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Tall and Shrinking Muslims, Short and Growing Europeans: The Long-Run Welfare Development of the Middle East, 1850-1980

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Abstract

In this study we estimate for the first time anthropometric values for eight countries in the Middle East for the period 1850-1910, and we follow those countries until the 1980s using Baten's (2006) estimates, and using additional Iranian data. We compare those trends with GDP and real wage data and find that the Middle East had a good position during the mid-19th century, if anthropometric indicators or real wages are considered, but much less so in terms of GDP/c. All indicators suggest that the Middle East lost ground after the 1870s relative to the Industrial Countries.

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1. Introduction

How did the standard of living develop in the Middle East over the past 150 years? When did the Western world become clearly better-off in terms of income and health? Those central questions cannot be answered easily, even if interest in this world region has grown substantially over the past years. We provide an alternative measure of living standards in the Middle East, using - by now well-established - anthropometric techniques (Komlos 1985, Steckel 1995, Steckel and Floud 1997). These techniques employ human stature as an indicator of the biological components of the standard of living, as heights are normally correlated with nutrition, health, and life expectancy. With our height data sets, we can cover the rural and agricultural populations of Turkey, Iraq, Iran, Egypt, Syria, Lebanon, Palestine/Israel, and Yemen. We will refer to these countries when we write "Middle East" in the following (please note that the Arabian Peninsula is not covered, except for Yemen). We will in particular test the hypothesis that some Middle Eastern populations were taller than Europeans in the mid-19th century, using British, German, Czech, and Italian samples for comparison. The hypothesis of initially taller Middle Eastern populations derives from the stylized fact that people making a living from animal husbandry – often in sparsely populated regions - might be taller than other populations in a situation in which some protein-rich, but less highly valued products of animal farming (offals and milk, for example) could not be shipped at sufficiently low cost. This implies that the inhabitants of industrializing cities who had higher purchasing power of tradable goods, still might not have been able to buy those untradable foodstuffs (Komlos 1996, Baten 1999, Baten and Murray 2000, Moradi and Baten 2005, Koepke and Baten 2008). In the Middle East, large parts of the population lived in deserts and other sparsely populated regions. They might initially have benefited from the advantages of remoteness. Consequently, as can be seen in Table 1, population densities were quite low in the eight Middle Eastern countries under consideration. The lowest population density was given in Iraq in 1820, and the largest population per arable land in Yemen.[1] After the late 19th century European urban industrial populations could buy cheap proteins and benefitted from improving disease environments during the 20th century. Industrialization in the Middle East took place much later, and its urban populations could therefore not improve its standard of living as much as the Western world (Pamuk 2006, Issawi 1995). As a result, the Western industrial countries soon overtook the Middle Eastern populations in terms of average body height.

Our primary sources are anthropological measurements which were carried out by a number of scholars during the late 19th and early 20th centuries. For an analysis of the more recent period (birth cohorts ca. 1950 – 1980) we combined an anthropological survey of Iran (Janghorbani et al. 2007) with Baten's (2006) estimates of mid-Eastern height development (which are based on the Demographic and Health Surveys [DHS]).

We compare the resultant height estimates for the Middle East with both GDP per capita and real wages (Pamuk 2006, Maddison 2001, Özmucur and Pamuk 2002). According to our findings heights and real wages provide a similar picture of relatively favorable living standards during the mid-19th century, whereas the level of Mid-Eastern GDP indicates a much worse situation.

In the next section, we will discuss the concept of the biological standard of living as well as the main data sources and estimation methods. In section 3, we report regional differences of height in countries on which we have sufficient information, and present a map for Turkey (Figure 1). Section 4 gives an overview of height levels in the Middle East, while section 5 discusses differences between the Middle East and the industrialized countries between the 1850s and 1910s. Subsequently, we compare GDP per capita, real wages, and height estimates, before section 6 concludes this paper.

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[1] Population per arable land refers to the number of people for land which can be used for agriculture, i.e. excluding deserts, mountains, and other wasteland.

2a. Heights, Real Wages, GDP, and our main hypothesis

We use human stature as an indicator of the "Biological Standard of Living" because it tends to be correlated with the quality of nutrition, health, and longevity (Komlos 1985). Heights are also important to study, because they tend to be correlated with life expectancy. Fogel (1994) stressed in his lecture to the Nobel Prize committee that a height gap of 17.5 cm meant even for modern Norwegian males in the 1960s and 1970s a higher probability of dying of not less than 71 percent. He based his work on Waaler (1984), who measured several thousands of Norwegians and followed them in a longitudinal study.[2] Baten and Komlos (1998) estimated that a centimetre of height equals about 1.2 years of life expectancy, with only negligible coefficient change over time between the birth cohorts of 1860, 1900, and 1950, i.e. the latter being around 60 years old today. Hence, even a change of one centimetre in average body height is momentous, as living 1.2 years more or less is a substantial asset in the quality of life portfolio.

How do our height estimates differ conceptually from estimates of real wages and GDP? The strength of GDP per capita is, of course, its comprehensive account of purchasing power and its comparability over time if given in standardized monetary units (such as the 1990 Geary-Khamis $). One of the disadvantages of GDP as a welfare measure is its bias against subsistence farming and production within the household. In general, non-traded goods and goods produced and consumed within households are often underreported. Moreover, other forms of informal markets, such as black markets, can often not be captured. Finally, the data requirements for GDP estimates are very large, hence strong assumptions have to be made in many cases. In contrast, real wages have a better reputation in terms of data quality for long-run studies, as nominal wages and prices were recorded by contemporaries (whereas GDP relies on estimates produced by later generations). From studying real wages, however, we cannot learn about the return to land, capital, or perhaps the return to the exploitative activities

[2] Norway had one of the populations with the best nutrition in the late 20th century.

of the rulers. Moreover, typical pre-modern subsistence goods (milk, offals) or less standardized goods such as housing are again difficult to include in the consumer basket, as those who created the written sources of the past did generally not provide sufficiently detailed information. Finally, both GDP and real wages concentrate on purchasing power and do not include other "biological" living standard components such as health, longevity, and the quality of nutrition.

Anthropometric techniques were developed to provide an additional welfare indicator that covers biological aspects and includes not only subsistence farmers, but also local rulers, craftsmen, and unskilled day-laborers. Although the quality of nutrition is partly determined by income, heights also reflect other living standard components quite strongly, such as the disease environment, hygienic behavior, and non-market nutrition factors such as proximity to the production of perishable proteins (e.g. milk or offals, which could not be transported and traded over longer distances before the mid-20th century, see Baten 1999, Komlos 1996, Baten and Murray 2000, Moradi and Baten 2005). In a seminal study, Margo and Steckel found a remarkable deviation of height and income for the mid-19th century U.S. (Margo and Steckel 1983).

Those considerations lead us to our main hypothesis, namely that the Middle East had relatively favourable biological welfare levels as long as a substantial part of the population lived from cattle farming, and the benefits of proximity to this agricultural specialization had a non-transportable component, which was substantial (apart from the products such as high-value meat, sausages etc., which could be transported). Moreover, relatively low population densities also allowed a benign disease environment in the Middle East of the mid-19th century, whereas the Western urban populations still suffered from "urban penalties" in this period (see, for example, Szreter and Mooney 1998). However, we would hypothesize that when protein became transportable, the Western urbanized and industrializing societies began to overtake the Middle East in terms of height and the biological standard of living, which will be assessed in the following.

