohort. The difference between early and middle-to-late birth cohorts of around 10 per cent more petty crimes for the later cohorts is almost negligible: 10 per cent difference in the share of petty crimes, relative to 5 per cent ABCC difference results in a negligible bias of 0.5 per cent between the early and the later cohorts.

We wondered whether theft rates were higher among slaves, relative to Europeans. To obtain diagnostics about possible censoring of less educated Europeans (and perhaps more numerate non-Europeans), we calculated crime rates per population. We used Shell's estimates of the number of slaves to deflate the number of criminals originating from the slave population. We used Fourie and van Zanden's estimates for the European population to calculate the corresponding crime rates.[36] On average, all crime rates were higher for slaves (see Table 5). Murder rates declined for both the Europeans and the slave group.[37] Hence the decline in murder rates is probably not evidence that the authorities overlooked petty crimes. It might also be informative to compare the ratio of murder rates to theft (see column 9, Table 5). We might imagine that slaves committed more crimes in general because of their oppressed status. Yet there is enough evidence to suggest large differences in European levels of wealth;[38] European settlers therefore had no less incentive than slaves to engage in crimes with a financial motive. In fact, this is supported by the evidence: Europeans were actually accused of theft more often than murder (arithmetic average: 10.7 times more theft than murder), whereas the ratio for slaves was lower (only 6.4 thefts per murder). In other words, it seems unlikely that Europeans who committed theft and similar crimes were prosecuted less often because the authorities were more lenient toward them (at least relative to murders). A possible explanation could be that the Calvinistic Dutch authorities did not accept it if their European subjects committed small crimes either. In summary, the ratio

[36] As no decadal population estimate exists for the Khoesan, they are excluded here.
[37] Cf. Eisner, 'Modernization', p. 623. See also app. E, which shows, using examples from Belgium and the Netherlands, that the decline in rates of murder by Europeans at the Cape was strikingly similar to the decline in murders by Europeans in Europe.
[38] Fourie and von Fintel, 'Settler skills and colonial development'.

between theft rate and murders suggests that there was no under-sampling of a large part of the poorer European population. In addition, the comparison with scattered census data of Asian (and more systematic census data for Europeans) we report in section IV suggests that the court record bias cannot be very large.

[TABLE 5 HERE]

We also looked at possible bias in our selection of slave imports. We needed to know the extent to which the slaves in our sample were representative of the general populations of the countries of origin included in our study. There could be bias if there had been a strong decrease in the cost of transporting slaves, allowing slave traders to bring more slaves to the Cape including slaves from regions with less basic skills. However, a substantial literature has argued that transport costs in intercontinental shipping did not decrease until the nineteenth century.[39] Nevertheless, we admit that the way slaves were selected might influence our results, although, again, we note in section IV that the slaves had broadly similar numeracy levels to that shown in census samples from their countries of origin.

To ascertain where the individuals in our sample came from, we matched the Court of Justice records, where the person's age was revealed, to the lists of convicts imprisoned on Robben Island, which gave us a clue to region of origin.[40] Only first names are available in the Court of Justice records, but the Robben Island lists reflect the origins of Cape slaves through their surnames: for example, Salomon van Mosambiek (Salomon of Mozambique), David van Bengalen (David of Bengal, India) and Willem van de Kaap (Willem of the Cape). Although the Robben Island lists are extensive, this nevertheless reduces our sample by nearly half, from 1,802 to 937. The reason for this is simple: those that were sentenced to

[39] O'Rourke and Williamson, 'After Columbus'.
[40] Liebenberg, *Introduction to the documents*.

death or were freed (as judged innocent) would not have been included in the Robben Island lists.

This suggested another possible sample selection bias, if those who were freed or sentenced to death had characteristics different from the rest of the defendants. However, we found no qualitative evidence to suggest that slaves from some regions were punished more severely than others. And when we compared the human capital of slaves who were sent to Robben Island with those who were not, we found no significant difference between the two groups.[41] Those not sent to Robben island were some 4 per cent more numerate, but this was to be expected. A very small number of these had committed no crime. Many had committed a severe crime such as murder, and, as mentioned above, murderers were around 4 per cent more numerate across the whole sample – which is again statistically insignificant. Hence we concluded that we could find no significant difference between those sent to Robben Island and those who were not (the small difference observed was caused by crime severity), which suggested we did not have to worry about this possible bias.

In conclusion we can state that most of the biases that we could imagine theoretically seem to be small empirically. We should keep in mind, however, that the petty crime bias might imply that our estimates are 3 to 3.5 per cent too low for the early birth cohort and 3.5 to 4 per cent too low for later cohorts.

IV

We ran regressions to estimate the ethnic breakdown of age-heaping after controlling for birth cohort, gender and age composition. We differentiated between slaves born at the Cape, slaves born in Mozambique or Madagascar or Mauritius, slaves with unknown

[41] We controlled for cohort effects. Table available from the authors.

birthplaces, European descendants, native Khoesan, slaves born in south-east Asian (mainly Indonesians), slaves from India, and slaves from China (see Table 6).

[TABLE 6 HERE]

As shown in Table 7, we found that the Europeans were 51 per cent more numerate than the Cape-born slaves (the constant), but the Indians and south-east Asians were 29 and 20 per cent less numerate, and the slaves born in Mozambique (or Madagascar and Mauritius) were 21 per cent less numerate. The individuals born at the Cape therefore performed better than those imported from other areas. The Khoesan and the slaves with unknown birthplaces were very slightly less numerate, but the difference was statistically insignificant. The Chinese slaves were very slightly more numerate that the Cape-born slaves, but again the difference was statistically insignificant. In the case of the Chinese, the small number of observations is the most likely reason for the statistical insignificance, whereas the Khoesan and the slaves with unknown birthplaces were numerous. The numeracy of female slaves[42] and those aged 23 to 32 was insignificantly different from the constant.

[TABLE 7 AND FIGURE 4 HERE]

To discover whether there were changes over time, in a separate regression we interacted the birth region and ethnic groups discussed above with three birth cohort dummy variables: an early birth cohort (1650s–1740s), a middle birth cohort (1750s–1780s) and a late birth cohort (the 1790s) (see Table 7). Our choice of birth decade cohorts was based on a combination of data availability (we had many more cases for the last decade – the 1790s

[42] We constructed a gender dummy through a subjective interpretation of the slave names. Because there were some names for which the gender was not entirely clear, we attach less weight to this variable.

represent about one-third of our data set – which we therefore treated separately) and a 'natural' round date, such as the one of 1750.

To partially control for the selection biases discussed earlier, we included a variable representing the share of severe crimes by decade and included it in the regression above (see Table 9, column 2). We also restricted the regression to non-severe crimes (column 3). In all three cases, almost all coefficients were virtually unchanged. As a result, we conclude that the selection bias effects were at best very small.

The Europeans maintained their high levels of numeracy throughout the three birth periods. In all three periods, their ABCC index was consistently between 92 and 93 (see Figure 4). These high levels are striking, considering that many of these individuals came from the poorest groups in Europe. The earliest migrants, for example, would have been born immediately following the Thirty Years War and would have sought refuge in Amsterdam only to find work as sailors and soldiers on outgoing ships. However, the high numeracy of the large numbers of Dutch and north-western German settlers and the French Huguenots was influenced by the similarly high numeracy in their home countries.[43]

[TABLE 8 AND 9 HERE]

The other groups in Table 9 had substantially lower levels, as could be expected from the results above. However, interestingly, the ABCC levels of Indian and Indonesia slaves (south-east Asians) declined from the early birth cohort to the middle cohort, and the same happened to Khoesan and slaves of unknown origin. Cape-born and Mozambican slaves were only available in sufficient numbers during the latter two birth cohorts. Their numeracy

[43] De Moor and van Zanden, 'Girl power', p.23; A'Hearn et al., 'Quantifying quantitative literacy' , p.881.

levels, as well as those of Khoesan and slaves of unknown origin, increased between the middle and the late cohorts.