2b. Data and Representativeness

Our height information on the Middle East stems mostly from anthropological studies. During the late 19th and early 20th century many European and American anthropologists went to the Middle East in order to study the physical characteristics of the local population. We could find some of the resulting measurements of height as individual height data, for example in the archives of the British Anthropological Collection. Sometimes anthropologists also published their individal data (for example, Chantre 1895 and Field 1956, see Table 2). However, this (ideal) individual data accounted only for 1,476 observations in total. Height data aggregated by 10-year -age groups, can also be analyzed without major methodological problems, as long as the samples were drawn representatively for the underlying population, like Inan (1939) did for Turkey. In order to increase our data coverage, we also included studies which reported anthropometric information in the form of height averages. When studying height trends, one frequent problem regarding anthropological surveys is the paucity of the information given on birth cohorts, as many anthropologists of the late 19th and early 20th century assumed no change in height over time. Hence, we had to find out when most of the measured individuals were born, and estimated the birth cohort in which the largest number of individuals was born. The time trend which results from these estimated birth cohorts resembles moving averages insofar as it smoothes the height development. For example, if there was a height decline in the 1880s but only 70% of the respective individuals were born in the 1880s and 30% in the 1870s, the decline would be smoothened. Moreover, statistical significance is difficult to assess when the distribution of heights is not known. Koepke and Baten (2005, 2008) have suggested estimating these grouped and individual data jointly with Weighted Least Square Regressions (WLS). They applied this method to populations for which we otherwise do not have any way of studying their anthropometric development, given the data which are obtainable. This also refers to the Middle East, as military records are not available. Our research in the Ottoman Archive in Istanbul showed that anthropometric measurements in the Ottoman army were only reported as “tall”, “middle”, and “short”, without clear definition of those categories. Another common sources of Heights of prisoners were only exceptionally recorded by Western anthropologists and included in our sample. We will also apply this technique here as no large-scale individual height data from archival records can be expected for future research. In the following, we will discuss in detail those cases where we can compare the height development based on individual cases on the one side, and grouped cases on the other, for example for Egypt and Turkey.

Including the grouped data, the total number of underlying cases was 47,797, after discarding height and age extremes (in the following, we will only use ages 20-50, with the one exception of Turkey where we also used the 50-59 year-olds, as this age range was reported in one aggregated group, see below).[3] We concentrate on male heights only in this study, as the aim will be to compare them to heights in the industrialized countries in the 19th century, which are almost exclusively male (due to the predominant data generating institutions being the military, prisons, etc.).

To what degree is our data set representative? Are the economic sectors represented by similar shares in our samples as in the overall population? The Inan (1939) dataset, which accounts for 28,992 underlying observations (or some 60 percent of our data), was representatively drawn from the Turkish population, also with respect to occupation (Inan 1939, p. 62). Inan (1939, p. 56-58) describes in great detail how he in cooperation with the

[3] We excluded extreme heights above 185 and below 140. When the measurement year was not reported, we assumed it to be the publication date of the survey minus three years. This increases the measurement errors – but concerns only 0.75% of our sample. Our robustness tests suggested that the impact is marginal and that the broad trends are unaffected. We also tested different criteria for the exclusion of outliers and found the results consistent with our findings.

Turkish Statistical Office made sure that adequate numbers of measurements were performed in each individual district. Without the direct support of Atatürk and his influence with the Turkish authorities, these large-scale measurement activites could not have been realized. Hence, for this part of our dataset, we do not expect strong selectivity biases. For our individual samples, we have occupations recorded for a smaller subset, namely 445 out of our 1,476 individual observations, of which 71% were engaged in the agricultural sector. For those we can compare the occupational composition with the overall population. Given Issawi's (1982, p.118) estimate that about four fifths of the Middle Eastern population were engaged in occupations related to agriculture, our best guess is that our sample might include a slightly lower share of rural people relative to the overall population. The rural population might have enjoyed a better nutritional status because of easier access to food and lacking market integration, and might thus have been relatively tall on average, but the difference between "four fifths" and 71 percent is not a very large difference.

Were there unrepresentative subgroups or regional biases in the dataset? Among the grouped samples, most of them were drawn randomly for a certain region of a country, hence we will need to control for regional composition in the following. Sometimes the anthropologists were particularly interested in desert tribes or in the Jewish part of the population. That is why we need to look out for those characteristics. All of the height measurements were taken within the country of origin. We excluded all migrants, with the one exception of 23 Yemenite Jews, who were measured in Israel. We included those 23 cases to fill the gap in the 1880s.[4] Those will deserve special attention in the following and will be controlled for using a dummy variable, even if they account only for a negligible 0.05% of our sample. Another group with potential social bias are prisoners. For Egypt, Craig (1911)

[4] Otherwise the 1880s would have been dropped for not reaching the minimum inclusion number of 30 height observations.

collected height data of criminals in Cairo in 1905.[5] He argued that the anthropometric information is representative for the underlying Egyptian population because of the relatively broad social spectrum of Egyptian prisoners. He argued that the elite groups within the Egyptian society, the wealthy merchant strata of Alexandria and similar cities, were not represented in this prison sample, but given that most had foreign origins, he did not consider them a part of the Egyptian people anyway. However, we have some doubts about his arguments. It might well be that the sample was slightly biased towards the lower income groups of Egypt, compared with the samples taken by anthropologists, who aimed at representative data collection. However, in the following paragraph we will find that the Egyptian samples were probably not downward biased in terms of numeracy, which would support Craig's hypothesis. Apart from those social groups, no other special subgroups were recorded in our data. But we certainly need to control for regional composition, religion, age, and migrant status below.

One strategy to assess the representativeness of historical samples is to compare the age heaping behaviour in the sample and in the underlying Mid-Eastern population. The idea of an age heaping analysis is that people who are not able or willing to state their exact age often report an age rounded to multiples of five, and those persons are typically less educated than people who report their age exactly (Baten, Crayen, and Manzel 2008). Age heaping indices such as the "Whipple Index" tend to be strongly negatively correlated with other human capital indicators such as literacy, and even stronger – in modern times – with measures of mathematical skills (as reported in the PISA survey, see A'Hearn, Baten, and Crayen 2006). Normally those indices require large individual samples of 500 or more persons reporting their age, which we do not have for each birth cohort and country (Table 3). Nevertheless, on average the Whipple index of 309 for our individual samples is quite similar to corresponding census values of 281. The total number of our individuals with age

[5] Our Egyptian data stem from five different sources: Ammar (1944), Chantre (1904), Craig (1911), Field (1952a).

statements is almost 600, hence this overall value is quite informative (we cannot use all our individual observations, as not for all countries and birth decades corresponding census data is available). Even if sample sizes are probably too small, we also compared individual countries and birth cohorts with at least 30 observations for which matching census data could be obtained. In some cases, the Whipple index is slightly higher for our samples (such as Iraq and Iran), and the samples of Turkey and Egypt in 1850 and 1870 have lower index values than apparent in the representative census data, but on average the difference is quite modest, especially when compared to the large differences of Whipple indices in the world, reported on the bottom of the table. We should note the possibility that assuming a negative correlation between Whipple indices and heights, our Iraq and Iran estimates might be slightly overestimated, and the Egyptian and Turkish estimates slightly underestimated, although the individual country differences might also be influenced by small sample size. We conclude that the average Middle Eastern level seems quite representative for the underlying population.

To sum up, we find that the dataset is probably broadly representative for the underlying population.[6] The large share of the agricultural population is reflected in the dataset. While there exists a small number of special subgroups these can be controlled for with dummy variables. Last but not least, the age heaping analysis suggests that our samples were overall quite representative in terms of human capital.

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[6] This reflects the efforts of many anthropologists who studied Mid-Eastern populations and attached great importance to a representative social mix of their data (for example, Craig 1911, p. 67 states that “it may be concluded, that the statistics are representative of the Egyptian and Nubian races with their local variations.”).

Number of cases for individual and grouped height figures

Our database contains both individual and grouped height observations (Table 4). With 687 Iraq has the largest number of observations of the individual samples, while Egypt 231, Iran and Turkey are represented with between 286 and 192 individual observations. These case numbers are relatively small in comparison with typical military and prison samples that have been used for Western anthropometric history. However, the early Turkish data fill a gap as they cover the 1850-70s period, before the very large grouped Turkish sample covers birth decades from the 1880s onwards (see below). The individual sample for Yemen is very small.

Among our grouped samples with more than 10 cases, the Turkish one is by far the largest, being based on almost 29,000 observations between the 1880s and 1910s. This sample contains the most accurate information in the way that we can determine the birth cohort by subtracting the age from the measurement year. A drawback of this sample is the fact that the oldest cohort consists of Turkish males aged 50-59 years. Studies on heights of this age group have found that shrinking leads to an underestimate of height by about one centimeter.[7] On the other hand, selective mortality counteracts this bias, as taller individuals tend to be healthier and hence more likely to survive up to this age.

The second-best documented country among the grouped cases is Egypt, again for the early cohorts from the 1850s, and the 1870s birth cohort is particularly well-documented. The grouped rates for Egypt concentrate on earlier birth decades. In Iraq we have numbers for the later cohorts based on both individual and grouped cases. The other countries' (Iran, Palestine, Lebanon, Syria, Yemen) grouped samples are concentrated in the 1850s and 1860s, allowing at least a rough impression of the height levels in those countries in the 19th century.