The differences in numeracy between the cohorts, shown in Table 10, vary in significance. For Indian slaves the coefficient (- 1.15), referring to the early cohort, with the middle cohort as a reference category, is not statistically significant at the 10 per cent level. For south-east Asian slaves, on the other hand, the coefficient is significant and negative for the development between the early and middle cohorts. This might be due to a larger number of observations, or it may be a genuine difference.[44] For Europeans we were able to cover all three birth cohorts (and hence we have two reference categories) – so we were able to compare the early with the middle and the middle with the late. Both coefficients are not statistically significant at the 0.10 level, which implies that the already high level of numeracy among Europeans at the Cape did not decline or increase. For the Khoesan, for whom we also had three cohorts and a relatively large number of observations, the coefficients are statistically significant: first a decline, and then an increase.

One way we can evaluate our estimates of numeracy based on our sample is to compare them with other sources. Unfortunately, until now, little has been known about African, south and south-east Asian numeracy in the early modern period, and some of the small bits of information that are available are based on modest sample sizes. However, comparing those bits with our evidence does help to evaluate both sources.[45]

Portuguese inquisition files allow a rough comparison. Juif and Baten suggested how to adjust numeracy figures for Portuguese inquisition cases (minus 13 ABCC points), and as

[44] The over-representation of south-east Asian slaves in our sample and the under-representation of Madagascan and Indian slaves, for example, may account for some of these differences.

[45] The earliest evidence on south-east Asia of 1613 consists of Malaysians and Philippines who were brought to Lima, typically as housemaids and servants (source: Gamboa, *Padrón de los Indios, p. 12*), with an ABCC of 43. Unfortunately, we cannot compare this evidence with our earliest evidence for south-east Asia, because the Philippines probably had a much higher numeracy, if we assume some stability over time: the Philippines had a reputation for high educational status from early times, see Friesen et al.; as late as 1900, the Philippines had a 20 per cent numeracy lead over Indonesia, see Prayon and Baten). Friesen et al., 'Women count', p.8; Prayon and Baten, 'Human capital', p.34.

also 30 south Asians were tried by the Portuguese inquisition, their estimate of 29 to 36 ABCC levels can be compared to our estimate for Indian slaves at the Cape in the late seventeenth and early eighteenth century, although their records are slightly earlier.[46] Both early comparisons are based on very small numbers of cases. A substantial sample comes from Sri Lanka in the late seventeenth and early eighteenth century (N=1,433, see also van den Belt et al.).[47] Again, the ABCC estimate yields levels around 30 to 40. The earliest estimate for India based on an extremely large sample is for the birth decade of the 1830s, with an ABCC of 34.[48] It is noteworthy that all estimates for south and south-east Asia are in a similar range. From the late seventeenth century to the early nineteenth century, numeracy either changed little, or was initially fairly low, declined sharply during the late eighteenth century (as our evidence suggests), and finally made a modest recovery. Comparing south Asia to Europe, we find that the difference in numeracy was probably only in the range of 20 in the sixteenth and seventeenth centuries, but then increased substantially during the eighteenth century, to reach more than 60 during the early nineteenth century.[49]

What does it mean to move from an ABCC level of 20 to one of 60? We can compare this with the European numeracy revolution, which took place between the late fifteenth and late eighteenth centuries: European numeracy rates grew from approximately 50 to approximately 95. This is a true revolution: the 45 point improvement is comparable to the difference between the poorest and the wealthiest economies of the early twentieth century. [50]

The earliest published estimate for China (during the early nineteenth century) is in the 85 to 90 ABCC range.[51] For Japan, early local estimates for the 1590s are available (ABCC of 81), but the situation in these two largest east Asian countries might be very

[46] Juif and Baten, 'Was human capital a hazard?'
[47] van den Belt et al., 'Digital *thombos*'.
[48] Prayon and Baten, 'Human capital', p.13.
[49] A'Hearn et al., 'Quantifying quantitative literacy'.
[50] South Asia had a numeracy rate of 52 per cent in the 1940s, whereas the richest countries had reached full numeracy, Crayen & Baten, 'New evidence and new methods'.
[51] Baten et al., 'Evolution of living standards'.

different than in other Asian countries. Our level of 54 is substantially lower. The difference might be caused by the difference in the dates of the estimates, or the definition of 'Chinese' as our Cape records might have included Chinese migrants from other parts of Asia (such as Indonesia), whose numeracy level might have been very different from that of mainland Chinese.

[TABLE 10 HERE]

For early modern Africa, samples are also very small. Africans (mainly from Portuguese colonies) were also victims of the Portuguese inquisition, and these records show their adjusted numeracy estimate is an ABCC level of 12. This is probably a lower bound estimate, as the adjustment procedure might slightly over-adjust at such low levels of numeracy. Hence, we add a plus sign in the table. Compared to our estimate for Mozambique (11 ABCC level), the adjusted figure may not be unrealistic (downward biases may have been compensated for by upward biases). Slightly larger samples are available for early nineteenth-century Africa. Comparing our ABCC levels for the 1790s (Whites, Khoesan, and mixed 'Cape born' slaves) with the 1810s to 1820s levels, the weighted ABCC rises noticeably for the Khoesan and Xhosa, respectively from 19 to 40 and from 20 to 28. As Fourie et al. show, this may have been due to the influence of missionaries.[52] Using an extensive census of Cape mission stations in 1849, they found that numeracy increased significantly for younger residents.

[52] Fourie et al., 'Literacy at Cape mission stations'.

V

We have shown above that Cape-born slaves had an educational advantage over imported slaves. This finding supports the qualitative evidence of contemporary travellers and historical accounts. O.F. Mentzel, a traveller in the mid-eighteenth-century Cape Colony, notes that the children of slaves (i.e. those born at the Cape) are 'found useful at a very tender age and cost little to bring up. They are likewise better mannered and better educated than imported slaves'.[53] Shell notes that while Cape settlers gave their slaves little education (in the rural areas), the Company's slave lodge offered some form of Christian education.[54] After various sporadic attempts at instruction, a Company slave school opened formally in 1685 and remained open until 1795. The teachers were mostly other slaves, convicts or Free-Blacks and, according to Shell, this was a rewarding position: two schoolteachers, upon being emancipated, asked to remain at the school.[55] Some lodge slaves used their education as a means to liberate themselves: 'from as early as 1705, enterprising baptized company slaves escaped on ships to Europe and then promptly *wrote* to their friends in the Lodge to tell them of the "great difference between liberty and slavery"'.[56] Apart from this basic schooling (which was performed partly for religious reasons, as bible-reading was important for reformed Christians), there may have been some learning through imitation. Prayon and Baten call this 'contact learning' and refer to education spillovers from contact between French settlers and natives in Algeria and Tunisia, and similar effects in the settlements of former US slaves in Liberia.[57]

This also explains why Cape-born slaves were, on average, more valuable than imported slaves. Du Plessis et al., using a hedonic price index, find that slaves born at the

[53] Mentzel, *A geographical-topographical description*, p. 130.
[54] Shell, *Children of bondage*.
[55] Ibid, p. 347.
[56] Ibid, p. 348 (Shell's emphasis).
[57] Prayon and Baten, 'Human capital', p.17.