[7] Sorkin et.al. (1999) estimate the effect for North Americans in 1980 to be 0.98 cm for the age group 50-59.

Measurement quality of individual countries: Turkey and Egypt as examples

We now study the two best-documented countries separately, - Turkey and Egypt - in order to assess the measurement quality of those two samples. In particular, we consider the question as to whether subsets of the available heights show similar height developments. The grouped Turkish heights were recorded in 1937 and refer to those aged 20-24 (i.e. born 1913-17), those aged 25-29, 30-39, 40-49, and 50-59. The latter persons were mostly born in the 1880s.[8] We assigned birth decades by taking the one during which the majority was born. Hence, one drawback that needs to be mentioned is the imprecision of birth cohorts for Turkey. It turns out that there was very little trend for the grouped Turkish sample anyway (Figure 2). The 1880s birth cohort might be slightly underestimated due to shrinking (perhaps by 0.98 cm, as the Sorkin (1999) analysis showed, although selective mortality probably reduced this bias). The youngest birth cohort might contain some individuals who did not yet reach their final adult height; hence this value might be underestimated. Given that the number of cases is quite small, not too much importance should be attached to the slightly taller individual data points before the 1870s . Only the 1860s have 63 cases and might allow a substantive height estimate. Moreover, the similar values of those born in the 1850s and 1870s might improve the credibility of the 1860s height level. The individual cases reflect mostly Erzurum-Kars province (with a share of 43 percent), and five other provinces with smaller shares. The map of Turkish heights for the birth cohorts of the 1880s-1910s shows that this region (Erzurum-Kars) had about average heights (Figure 1). Hence, the height of the first Turkish birth cohorts are unlikely to have a strong regional bias. In conclusion, we find that Turkish heights were mostly stagnant between the 1880s and 1910s. This stands in contrast to most European height series that indicate a strong increase in height during the period after the 1880s. After the 1850s, our evidence suggests a slight decline in Turkey, although this can only be tentative, being based on a relatively small sample size.

[8] although a smaller share was also born in the 1870s

Egypt is another large country in the region, which is relatively well-documented in our sample. We can, for example, compare one well-documented individual province with the overall Egyptian development. This avoids any risk that a development over time might be caused by adding different regions for different birth cohorts and then arriving at a misleading impression of development over time. The best documented province in Egypt is Sharqia. Here we find a modest increase among the grouped samples between the 1850s and 1860s from 166.4 to 167.1 cm, and then a strong decrease to 165.5 cm in the following decade of the 1870s. The latter decrease between the boom period of the 1860s and the following period amounts to 1.6 cm. We cannot perform significance tests, as we only have the average, but such a large coefficient – combined with a relatively large number of cases – is almost always statistically significant looking at other height studies. The results for Sharqia correspond very well with the overall pattern of Egyptian heights, even if the decline of the 1870s is slightly less strong for the Egyptian average (Table 5). This actually fits very well into the classical Egyptian economic historiography: There might have been an effect of the cotton boom of the 1860s on living standards: heights did increase, when the cotton from the U.S. South did not arrive in European cotton mills, and Egypt experienced a substantial cotton boom. Both, the relatively high level during the 1860s as well as the development over time can be supported by the grouped data for Sharqia and Egypt in general.

Now, we could continue and go through all the countries and different samples individually, but this would take too much space. Instead, we consider the average heights jointly, and turn to consider the raw heights first, i.e., heights not adjusted by age, region, and religious composition (Table 5). We find that those raw heights were relatively similar across Middle-Eastern countries (for example those of the birth decade of the 1850s), except Yemen that had substantially lower average anthropometric values. The trend over time of those countries with sufficient data is relatively stable, which might be partly caused by the smoothing effect of estimating the birth decades. However, during the 1880s there was apparently a temporary decline of heights in the Middle East, which is supported by data on Egypt, Iran, and Turkey. Before comparing those raw results with the results of regression analyses, we will first consider potential regional differences.

3. Regional height differences

Regional differences of living standards were quite strong in other countries of the world (on the U.S., see, for example, Margo and Steckel 1983). In order to ascertain spatial variations in the levels and trends in physical stature for the Middle Eastern countries, we estimate heights at the regional level. This will also prove useful in the following trend regressions, which includes control variable for regional differences. A detailed analysis of the determinants of height differences remains a subject of future research though.

Reasonably good regional information is available for Iraq. The north and northeast of Iraq are mountainous and most inhabitants are Kurdish. The regions around Mosul (Ninawa) are treeless uplands and highly dependent on irrigation from smaller rivers and rivulets. The central districts of Bagdad, Babil, and Karbala are hot flatlands. Crop cultivation was only possible by using irrigation systems. At the onset of the eighteenth century, systematic cultivation was established and controlled by Ottoman garrisons, in particular around Basra, Diyala, Arbil, and Mosul. The rest of Iraq was inhabited by tribal groups (*dira*[9]) who were self-sustaining and only under limited control by the government in Istanbul. Having large areas at their disposal, the tribesmen made use of shifting cultivation and stock-breeding (Issawi 1966, p. 129f.). The cattle herding tribesmen consumed relatively large quantities of milk, meat, and offals. In contrast, the settled inhabitants in the cities and agricultural areas relied more on starches and proteins from vegetables. Moreover, they eventually suffered from insufficient rainfalls and the devastating annual flood of the Tigris and Euphrates (Issawi 1988, p.105). In Iraq, there is a height advantage for the population living in deserts (Table 6).

[9] The *dira* is the area claimed by the tribe (Issawi 1995 p. 163).

Those desert inhabitants were on average 0.85 cm taller than the urban dwellers in large cities such as Bagdad or Basra. Desert populations had an even stronger height advantage over Iraqis from other rural regions, such as the irrigated land along the Tigris and Euphrates rivers. Hence, it will be important to pay attention to desert regions in the following regressions. In a separate WLS regression analysis of height which include age, religion, and regional dummy variables, it is possible to assess whether the regional differences might be distorted by different time coverage. The constant refers to the desert population. In Iraq, the coefficient for "other rural inhabitants" indicates that they were 1.25 cm shorter than desert inhabitants (significant at the 0.01 level) after controlling for birth periods and other variables, whereas urban dwellers were 0.46 cm shorter, but not statistically significant (see appendix Table A-1). Over time, the share of nomadic Iraqis in the total population fell considerably, as population increased, from 35% in 1867 to 5% in 1947 (Issawi 1966, p. 158).

The grouped height data for Turkey published by Inan (1939) consists of 28,992 observations from all over Turkey. Inan also reported height averages by ten regions (Figure 1). Unfortunately, he also included very old Turks born in the 1850s to 1870s, for whose shrinking bias he did not adjust in his regional averages[10]. Therefore the height levels for the regions are likely to be downward biased. Hence we do not consider the regional height levels, but only the ranking between the regions, assuming that the share of old people was more or less equal across regions. The shortest populations were from the Dardanelles in the northwest of Turkey and the Aegeis, whereas the tallest Turks could be found in central Anatolia. An important part in the economic life of Turkey was livestock breeding. This was done mainly by nomads outside of the cultivated areas. Issawi (1980, p. 270) analyzed tax returns and reported that animal husbandry was prevalent primarily in the relatively dry inland while it did not figure as a common occupation in the moist coastal regions. Stock-breeding was also widespread in the European provinces of Turkey, but per capita values were not as

[10] It is an average of both adult height and the height of persons who had already started to shrink.

high. Issawi (1980, p. 8) reported that the Turkish peasants of the 19th century ate meat very rarely, whereas milk was available in considerable quantities. While Turkey did not have as strong a desert advantage as Iraq, a similar pattern emerges for the dry inland region of central Anatolia, which had high anthropometric values, low population density, and quite a strong nomadic element.

The third of the large countries for which we can document regional inequality is Egypt. Because of Egypt's aridity, most of the population lived along the Nile valley and delta. For agriculture, irrigation is a necessary precondition. Only the northern coast has sufficient rainfall, which might have made life somewhat easier in this region – heights were greatest in the coastal regions of Egypt (Table 6). Egypt again had a height advantage for its desert population over the urban population, although the coastal population was even taller than the desert inhabitants in this case ("other rural" being equal). Some coastal and river delta inhabitants might have benefitted from the strategy that provided a substitute for drinking water during the inundation months of the Nile: In Cairo and perhaps other cities of this region, cow milk was consumed in quite large quantities, substituting unavailable water (Kuhnke 1990, p. 25). In a similar WLS regression analysis as for Iraq, we included birth decade, age, religion, and regional dummy variables. The constant refers to the desert population. Urban dwellers were 1.04 cm shorter than desert inhabitants (significant at the 0.01 level) after controlling for birth periods and other variables (see appendix Table A-1).