Cape were more likely to be sold at higher prices than imported slaves.[58] They argue that this difference is explained by the local slaves' knowledge of the local language, culture and geography, and their lower susceptibility to disease. We suggest another reason for the price premium: their higher level of human capital evidenced by their slightly higher levels of basic numeracy. We stress, of course, that we are speaking of very basic skills, such as counting with integers to 50. It should be noted that the free populations of many countries were also not very advanced in those basic skills during the seventeenth and eighteenth centuries.[59]

Some might wonder whether numerical ability would be valued in slaves and whether it might rather be considered dangerous for a master to have an educated slave. But the image of a slave performing only fieldwork that required physical strength and permanently supervised by his master is a modern myth. Though it was the reality for some slaves, the majority did the same kind of work as the other farmhands. For farming to be efficient, some very basic abilities were important. Green also suggests that an active market existed for hiring slaves, moving from wheat and wine farms depending on need.[60] Slaves with more skills would have earned a higher income for their master.

Another reason Cape-born slaves attained a higher level of numeracy may be better nutrition. A wealth of evidence suggests that height reflects net nutritional status, and that protein malnutrition limits cognitive development. Fogel and Engerman, for example, famously argued that the nutrition of slaves in the southern states of the US was astonishingly favourable, even if their lack of personal freedom was of course the most crucial disadvantage.[61] A number of studies have found that while US slaves were shorter than US-born Whites, they were much taller than European-born Whites.[62]

[58] du Plessis et al., 'Willingness to pay'.
[59] A'Hearn et al., 'Quantifying quantitative literacy', table 4, p.801.
[60] Green, 'The economics of slavery'.
[61] Fogel and Engerman, *Time on the cross*.
[62] Komlos, 'Anomalies'; Margo and Steckel, 'The heights of American slaves'.

How does this compare to African-born Blacks? Austin et al. report that African-born slaves in the US were substantially shorter than US-born slaves.[63] Similarly, Eltis showed that the descendants of African slaves born in the Caribbean were taller than Caribbean slaves born in Africa.[64] Using nineteenth century male prison records from Rio de Janeiro, Baten et al. found, after controlling for occupation and birth decade, that African-born slaves were substantially shorter than Brazilian-born slaves.[65] Using these authors' data set, we compared the ABCC levels for their two samples and found that the numeracy of the Brazilian-born slaves was a substantial 23 per cent higher than that of the African-born slaves.

What might explain such a large difference? One possible reason could be differences in income per capita between the two regions, resulting in higher protein intake in the more affluent region. Is this also a possible explanation for fairly high numeracy of Cape slaves? While we cannot of course measure slaves' income, we can assume that their masters' income would affect them. Fourie has shown that the average eighteenth-century Cape settler household attained a high level of wealth, even compared with some of the wealthiest countries in Europe.[66] In particular, he noted that settlers owned comparatively large numbers of protein-rich commodities, such as cattle and sheep. This might add one additional explanatory factor for the higher numeracy of slaves beyond the 'contact learning' and basic slave schooling explanation: the slightly more favourable nutrition of Cape slaves could have improved their cognitive development and hence their ability to acquire basic numeracy.[67]

VI

From looking at the differences in numeracy levels of the Cape settlers we turn to considering the possible consequences. Together with a high overall level of basic numeracy,

[63] Austin et al., 'The biological standard of living', p.17.
[64] Eltis, 'Nutritional trends', p.466.
[65] Baten et al., 'The anthropometric history'.
[66] Fourie, 'The remarkable wealth'.
[67] See also app. D.

the settlers enjoyed high standards of living for most of the eighteenth century. Using Cape real wages, de Zwart has shown that living standards increased throughout the century, resulting in wage incomes similar to those of London and Amsterdam, the wealthiest societies of the eighteenth century.[68] Du Plessis and du Plessis also calculate high real wages, but emphasize the wide disparity within the group of wage earners, who were mostly Dutch East India employees.[69] Even though per capita GDP declined during the first half of the nineteenth century, income was surprisingly high.[70] These findings corroborate Fourie's estimates of remarkable settler wealth using probate inventories.[71]

Yet this picture of an affluent society stands in stark contrast to the living standards of the slaves and Khoesan. The Cape was a labour-intensive economy, relying on slave imports and Khoesan servants for most of its labour requirements, creating a bifurcated, unequal society. Because a number of studies have emphasized a strong path dependence of numeracy, the high inequality in the human capital levels of settlers, slaves and Khoesan servants must have had long-term consequences for the economy of the Colony.[72] According to Engerman and Sokoloff, high initial inequality would result in institutions that maintain these high levels of inequality. Our results show that numeracy was already very unequal during the eighteenth century. South Africa's pattern of exclusive education continued up to the end of apartheid and its effects continue to be seen in current South African education outcomes.[73] It is interesting to see that it was already predetermined to a certain degree during the eighteenth century. As a caveat, we should mention that we did not test this predetermination econometrically. However, if we look at other countries that had (partly

[68] De Zwart, 'Real wages at the Cape'.
[69] Du Plessis and Du Plessis, 'Happy in the service'.
[70] Fourie and Van Zanden, 'GDP in the Dutch Cape Colony', table 1, p.28.
[71] Fourie, 'The remarkable wealth'; Fourie and Uys, 'Luxury product consumption'.
[72] Engerman and Sokoloff, *Economic development, p.29*; Prayon and Baten, 'Human capital', p.1.
[73] We note that the general poor quality of education in South Africa today is largely the result of differences in the *quality* of education black and white children receive and not necessarily the number of schooling years (attainment). Even so, significant differences in attainment remain; see Lam et al., 'Schooling as a lottery'. It is also very likely that past discrepancies in the attainment of education influence present discrepancies in the quality of education.

forced) immigration from diverse world regions, we find that high inequality was often the result: for example, Brazil had a very unequal society over most of its history, as did Cuba before the revolution.[74] Both countries had substantial immigration from world regions with initially large differences in numeracy. Because of high and persistent differences in the levels of human capital, these countries were 'locked into' a pattern of persistent income inequality.

VII

In this study we used the Whipple index, an age-heaping indicator, to provide information on the basic numeracy of various settler groups in the Cape Colony in the early modern period and thus shed light on some patterns and processes of educational and economic development. Our data from the Court of Justice records provided new estimates of numeracy levels for the Colony.

We found high levels of numeracy for European settlers at the Cape, similar to their counterparts in their regions of origin in Holland and north-western Germany. But our most revealing findings were for eighteenth-century slaves of various origins. Slaves from India, Indonesia and Mozambique had significantly lower levels of numeracy than slaves born in the Cape Colony. Overall, numeracy in south Asia between the late seventeenth and early nineteenth centuries either barely changed or was initially fairly low, declined sharply during the late eighteenth century and finally made a modest recovery. Comparing south Asia to Europe, the difference in numeracy was probably only in the range of 20 in the sixteenth century, but then improved substantially during the eighteenth century, and was more than 60 during the early nineteenth century.[75] The period of decline in the late eighteenth century, which we also identify for south-east Asia and regions of Africa, should be researched in

[74] Twrdek, 'Cuba, the "always most faithful island"', p.4; Engerman and Sokoloff, *Economic development, p.18.*
[75] A'Hearn et al., 'Quantifying quantitative literacy', p.801.

further studies. If it turns out to be true that Asian and African numeracy achievement fell back relative to Europe just at the eve of the greatest divergence movement of the nineteenth and early twentieth century, this would have far-reaching implications. But already the stagnation during this critical eighteenth- and early nineteenth-century birth period, which we are documenting here, is an important result.