4. Height development (or non-development) in Middle Eastern countries 1850-1910

We will incorporate our findings from the spatial pattern analysis into our national trend analysis. Controlling for age, region, migration, and religion in a regression, we pool all height data and assign dummy variables to each country and birth cohort (Table 7, column 1).

For those regressions, we included an age dummy for those of age 20.[11] Since the human body is subject to a shrinking process at advanced ages, we restrict our sample to individuals who were not older than 50 (except for Turkey in the 1880s). We also inserted a control variable for the Jewish minority within those mostly Islamic countries. The reason for this could be different religious food consumption rules, or possibly occupational and education differences. Lastly, we pay attention to regional variation. For our analysis of grouped data we follow Dickens (1990) and weight each observation by the square root of its group size. The resulting time coefficients are reported in Table 7 and graphed for each country (Figure 3).

We also checked the distribution of height for normality (Figure 4); the overall height distribution appears normal, which confirms the validity of the estimation procedure. Heaping on round numbers is very mild, the fact that the height measurements of our sample were performed by well-qualified anthropologists. The first regression controlled for age, regions, migrant and religious characteristics, the second is based on migrant and religion (Table 7, Col. 1 and 2). The third regression controls only for age (Col. 3). Apparently, those who reported age 20 were consistently shorter than older Mid-Easterners. This might be either caused by the fact that they were still growing at age 20, or that less educated persons reported a rounded age and came from lower strata families with shorter stature (or both). Among the regional dummies, the desert region variable is positive and significant, although the coefficient is not very large. Coastal and urban dwellers were not significantly different from the other rural population of the whole sample. The results for the country-decade dummies are not very sensitive to including or omitting the dummy variables for region, migrant and religion. Only the Iranian decline of the 1880s looks erroneously large if religion is ignored (many Iranian Jews were born during the decade), and the Yemenites of the 1880s would appear too tall without attention to migrant status. We graph the dummy variable

[11] Additional dummies for ages 21 and 22 were not significantly negative, hence they were excluded from the regressions.

coefficients of birth decade and country reported in Table 7, column 1, in Figure 3. In the Middle East, most populations tended to be fairly tall in the 1850s-1870s by 19th century standards, especially the Turkish, Iraqi, and Palestine/Israel population, whereas Yemenites were much shorter (Figure 3). This confirms the results we found by studying the raw height data. The development over time was mostly stagnant between the 1850s and 1910s.

What was the background for this stagnation of height in most countries? We will first describe the general economic history trends of this country, before comparing it with the anthropometric results. Under the reform policy of Muhammad Ali (1805-49) between the 1820s and the 1840s, Egypt's GDP rose (Issawi 1982, p. 104). However, we do not know whether this GDP growth was also translated into a height increase, as Ali accepted quite large costs for the population in pursuing his aims – for example, he required 12% of the population to serve in forced labor institutions, and 3% to serve terms of military conscription. Export activities and the corresponding profits were gained by a small group of foreigners (Issawi 1966, p. 359). However, Ali slightly improved the catastrophic educational situation in Egypt by creating new schools. For example, while less than 5% of Egyptians reported their exact age in the 1820s, this share had slightly risen to 15% by the 1860s – a value which was still much lower than that for Turkey with its 45% (Crayen and Baten 2008). He also improved the Public Health system dramatically, by introducing smallpox vaccination, for example, and by training former slaves as mid-wives (Kuhnke 1990, p.14, 123 and 132). Better perennial irrigation increased both agricultural production and cultivation area by a large amount. Yet due to the heavy burden of taxation, the situation of the peasant population did not ease. Moreover, Issawi (1966, p. 377) reports that the Egyptians did not consume much meat in this period, which also might indicate a low standard of living. Nevertheless, GDP growth, Public Health progress, and marginal educational development might have prepared the ground for some welfare increase during the subsequent period of the 1860s (Figure 3). Between the 1850s and 1860s, Egyptian heights increased by about 1.34 cm. Moreover, in this period, the conscription burden declined and the Crimean war boom is reported as having had a beneficial effect even for the Egyptian peasants (Issawi 1982, p. 104). In the early 1860s, the cotton boom which resulted from a supply shortage during the American Civil war provided additional income for the Egyptian peasants, although it did not last long. Already in the late 1860s and especially in the 1870s prices for Egyptian products began to fall, and taxes rose (Issawi 1982, p. 105). Hence, it is not surprising that heights in Egypt declined in the 1870s. For Egypt, the decline during the 1880s might have been exaggerated due to small sample size, although the fact of a decline is supported by similar height decreases in the other countries. Iran also experienced a temporary height decline during the 1880s, whereas the decline in Turkey might partially be caused by changes of the sample and ageing effect (see section 3 above). What might have caused the 1880s decline? At the current state of research, not much can be said about it. One potential candidate is the cattle plague, which wiped out 80-90% of the cattle in neighboring Ethiopia and Somalia (and consequently one third of the human population) during the late 1880s before it continued its way south to Africa (Barrett and Rossiter 1999). Ethiopia and Somalia are situated just to the South of Yemen, and it is likely that the cattle plague epidemic moving slowly from Central and East Asia to Africa had reduced Middle Eastern cattle stocks before coming to Africa, albeit with less severe mortality impact, as the epidemic had been around in Asia for centuries. Nevertheless, the evidence on this temporary decline during the 1880s and its causes is not very conclusive. Cattle plague was always a relatively poorly documented epidemic, as it affected remote nomadic tribes the most, and those typically left very few written records due to their illiteracy (Barrett and Rossiter 1999). The contribution of our study is rather to document that there was not an upward trend after the 1870s in the Middle East, when heights in Europe and the other industrializing countries started to grow continuously and substantially.

Iran also did not show improvements in physical stature. Gilbar (1986) argues that in Iran, the increasing cultivation of crops such as grain, opium, cotton, and fruits implied a structural development away from animal farming. However, given the similarity of stagnation tendencies in other countries, we would argue that the opium and cash crop trade might not have been the most important driving force. Moreover, Okazaki (1986) found that only a relatively small area was affected (on the opium trade, see also Hansen 2001).

Average anthropometric values were prevalent in Syria and Lebanon in the 1850s and 1860s. In general, purchasing power was relatively high in this economic core region of the Ottoman Empire (Issawi 1982, p. 106-7). Being one of the commercial centers of the Middle East, Lebanon developed a wealthy mercantile sector early on which demanded high quality food from the surrounding countryside and invested in the silk (and later fruit) exports from this region. This might have been one of the reasons for the relatively tall population in neighboring Palestine/Israel.

In contrast, the Yemenite population displayed catastrophically low anthropometric values. Since antiquity when Yemen was reportedly remarkably rich, population density was high and the economy specialized in spices, coffee, and other cash crops. One can speculate whether Yemen fell into a kind of Malthusian trap in the mid- to late 19th century, as conflicts did not allow the maintenance of the irrigation systems which would have been necessary for generating sufficient income for such a dense population. In the years around 1900, Yemen's territory was split into many small centers of power and its political situation was very instable due to tribal attacks against the Ottoman leadership in 1872. Those conflicts and other factors led to severe famines (Dresch 2000, p. 4).

5. An Overall Middle Eastern Height Trend

We now combine all country estimates into a Middle Eastern trend, weighted by population size and interpolated wherever necessary with the growth rate of height of a country with relatively robust height trend estimates (following Baten 2006). For the early half of the period, we used the Egyptian development to interpolate, and for the latter half we used the Turkish development, always using a true measurement for an individual country as a benchmark (results in Figure 5). The levels are therefore relatively close to the true values. For the period after the 1910s, we join the trend estimates of Baten (2006) which are mainly based on the Demographic and Health surveys (DHS) for the Middle East, as well as a variety of other sources and studies on the industrialized countries (which include North America and the Asia/Pacific countries of Australia, New Zealand, and Japan). We updated this trend estimate for the Middle East with recently recorded data on Iran (Janghorbani et al. 2007), again with appropriate population weights. Finally, we used linear interpolation for the 1920s and 1930s, as most world region height estimates indicate a rather smooth upward trend for this time period. The most recent birth cohort in these series is the decade after 1980, i.e. our study covers a range of individuals from those born in the 1850s to those living today.