The advantage of Cape-born slaves in achievement of numeracy is an important finding of this study. Formal education in the slave lodge, imitation behaviour and, perhaps, better nutritional status, may explain the better performance of locally born slaves. The native Khoesan did not perform significantly differently from Cape-born slaves, although we found a sharp fall in their numeracy levels for the birth period following their integration into the settler economy.

Yet our findings point to some already high levels of educational levels during South Africa's early colonial period. Centuries of colonial and white rule did little to eradicate the inequalities, and may even have aggravated them. South Africa's bifurcated education outcomes today have roots much deeper than the apartheid regime, although political forces of the nineteenth and twentieth centuries might have prevented a convergence of numeracy between ethnic groups.[76]

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[76] Spaull, 'Poverty and privilege', p. 440.

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Tables

Table 1. C*omparisons of Shell's and our slave sample by region of origin*

Region	*Shell's estimate*	*Our sample*	*Difference*
Africa	26.4	31.7	5.3
Madagascar & Mauritius	25.1	9.6	-15.5
India & Ceylon	25.9	21.9	-4.0
South-east Asia	22.7	32.5	9.8

Source: own calculations

Table 2. *Age, knows age, numeracy and share of Europeans by birth decade*

Birth decade	*N*	*Age*	*Knows age (not guessing)*	*Numeracy (ABCC)*	*% Europeans*
1650	4	48.8	0.50	62.5	0.50
1660	11	38.5	0.36	45.5	0.36
1670	44	34.8	0.57	93.8	0.57
1680	63	29.8	0.37	67.5	0.37
1690	81	34.5	0.21	50.9	0.21
1700	93	34.2	0.17	52.4	0.16
1710	128	32.5	0.18	44.9	0.17
1720	114	33.2	0.21	47.1	0.20
1730	77	31.9	0.22	51.9	0.22
1740	73	36.0	0.27	54.8	0.26
1750	123	34.8	0.27	45.7	0.27
1760	127	37.5	0.27	32.5	0.27
1770	195	36.2	0.27	39.1	0.23
1780	291	33.0	0.26	42.1	0.20
1790	378	27.1	0.27	52.9	0.15
Total	1802	32.7	0.26	-	0.22

Note: 'Knows age' represents those not reported in the court sources as guessing their age.
Source: own calculations

Table 3. *Numeracy (ABCC) by ethnicity and by crime (theft or murder)*

Crime	*Ethnicity*	*ABCC*	*N*	*Ethnic difference*
Theft	Non-Europ.	26.7	794	
Theft	Europeans	88.3	161	
Theft	All		955	61.6
Murder	Non-Europ.	31.8	253	
Murder	Europeans	96.7	53	
Murder	All		306	64.8

Source: own calculations

Table 4. *Regression of numeracy on crime categories to investigate possibility of social gradient of crimes*

	(1)	*(2)*
Minor crimes	-9.26* (0.059)	-3.86 (0.466)
Violence	0.49 (0.916)	2.90 (0.573)
Murder	4.66 (0.222)	3.63 (0.364)
Time fixed effects	Yes	No
Regional fixed effects	Yes	No
Constant	56.41*** (0.000)	47.56*** (0.000)
Observations	1,798	1,798
R-squared	0.19	0.00

Note: * represents statistical significance at the 10% level, ** at the 5%, and *** at the 1% level. 'Constant' refers to theft. N is smaller here than in the general sample because in four cases the crime was not specified. The coefficients were multiplied by 125, see Juif and Baten, 2013, on this technique.
Source: own calculations

Table 5. *Number of different crimes, and crimes per capita*

Group	Birth cohort	N Minor	N Theft	N Violent	N Murder	Minor p.c.	Theft p.c.	Violent p.c.	Murder p.c.	Ratio theft /murder
European	Early	25	95	14	32	1.0	3.8	0.6	1.3	3.0
European	Middle	12	114	22	19	0.3	3.2	0.6	0.5	6.0
European	Late	3	46	4	2	0.3	5.1	0.4	0.2	23.0
European	Sum/Avg.	40	255	40	53	0.6	4.0	0.5	0.7	10.7
Slave	Early	77	230	47	127	2.4	7.1	1.4	3.9	1.8
Slave	Middle	16	280	30	50	0.2	3.8	0.4	0.7	5.6
Slave	Late	2	141	17	12	0.1	6.5	0.8	0.6	11.8
Slave	Sum/Avg.	95	651	94	189	0.9	5.8	0.9	1.7	6.4

Note: To calculate crime per capita (columns 5 to 8), we divided the number of crimes (columns 1 to 4) by the slave population as reported by Shell (1994). We calculated the underlying population for the early birth cohorts as the populations of 1660, 1670 … 1770 (we used lags of 30 years, because this corresponds roughly to the mean age of criminals), the populations of 1780, 1790, 1800, 1810 for the middle birth cohort, and 1820 for the late cohort. Rates (columns 5 to 8) are decadal crimes per 1,000 of population. 'N' refers to the total number of crimes. There are 10 decades of the early cohort, four of the middle, and only one decade of the late cohort. 'Sum/Avg.' in rows 4 and 8 refers to sums in columns 1 to 4 and arithmetic averages in columns 5 to 9. See Appendix F on the decline of murder rates in Europe.

Source: own calculations

Table 6. *Logit regression results (dependent variable: individual states an age not ending in 0 or 5)*

Variable		
Female	-2.15	(0.67)
Age 23–32	3.73	(0.31)
Chinese	8.29	(0.63)
European	51.38	(0.00)
South-east Asian	-28.63	(0.00)
Indian	-20.25	(0.01)
Khoesan	-6.30	(0.29)
Mozambican	-21.38	(0.00)
Slave, origin unknown	-8.01	(0.19)
Time FE		Included
Observations		1,802
Pseudo R2		0.149

Note: 'Constant' refers to Cape-born slaves, male, aged 33–72. P-values are in parentheses. 'Indian' includes a very small number from Sri Lanka, 'Mozambican' includes a very small number from Madagascar and Mauritius. The dependent variable is 1 if an age not ending in 0 or 5 was reported. Marginal effects are included in the table and are multiplied by 125, see Juif and Baten (2011), pp. 234-5.
Source: own calculations

Table 7. *Number of cases for interactions of three cohort dummies with ethnic groups*

	Early	*Mid*	*Late*
Europe	167	170	55
SE Asian	74	53	
Indian	42	29	
Khoesan	28	189	151
Mozambican		63	29
Cape-born		79	58
Other slaves	364	156	79

Note: 'Indian' includes a very small number from Sri Lanka; 'Mozambican' includes a very small number from Madagascar and Mauritius.
Source: own calculations

Table 8. *Interaction of three cohort dummies with ethnic groups*

	(1)	*(2)*	*(3)*
Included crime	*All*	*All*	*Non-severe*
	(0.0339)	(0.0339)	(0.0383)
Age 23–32	2.841	2.772	3.383
	(0.0230)	(0.0230)	(0.0268)
Eur_early	38.01**	37.11**	36.14**
	(0.130)	(0.130)	(0.132)
Eur_mid	39.21**	38.40**	40.08**
	(0.130)	(0.130)	(0.131)
Eur_late	38.84**	38.52**	34.82**
	(0.139)	(0.139)	(0.142)
Indon_early	-29.84*	-30.92*	-32.96*
	(0.134)	(0.134)	(0.137)
Indon_mid	-47.88***	-48.45***	-52.07***
	(0.129)	(0.129)	(0.128)
India_early	-25.12	-26.65	-22.10
	(0.142)	(0.142)	(0.156)
India_mid	-37.85**	-38.55**	-38.55**
	(0.141)	(0.141)	(0.145)
Khoesan_early	11.54	9.987	10.81
	(0.157)	(0.157)	(0.180)
Khoesan_mid	-31.58**	-32.27**	-32.27**
	(0.128)	(0.129)	(0.130)
Khoesan_latet	-6.879	-7.440	-12.48
	(0.132)	(0.132)	(0.134)
Mozamb_mid	-43.36***	-44.04***	-42.83***
	(0.131)	(0.131)	(0.133)
Mozamb_late	-8.949	-9.850	-8.948
	(0.156)	(0.156)	(0.167)
Slaves_unknown_early	-11.68	-12.89	-9.699
	(0.128)	(0.128)	(0.130)
Slaves_unknown_mid	-26.14	-26.92*	-27.77*
	(0.130)	(0.130)	(0.131)
Slaves_unknown_late	-16.95	-17.26	-16.35
	(0.137)	(0.137)	(0.139)
Cape_born_mid	-17.03	-17.75	-18.58
	(0.136)	(0.136)	(0.139)
Cape_born_late	-9.036	-9.699	-10.58
	(0.142)	(0.142)	(0.146)
Crime severity		3.365	
		(0.0248)	
Constant	53.96***	53.97***	53.85***
	(0.125)	(0.125)	(0.126)
R-square	0.19	0.19	0.20
Observations	1,802	1,802	1,348

Note: Indian includes a very small number from Sri Lanka; Mozambican includes a very small number from Madagascar and Mauritius; 'constant' refers to Chinese; fixed effects for gender and share aged 23–32 are included; coefficients are multiplied by 125, see notes to Table 6.
Source: own calculations

Table 9. *Significance of geographic and cohort differences*

	Reference category	Coefficient refers to	Coefficient	P-value	N
Indian	1650s–1740s	1750s–1780s	-12.5	0.286	71
SE Asian	1650s–1740s	1750s–1780s	-18.3*	0.011	127
European	1650s–1740s	1750s–1780s	0.5	0.925	337
European	1750s–1780s	1790s	1.4	0.872	225
Khoesan	1650s–1740s	1750s–1780s	-43.9*	0.000	217
Khoesan	1750s–1780s	1790s	26.5*	0.000	340
Mozambican	1750s–1780s	1790s	35.5*	0.005	92
Cape-born	1750s–1780s	1790s	9.5	0.363	137
Slave, unknown	1650s–1740s	1750s–1780s	-14.8*	0.005	520
Slave, unknown	1750s–1780s	1790s	10.8	0.172	235

* Indicates statistical significance at the 10% level.

Source: own calculations

Table 10: *Comparison of our ABCC estimates ('ABCC here') with other numeracy estimates for similar countries and periods*

Region	*Today's countries*	*Birth cohort*	*Context*	*ABCC*	*ABCC here*	*Cases*	*Sources*
South Asia	India, Sri Lanka, Iran, Malaysia	16th/17th c.	Portuguese Inquisition	29–36	29	30	Juif & Baten 2013
South Asia	Sri Lanka	1690s–1720s	Pop. register (*thombos*), age 33–62	34	(29)	922	Huijgen 2010
South Asia	Sri Lanka	1730s	Pop. register (*thombos*), age 23–32	40	(29)	511	Huijgen 2010
South Asia	Sri Lanka	1690s–1730s	Pop. register (*thombos*)	36	(29)	1433	Huijgen 2010
South Asia	India	1830s	Census 1891	34	(29)	686521	Prayon & Baten 2012
East Asia	Japan	1590s	Pop. register	81	(54)	551	Baten & Sohn 2013, Hayami 2001
Sub-Saharan Africa	Angola and 7 other	15th–early 18th c.	Portuguese Inquisition	12+	11	55	Juif & Baten 2013
South Africa	South Africa	1810s–1820s	Census 1865, Xhosa	28	45	284	Tuebingen Database on Human Capital
South Africa	South Africa	1810s–1820s	Census 1865, Khoesan	40	47	205	Tuebingen Database on Human Capital
South Africa	South Africa	1800s–1810s	Census 1865, White	89	93	284	Tuebingen Database on Human Capital

Note: The Portuguese inquisition sample on South Asia refers mostly to Indians. Omitting Iranians, for example, does not change the results notably (but reduces N).
Sources: Juif and Baten, 'Was human capital a hazard?', p.27; Huijgen, 'Family formation and marriage patterns'; p.38; Baten and Sohn, 'Back to the 'Normal' level', p.27; Hayami, *The Historical Demography, p.25*.
Source: own calculations