Compared with the Industrial countries, height values in the Middle East were quite favourable until the 1870s. But was this difference actually significant? In order to test the statistical significance, we compiled anthropometric data from three different industrializing European countries and regions (see Table 8), namely Germany, Northern Italy, and the Czech lands (part of Austria-Hungary at the time), which we will compare with the UK below. We took care not to include the very extreme cases of the height distribution of Industrial countries, such as Sweden, the U.S. or other New World economies on the one hand (with tall heights), or Japan, Spain, and Portugal on the other hand (short heights) in this particular regression. The Middle Eastern "old world" populations were clearly shorter than the former, but taller than the latter. In contrast, we took comparable "old world" economies of Central and Southern Europe, which were closer to the average of the industrializing societies of the 19th century. We also took heights from different institutional backgrounds in order to make sure that any statistical difference was not caused by one of those institutional factors: The German data ("DE1850" and "DE1860") refer to male convicts in Bavaria, who have been shown to have similar heights as military conscripts who were measured at the same time in Bavaria and who consisted of the whole 21-year-old population of this kingdom in Germany (Baten 1999). We also compared military conscripts from Southwest and Southeast Germany (districts of Frankenthal and Brueckenau, respectively, see Baten 1999). The second sample was drawn from North Italian soldiers and deserters (Meineke 2008). A'Hearn (2003, p. 370) has shown that Northern Italians were not exceptionally short before mid-century (his sample ends with the 1840s birth cohort). Finally, we included Czech prison height data (Hodinova 2007). All those data sets are publicly available on the IEHA data hub[12]. The Italian data were the only ones which required a truncated regression estimate, given the minimum height requirement of the Italian army at that time. In contrast, the German conscripts were measured before the minimum height requirement was applied (hence the lists included also the rejected ones). We pooled those samples with our individual Middle Eastern height data, and tested whether a Middle East dummy variable was statistically significant, regressing each birth decade separately (Table 8). It turned out that in almost all cases, the Mid-Eastern heights were significantly larger than those of Industrial countries during the 1850s and 1860s - only the German prisoners in the 1850s were not statistically different from the Middle Eastern populations. But in most cases, there was clearly a statistically significant height differential between Middle East and Industrial Countries during the 1850s and 1860s (Table 8). We can also speak of economic significance for those decades, as the height differential was always larger than one centimeter, which is a substantial amount. For example, Baten and Komlos (1998) estimated that one centimetre of height corresponds to 1.2 years of life expectancy (as already mentioned in the introduction), which most people would consider to be a substantial addition to biological welfare. For the UK, Floud, Wachter, and Gregory (1990) arrive at similar height levels as the Middle Eastern

[12] http://www.uni-tuebingen.de/uni/wwl/dhheight.html

populations, although there has been some debate about the absolute level of height as estimated by different truncated regression models (see Komlos 1998). Also, apart from the Minimum Height Requirement, the English Army was a volunteer army, hence it is not clear whether the army had a positive height selection compared to the civilian population.

During the 1870s and 1880s, the difference between Middle Eastern and European populations vanished and there were neither statistical nor economic differences (Table 8). The era after the 1870s was characterized by similar anthropometric values for both world regions. Only from the 1910s did the Industrial countries overtake the Middle East. The Middle East was probably one of the very few world regions which had a height advantage in comparison with Central European countries during the mid-nineteenth century (Baten 2006).

6. Comparison of GDP Per Capita, Real Wages, and Height

How do those height trend estimates compare with existing GDP and real wage estimates? In general, both GDP per capita and heights diverged in the course of the 20th century (Figure 5 and 7). However, the picture for the 19th century is fundamentally different. During the 1850s and 1860s, when the Middle Eastern countries still had a height advantage over the Western world, GDP per capita was already higher in the industrialized countries. The reason for this could be hypothesized to be distributional, as income inequality was perhaps higher in the West (Williamson 1998). Given that heights are quite sensitive to the well-being of the lower income strata, low inequality might ceteris paribus result in greater heights. The real wage of unskilled laborers relative to GDP might give a first impression. Allen (2001) calculated real wage estimates for a number of cities, including London, Amsterdam, Antwerp, Milan, and Madrid, for almost every decade of the 19th century. Comparing Allen's estimates with Özmucur and Pamuk (2002) for Istanbul, it turns out that in terms of real wages, the West was also ahead of Istanbul in the 1870s, with real wages for the Western cities being almost twice as high (Figure 7). However, this applies mainly to London and Amsterdam. If we consider the Western countries without those cities, Istanbul had in fact a real wage advantage in the early 19th century and wages were more or less equal in the period between the 1850s and the 1890s. If we remember that the UK and the Netherlands accounted for only 10.7% of Europe's population in 1890 (Maddison 2001), the gap between the richest decile and the remaining ninety percent of Europe on the one hand and the Middle East on the other hand was not particularly large in terms of real wages. Could this have been a result of the fact that we considered until now only wage data for the large city of Istanbul? The answer is probably negative, as Özmucur and Pamuk (2002) showed that wages in Istanbul were in fact quite representative of Middle Eastern cities, with some cities (such as Edirne, Bursa, Damascus, and Jerusalem) having higher and others having lower estimated real wages.

Is the result for GDP per capita similar if we exclude the richest decile of Europe? When comparing Belgium, Italy, and Spain with the Middle East, we found no country composition effect: those three countries from the poorer part of Europe were still much richer than the Middle East (Figure 8). Assuming that both real wages and GDP estimates reflect the purchasing power of the respective social strata, we thus conclude that Western Europe must have had much stronger income inequality. The Middle East had some proximity advantages which made its population taller during the pre-1880 period. But its urban lower classes had similar purchasing power as those in the poorer four fifths of Europe. In contrast, urban merchants, factory owners, large land-owners, highly qualified engineers, other professionals, and similarly well-to-do persons who might have increased GDP per capita in Western Europe were probably substantially poorer in the Middle Eastern regions in relative terms. And what happened after 1950? The Middle East had a substantial increase of GDP per capita particularly from 1950 to 1970, but the economic development in the Industrial Countries was even stronger (Figure 6).

Conclusion

In sum, this study enlarges our understanding of the Middle Eastern biological standard of living in the nineteenth and early twentieth centuries by providing anthropometric estimates for eight countries of this world region. We have to admit that the data might potentially contain more measurement errors than height studies from Industrial countries, as we had to rely partly on anthropological surveys which reported heights in an aggregated way. Unfortunately, for the Middle East, military records are not available. Our research in the Ottoman archive in Istanbul showed that heights in the Ottoman military were only recorded as “tall-middle-short” without clear definition of those categories. Heights of prisoners were only exceptionally recorded by Western anthropologists and included in our sample. Hence no large-scale individual height records from archival records can be expected from the typical sources. Here the choice is between either leaving a large white spot on the anthropometric history world map, or undertaking a challenging exploration into these important world regions. We clearly suggest the latter strategy. Moreover, our dataset also has strengths, as for example half of the underlying data comes from a Turkish study which was drawn representatively for the whole population. Here we are on relatively firm ground. Moreover, robustness tests showed that also the anthropometric estimates of the other countries might be quite reliable, at least for obtaining an idea of the general level of heights. Also, the development over time was quite similar in the main countries under study, which again suggests relatively robust estimates.

In general, Middle Eastern height values were higher than those of industrialised countries in the mid-19th century. During the early stages of modern economic growth, the Middle Eastern regions enjoyed some of the well-known “advantages of proximity” to animal husbandry, as a substantial proportion lived in regions specialized in this agricultural activity. Those people were taller than other populations in a situation in which some protein-rich, but less highly valued products of animal farming (offals and milk, for example) could not be shipped at sufficiently low cost. It fits into this picture that desert inhabitants in Iraq were 1.3 cm taller than those from other rural regions. Moreover, in Egypt desert populations had an 1 cm advantage over urban dwellers, and for all eight countries the height advantage of desert people was 0.6 cm (significant at the 0.10 level). The share of nomadic people in Iraq declined from 35 percent to 5 percent, suggesting that the share of people enjoying those "advantages of proximity" declined between 1867 and 1947, (Issawi 1966, p. 158). This is important for the economies of the industrialized countries as well, because inhabitants of industrializing cities sometimes had higher purchasing power of tradable goods, but did not have these proximity advantages (Komlos 1996, Baten 1999, Baten and Murray 2000). In the Middle East, substantial parts of the population lived as Beduins, who initially benefitted from those advantages, but after the late 19th century European urban industrial populations could buy cheap proteins and benefitted from improving disease environments during the 20th century. This was the period when the Western Industrial countries overtook the Middle Eastern populations, especially so, as its urban populations could not benefit sufficiently, as industrialization took place much later (Pamuk 2005, Issawi 1996). During the 1880s-1900s period, the Industrial countries started to overtake the Middle East in terms of net nutritional status. Afterwards, a strong divergence was observable. In this study we have been able for the first time to identify the point in time when the Middle East fell back relative to industrial countries.