Figures

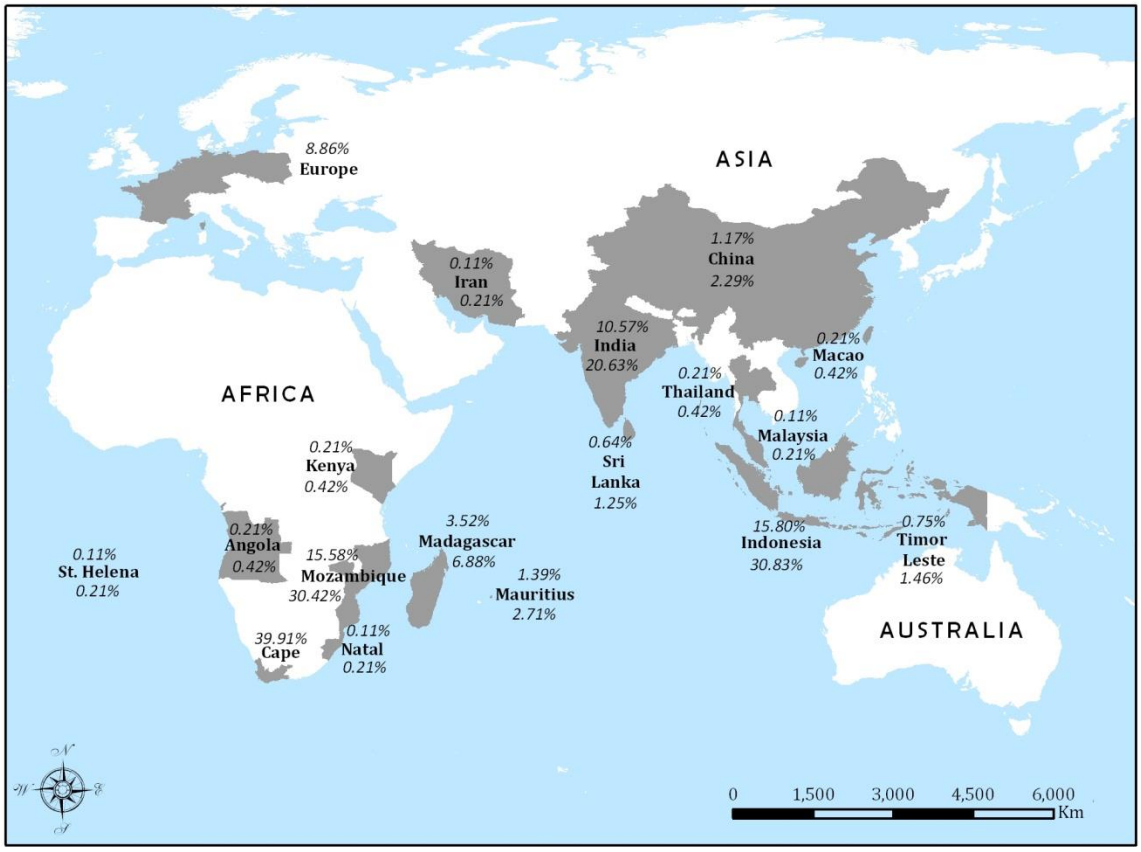

Figure 1. *The origin and share of criminals at the Cape Colony in our dataset*
Notes: The top percentage represents the share of individuals at the Cape including Europeans and locally born slaves; the bottom percentage represents slaves at the Cape excluding locally born slaves, i.e. the percentage of 'imported' slaves. The map shows country borders as they are today.
Source: own calculations

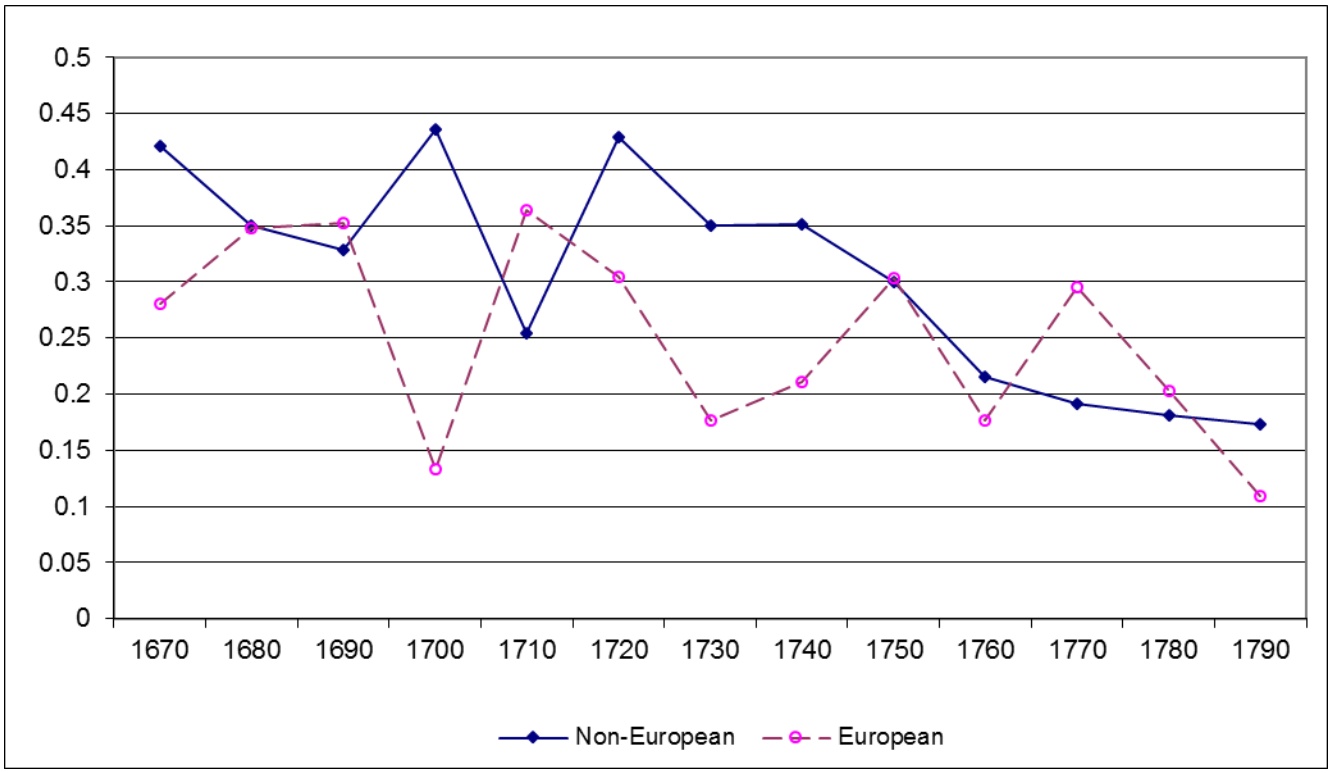

Figure 2. *Share of severe crimes by birth decade and world region*
Source: own calculations

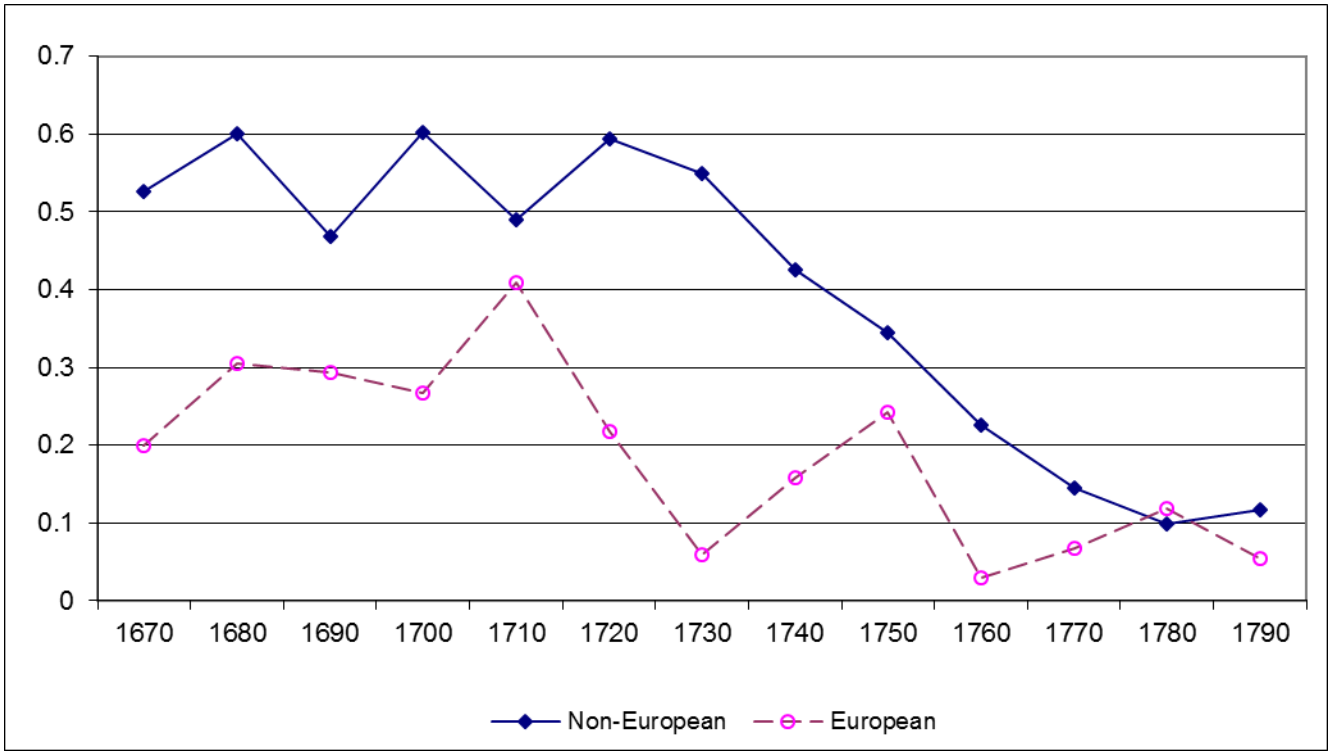

Figure 3. *Share of severe punishment by birth decade and world region*
Source: own calculations

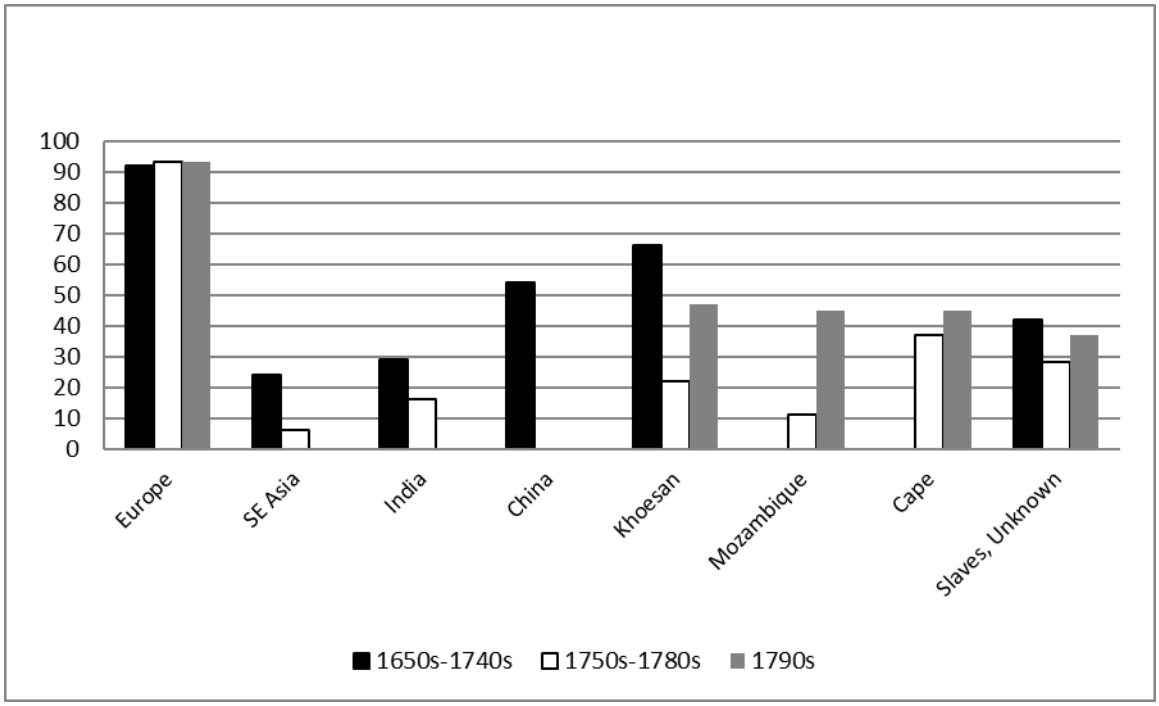

Figure 4. *Numeracy (ABCC) levels by birth regions and cohort (early, middle and late)*
Note: Graph based on coefficients of interaction terms shown in Appendix A.
Source: own calculations

Appendices

Appendix A (online): Background numeracy (ABCC) levels for figures

Table A.1. *Numeracy (ABCC) levels underlying Figure 4: Interaction of three cohort dummies with ethnic groups*

	Europe	SE Asian	Indian	Chinese	Khoesan	Mozam-bican	Cape-born	Slaves, unknown
1650s–1740s	92	24	29	54	66§			42
1750s–1780s	93	6	16§		22	11	37	28
1790s	93				47	45$	45	37

Notes: § indicates estimate based on N below 30 (25–29).
'Indian' includes a very small number from Sri Lanka; Mozambican includes a very small number from Madagascar and Mauritius; 'constant' refers to Chinese; fixed effects for gender and share aged 23–32 are included; coefficients are multiplied by 125.

Appendix B (online): Heaping on other preferred digits

Other forms of heaping could be on multiples of 12 and on multiples of 2 in particular. A heaping on multiples of 12 has been observed for early-modern European samples (because Christianity emphasizes the number of 12 apostles).[77] However, in our sample, multiples of twelve are not preferred. For example, fewer people report an age of 24 than 26. Among the Europeans, from whom such a heaping could be most easily expected, the rounding on multiples of 12 is also not observed.

In contrast, multiples of 2 are preferred over odd numbers. But this type of multiples-of-2 heaping has been identified by earlier research as an intermediate stage of innumeracy: those aged 27, for example, round up to 28 rather than 25 or 30, i.e. they can estimate their age at least with a resolution of two years. In a large-scale international comparison project of various types of numeracy with other educational indicators such as literacy rates, Program for International Student Assessment (PISA) tests, and school enrolment rates, A'Hearn et al. found that more comprehensive measures of numeracy are actually less correlated with these educational indicators.[78] In contrast, the Whipple index (or the ABCC) is most closely correlated with these educational comparison indicators. The reason for this result is that the intermediate group of those rounding on two instead of 5 is sometimes less, but sometimes

[77] de Moor, T. and von Zanden, J. L., *Vrouwen en de geboorte van het kapitalisme*.
[78] A'Hearn et al., 'Quantifying quantitative literacy'.

actually more, educated than the average population. Hence the impact of this form of rounding on 2 is less clear cut. The heaping on multiples of 2 might still have informative value for populations that were already quite numerate (but this probably requires more study).[79] For comparisons that also include many innumerate individuals (such as the Africans and Asians in our study), the standard measure of the ABCC index allows international and between-group comparisons more easily. These measures should be standardized for the lower heaping on multiples of 5 in the 23 to 32 age group, however.

Appendix C (online): Development of the court system

Initially, lawsuits were prearranged and controlled by Governor Jan van Riebeeck and his council.[80] The Governor played a key role in the final decision-making of the court, as he invariably retained a right to veto sentences that were passed.

Governor A.H. van Rheede visited the Cape in 1685 and suggested the creation of a more effective court system that would comprise a governor, nine members, a secretary, and a prosecutor. The Governor had to serve as chairperson of the Court of Justice, but he was to be replaced by the *Secunde* in 1734, though the latter still had to gain the approval of the governor to impose sentences.[81]

After a period of nearly 45 years, the colonists demanded greater representation in the Court of Justice on the grounds that it should comprise an equal number of civil servants and citizens. The Lord's XVII, the shareholders and rulers of the Dutch East India Company, agreed to this request and accordingly changed the composition of the Court. From 1783 the court therefore consisted of a president, a member of the Council of Policy assisted by six company servants and six *burgerrade* or civil councils. The latter became known as the *heemraden*, of which the *landdrosts* were appointed prosecutors in the rural districts.[82]

[79] de Moor and van Zanden, looking at a data set of quite numerate Dutch, also studied the share of those rounding on multiples of 2.
[80] Archives and Records service of the Western Cape, KAB, *Kriminele en siviele regsrolle*; Leibrandt, *Précis of the archives*.
[81] Theal, *Belangrijke historische dokumenten*.
[82] Dooling, *Law and community*, p. 3. These local councils or boards also had so-called *veldcornets* or armed patrols to help them police the rural districts and gather vital information or evidence on criminal cases. Notwithstanding the allowances made by the Company and Lord's XVII, strict control was maintained over the *heemraden* and *landdrosts*. The early legal system at the Cape was therefore made up of three main bodies; first, the Court of Justice in Cape Town, second, the Fiscal as prosecutor, and third, the *heemraden*, who had to impose the law and regulations in the rural districts.