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Table 1: Population densities in selected European and Middle Eastern countries

	Pop. Density 1820	Pop. Density 1870	Pop. Density 2003	Pop. /arable land 1820	Pop. /arable land 1870	Pop. /arable land 2003
Germany	70	110	231	199	314	681
Italy	67	93	192	153	212	698
United Kingdom	87	129	247	295	436	981
Czechoslovakia	97	129	199	236	314	496
Iraq	2	4	56	24	34	448
Yemen	5	5	37	205	225	1,344
Middle East (8 countries)	8	10	99	79	110	996

Notes: Middle East (8 countries) is weighted with population size. „Arable land“ refers to 1961 for 1820 and 1870, and to 2003 for 2003. Source: Maddison (2001).

Table 2: Anthropometric data sources 1850 -1930

Country	Country code	Height sources
Egypt	eg	Ammar (1944), Chantre (1904), Craig (1911), Field (1952a), Orensteen (1915)
Iran	ir	Weissenberg (1913), Field (1939), Pardini (1975)
Iraq	iq	Field (1929, 1931, 1936, 1940, 1951, 1952, 1956)
Palestine/Israel	is ps	Genna (1938), Gloor (1950), Vallois (1964), Huxley (1906)
Lebanon	lb	Seltzer (1936, 1940), Shanklin (1935,1946)
Syria	sy	Seltzer (1940), Shanklin (1936,1938), Weissenberg (1911)
Turkey	tr	Inan (1939), Chantre (1895), Wagenseil (1925), Crowfoot (1900), Field (1956)
Yemen	ye	Weissenberg (1909), Cipriani (1938), Thomas (1929, 1931, 1932)

Table 3: Whipple Indices of our sample (by country and birth decade) in comparison with census data for the total population

Country	Birth decade	Sample	Census	N (sample)
iq	1900	325	237	231
iq	1910	300	226	30
ir	1890	367	228	60
ir	1900	308	239	99
ir	1910	228	198	46
tr	1850	297	361	37
tr	1860	315	315	54
eg	1870	330	451	47
Mean		309	282	
For comparison:				
United Kingdom	1850		115	
Poland	1850		149	
Dominican Rep.	1910		221	
Nigeria	1910		304	
India	1910		367	
Pakistan	1910		412	

Note: iq1910, ir1910 refers to age 20-49 (otherwise N would be <30). Source: we thank Dorothee Crayen and Joerg Baten for friendly providing the Whipple Indices based on censuses (males). See also Table 2. Abbreviations: see Table 2.

Table 4: Number of height observations by country, birth decade, and individual versus grouped data

	1850	1860	1870	1880	1890	1900	1910	Total
eg	738	109	9447					10294
	22	145	28	36				231
iq					1733	740		2473
			20	78	165	394	30	687
ir	119							119
			30	50	61	99	46	286
isps	381	640						1021
								0
lb	1066	415						1481
								0
sy	1581	282						1863
								0
tr				4402	5098	7014	12478	28992
	39	63	37	23	28	2		192
ye	38	40						78
			22	30	10	18		80
	3984	1694	9584	4619	7095	8267	12554	47797

Notes: Grouped data are grey-shaded. Source and Abbreviations: Table 2.
Abbreviation: EG-Egypt, IQ-Iraq, IR-Iran, IS-PS-Israel/Palestine, LB-Lebanon, SY-Syria, TR-Turkey, YE-Yemen

Table 5: Raw height by country and birth decade

co	1850	1860	1870	1880	1890	1900	1910
eg	166.44	167.82	166.92	163.55			
iq				168.55	166.52	168.85	165.73
ir	165.34		165.82	163.44	165.44	166.83	166.08
isps	168.42	168.63					
lb	166.58	167.23					
sy	166.35	168.03					
tr	168.82	168.94	168.34	167.39	168.41	168.40	167.70
ye	162.45	161.30		158.80			

Note: Height averages are weighted by the number of observations. Only cases with N>30 shown.
Source and Abbreviations: Table 2.

Table 6: Height by region type and country

co	coast	desert	other rural	urban	desert-urban
eg	167.03	166.92	166.99	165.79	1.13
iq		168.78	166.71	167.92	0.85
ir			166.03	164.59	
isps	168.06		168.00	168.73	
lb	166.76				
sy	167.16		165.93	168.10	
tr	168.12		167.95		
ye	161.45				

Note: Height averages are weighted by the number of observations. Only cases with N>30 shown.
Source and Abbreviations: Table 2.

Table 7: Weighted Least Square regressions of heights in the Middle East

	(1)	(2)	(3)
Age20	-0.52***	-0.52***	-0.51***
	(0)	(0)	(0)
sy1850	-1.61**	-1.61***	-1.60***
	(0.012)	(0.0062)	(0.0065)
sy1860	0.03	0.07	0.08
	(0.96)	(0.88)	(0.86)
lb1850	-1.50***	-1.38***	-1.37***
	(0.00056)	(0.0000058)	(0.0000073)
lb1860	-0.79**	-0.73***	-0.72***
	(0.027)	(0)	(0)
ir1850	-2.62**	-2.62**	-2.61**
	(0.023)	(0.023)	(0.023)
ir1870	0.31	0.33	-2.13*
	(0.81)	(0.80)	(0.070)
ir1880	-2.76***	-2.84***	-4.51***
	(0.0017)	(0.00091)	(1.2e-09)
ir1890	-1.97**	-2.03**	-2.51***
	(0.018)	(0.012)	(0.0026)
ir1900	-0.48	-0.55	-1.12
	(0.54)	(0.46)	(0.13)
ir1910	-0.76	-0.83	-1.63**
	(0.38)	(0.32)	(0.038)
iq1870	0.93	1.31	1.32
	(0.51)	(0.34)	(0.34)
iq1880	0.42	0.60	0.61
	(0.50)	(0.32)	(0.31)
iq1890	-1.35***	-1.30***	-1.43***
	(0)	(0)	(0)

iq1900	0.61	0.95***	0.96***
	(0.12)	(0.0072)	(0.0068)
iq1910	-1.80	-1.91*	-1.91*
	(0.11)	(0.066)	(0.067)
ye1850	-5.69***	-5.51***	-5.50***
	(0)	(0)	(0)
ye1860	-6.83***	-6.66***	-6.65***
	(0)	(0)	(0)
ye1880	-7.18***	-7.01***	-9.15***
	(0.000000019)	(2.0e-10)	(0)
ye1890	-5.23***	-5.06***	-5.05***
	(0.00012)	(0.000095)	(0.000097)
ye1900	-5.96***	-5.78***	-5.78***
	(0.0000016)	(0.00000087)	(0.00000088)
tr1850	0.71	0.86	0.87
	(0.41)	(0.29)	(0.28)
tr1860	1.11	1.22*	1.00
	(0.14)	(0.083)	(0.16)
tr1870	2.13**	2.15**	0.49
	(0.030)	(0.022)	(0.57)
tr1880	-0.56***	-0.56***	-0.56***
	(0)	(0)	(0)
tr1890	0.46***	0.46***	0.46***
	(0)	(0)	(0)
tr1900	0.45***	0.45***	0.46***
	(0)	(0)	(0)
isps1850	1.11***	1.08***	0.47
	(0.00079)	(0.00040)	(0.22)
isps1860	0.90***	0.90***	0.68***
	(0.0096)	(0.0047)	(0.00014)

eg1850	-1.60***	-1.51**	-1.50**
	(0.0099)	(0.013)	(0.014)
eg1860	-0.26	-0.14	-0.13
	(0.51)	(0.73)	(0.75)
eg1870	-1.07***	-1.04***	-1.03***
	(0.00000025)	(0.00000024)	(0.00000041)
eg1880	-4.96***	-4.41***	-4.40***
	(0)	(0)	(0)
Jews	-2.56***	-2.47***	
	(0.000012)	(0.0000019)	
Migrant	-0.24	-0.33	
	(0.63)	(0.29)	
Coast	0.18		
	(0.66)		
Desert	0.56*		
	(0.092)		
Large urban	-0.11		
	(0.81)		
Constant	167.95***	167.96***	167.95***
	(0.00)	(0.00)	(0.00)
N (Original)	47797	47797	47797
R-squared	0.32	0.31	0.30

Notes: Robust p-values in parentheses. ***, **, * significant at the 0.01 , 0.05 level, 0.10 level respectively. Intercept represents a 20-50 year old male who was born in Turkey in 1910 (col. 1-3), in a "other" rural province (col. 1), and who was not migrant or Jewish (col. 1 and 2). N(Original) refers to the underlying, originally measured persons. The number of different height figures (counting grouped data as 1) is 1,595, 1,476 individual and 119 grouped. Source and Abbreviations: Table 2.