As in the Netherlands and Dutch East Indies, attorneys could defend the accused during lawsuits in the Court of Justice. In stark contrast to the legal defence and representation of European wrongdoers, the non-Europeans and slaves were largely left to defend themselves. In essence, the slaves were initially legally defenceless, as they did not possess any rights or privileges whatsoever because they were emphatically regarded as forms of 'possessions'. Entrenchment of colonial rule affected the behaviour of colonial subjects. According to Heese, there was a marked decline in slaves deserting their masters towards the end of the eighteenth century, as their 'mentality of subjugation increased' and the futility of escape became apparent.[83] Worden also notes that there was no successful slave revolt or attempt in the interior, as the farms were too isolated for slaves to communicate or organize a revolt.[84]

Appendix D (online): What might have determined the development of numeracy?

Were there perhaps real changes in education, perhaps due to nutritional influences on cognitive abilities? This explanation is based on the influence of malnutrition on cognitive development and therefore age-heaping scores. Height is often used as a measure to capture the effects of malnutrition on numeracy.[85]

Unfortunately, little is reported in the literature about nutritional status and development in the slaves' regions of origin in south and south-east Asia. What about the socio-economic conditions within the Cape Colony? In an attempt to substitute for the high slave prices of the 1750s, Cape farmers turned to the native Khoesan as indentured labourers.[86] Although Khoesan could not formally be enslaved (and thus sold via the market), the unrelenting movement of farmers into former Khoesan territory, combined with several smallpox epidemics, left many Khoesan marginalized with little option but to accept labour on farms in exchange for meagre in-kind payment. Thus, Colonel Dalrymple noted in 1785, 'the Hottentot [Khoe] cannot go from one master to another and is obliged to work without payment. … If a British Army acts in that country they should make them presents of clothing according to their services, and feed them with meats which attracts them, as they seldom get anything from their masters but Bread, Milk, Roots and Vegetables'.[87] As a

[83] Heese, *Reg en onreg*, p. 28.
[84] Worden, *Slavery in Dutch South Africa*, p. 120.
[85] Margo and Steckel, 'The heights of American slaves'; Monasterio et al., 'Growth and inequalities'.
[86] Shell, *Children of bondage*.
[87] Quoted in Shell, *Children of bondage*, p. 31.

formerly cattle-owning people, 'forced' settlement on farms, with little access to sources of protein, certainly lowered the Khoesan's nutritional status and cognitive abilities in the second half of the eighteenth century. The fall in the numeracy score for the Khoesan in Table 5 reflects these socio-economic shifts. We do not know much about the other regions of origin in Mozambique, Madagascar and Asia, but the increasing intensity of contact with European traders could have similarly distributed infectious human and cattle diseases. For example, recent research has found that cattle plague moved from Mongolia to India during the eighteenth century, before moving on to Europe and killing 200 million cattle there.[88] The spread to Africa is not well documented yet, but very likely, given the typical geography of cattle plagues.[89] This collapse of protein-rich nutrition and human capital in India might even have played some part in the de-industrialization which occurred during the nineteenth century.[90]

Appendix F: (online): Decline in homicide rates between the late seventeenth and late eighteenth centuries

How does the decline of homicide rates which we observed between the late seventeenth/early eighteenth century to the late eighteenth century compare with other evidence? There is no evidence on slaves, or populations in Asia or Africa before 1800, but Eisner has published on European rates.[91] Figure F1 shows his estimates for the Netherlands and Belgium. His estimates are from the fourteenth century to the present. We were interested in the period between the mid-seventeenth century and 1800. Homicide rates declined in this period from around eight to 11 annually per 100,000 population to around one to three. As the evidence in our paper was per decade, our comparative values on the same scale for the Europeans would decline from 13 per 100,000 population to two (see Table 5). Our sample included the category 'murder' rather than homicide in general. However, as most homicides are murders, we can argue that the decline in murders for Europeans in our Cape sample is very similar to Eisner's estimates for the decline in homicide, the rate being perhaps only marginally higher for Europeans in our sample.

[88] Ramachandran, 'Rinderpest'.
[89] Spinage, *Cattle plague*.
[90] Broadberry and Gupta, 'The historical roots'; Clingingsmith and Williamson, 'Deindustrialization'.
[91] Eisner, 'Modernization'.

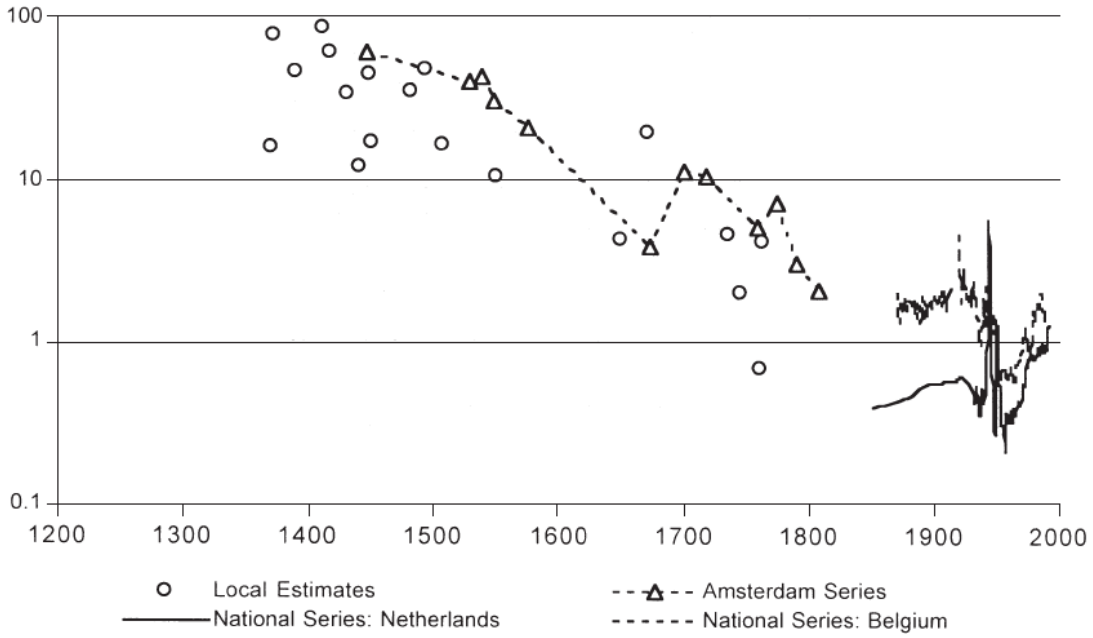

Figure F.1. *Homicide rates in Belgium and the Netherlands*
Source: Eisner (2001)