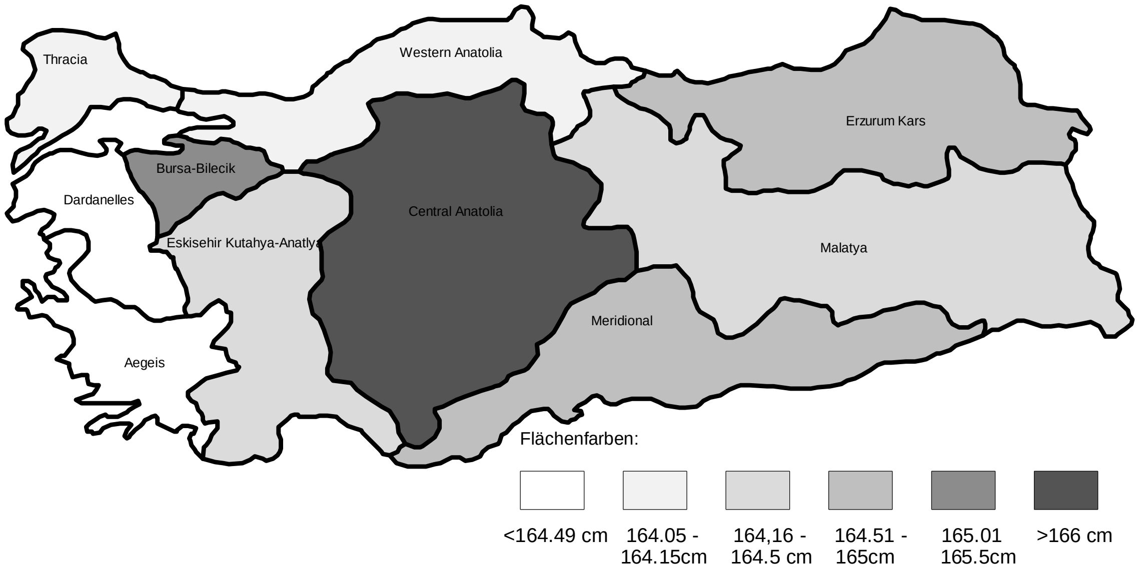
Table 8: Was the difference between the Middle East and various European countries statistically significant?

SAMPLE	IT1850	IT1860	DE1850	DE1860	DESW1850	DESW1860
Middle East	2.086***	3.487***	1.338	2.279***	2.742***	3.627***
	(0.81)	(0.47)	(0.89)	(0.66)	(0.91)	(0.57)
Constant	165.9***	165.2***	166.2***	166.4***	164.8***	165.1***
	(0.11)	(0.17)	(0.52)	(0.47)	(0.55)	(0.34)
Observations	4241	2157	241	369	182	556
R-squared	.	.	0.01	0.03	0.05	0.07

SAMPLE	DESW1870	DESW1880	DESE1850	CZ1850	CZ1860	CZ1870	CZ1880
Middle East	0.560	-0.178	1.386*	2.906**	3.217***	0.587	-0.683
	(0.58)	(0.69)	(0.80)	(1.30)	(0.80)	(0.82)	(1.06)
Constant	165.7***	165.0***	166.2***	164.7***	165.5***	165.6***	165.5***
	(0.31)	(0.55)	(0.35)	(1.08)	(0.66)	(0.66)	(0.97)
Observations	562	337	429	98	293	254	262
R-squared	0.00	0.00	0.01	0.05	0.05	0.00	0.00

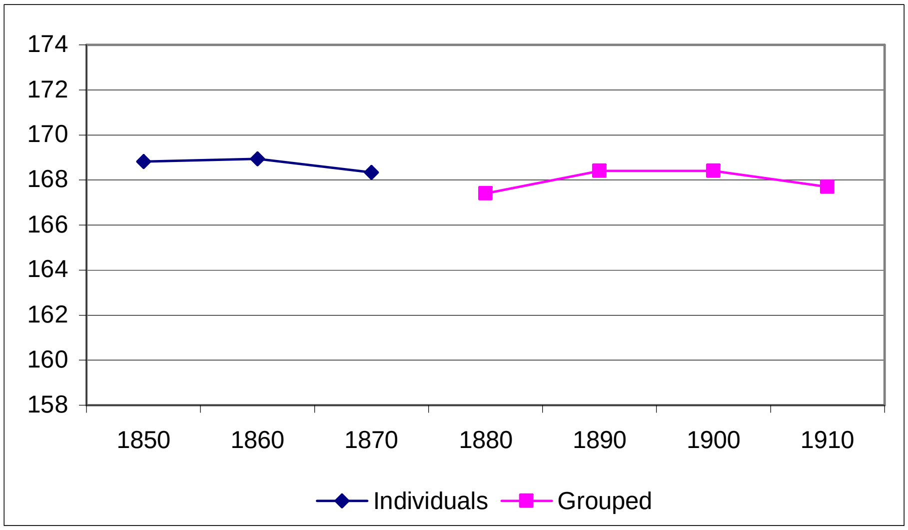
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notes: the standard deviations of Italy in the truncated regression model are estimated -- quite plausibly -- as 5.784 (1850) and 6.006 (1860). R-square for Italy is not reported, as this cannot be calculated for this truncation model. The number of cases refers to both Middle East and European comparison samples, for the number of cases on the Middle East, see Table 4. Source and Abbreviations: Table 2.
Reported is always the coefficient for Middle East (ME) in pooled samples of ME and Germany (DE: Bavarian prisoners, DESW: Germany Southwest, conscripts; DESE: Germany Southeast, conscripts), ME and Northern Italian soldiers (IT), ME and Czech prisoners (CZ). For sources on European heights, see http://www.uni-tuebingen.de/uni/wwl/dhheight.html

Figure 1: Regional mean stature of Turkish males, 1850-1910



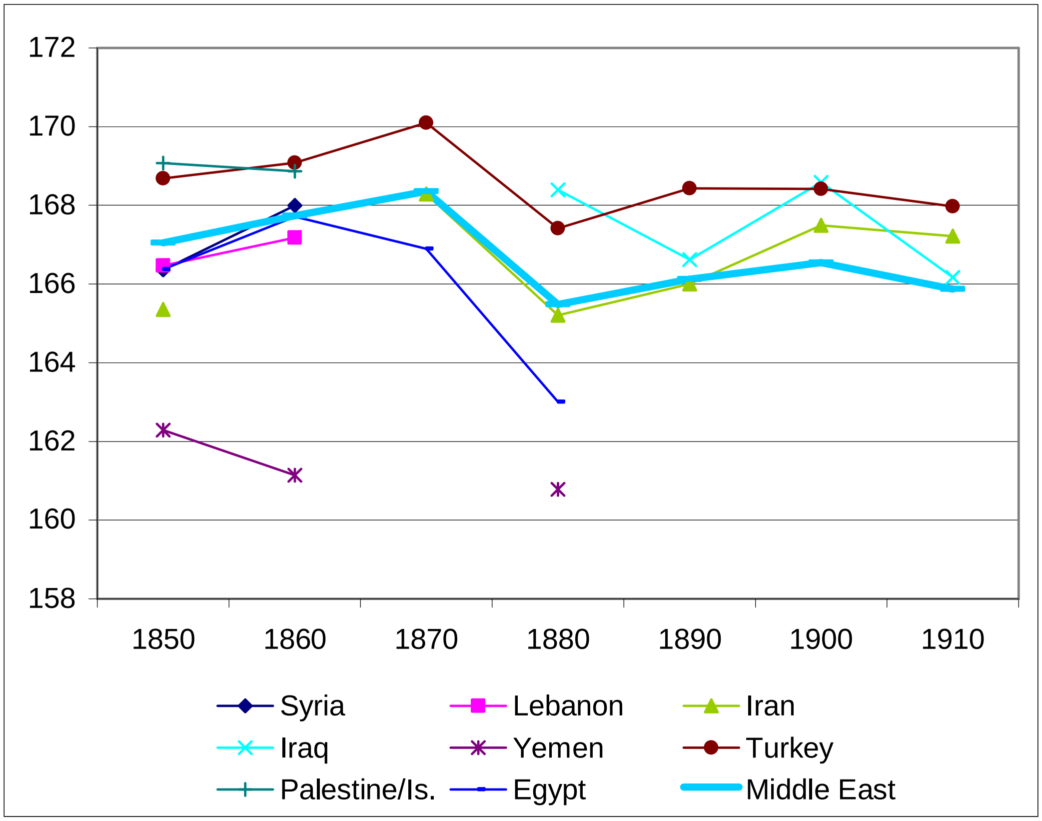
Note: due to the inclusion of elderly persons, the height levels are too low. Only the ranking between regions is informative. Source: processed from Inan (1939).

Figure 2: Individual and grouped data for Turkey



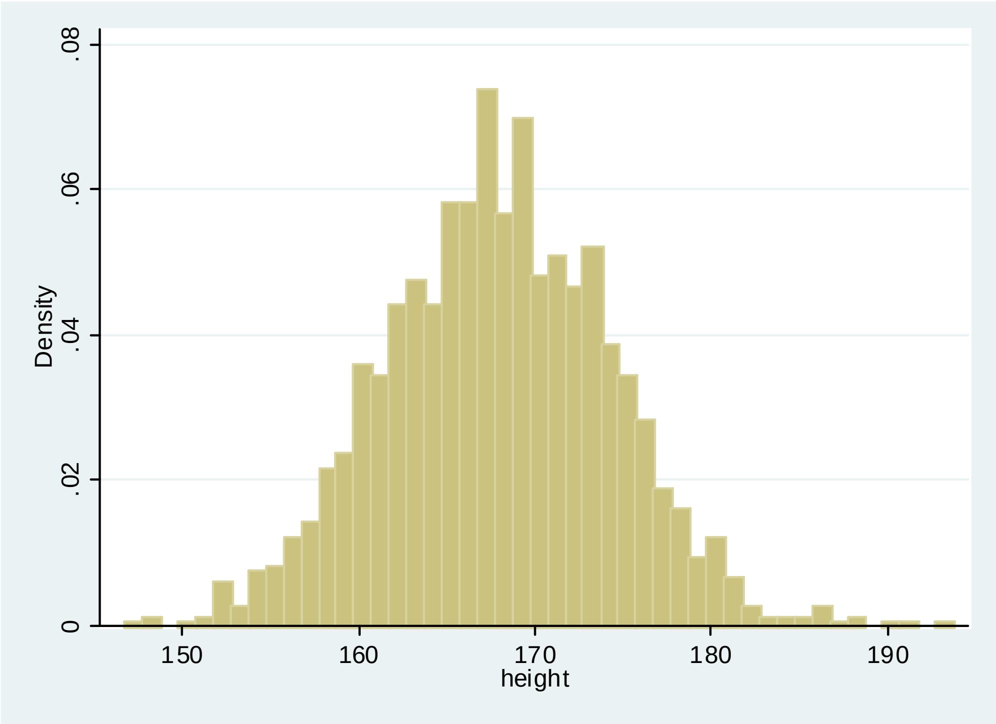
Notes: for the vertical axis, the same height interval is taken as in Figure 3. Only cases with N>30 are reported. Source and Abbreviations: Table 2.

Figure 3: Height Development in the Middle East (regional, migratory, and religious controls included)



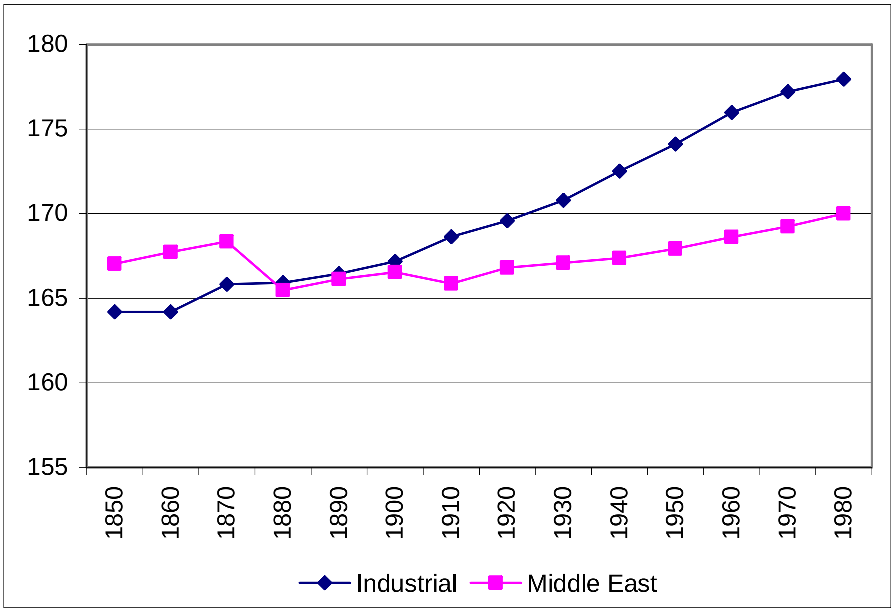
Notes: Source and Abbreviations: Table 2. Iraq 1870, Yemen 1870, 1890 and 1900 is not shown, because N is less than 30.

Figure 4: Distribution of individual height (males)



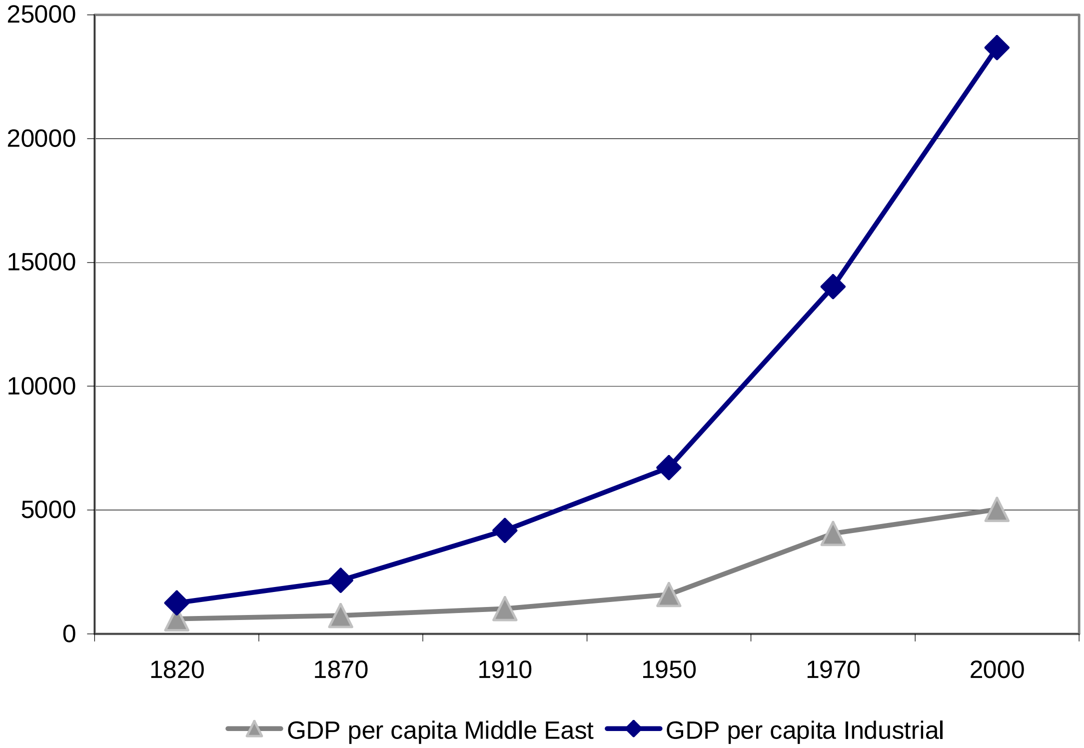
Sources: see Table 2

Figure 5: Heights trend in the Middle East and industrialized countries, weighted by population size



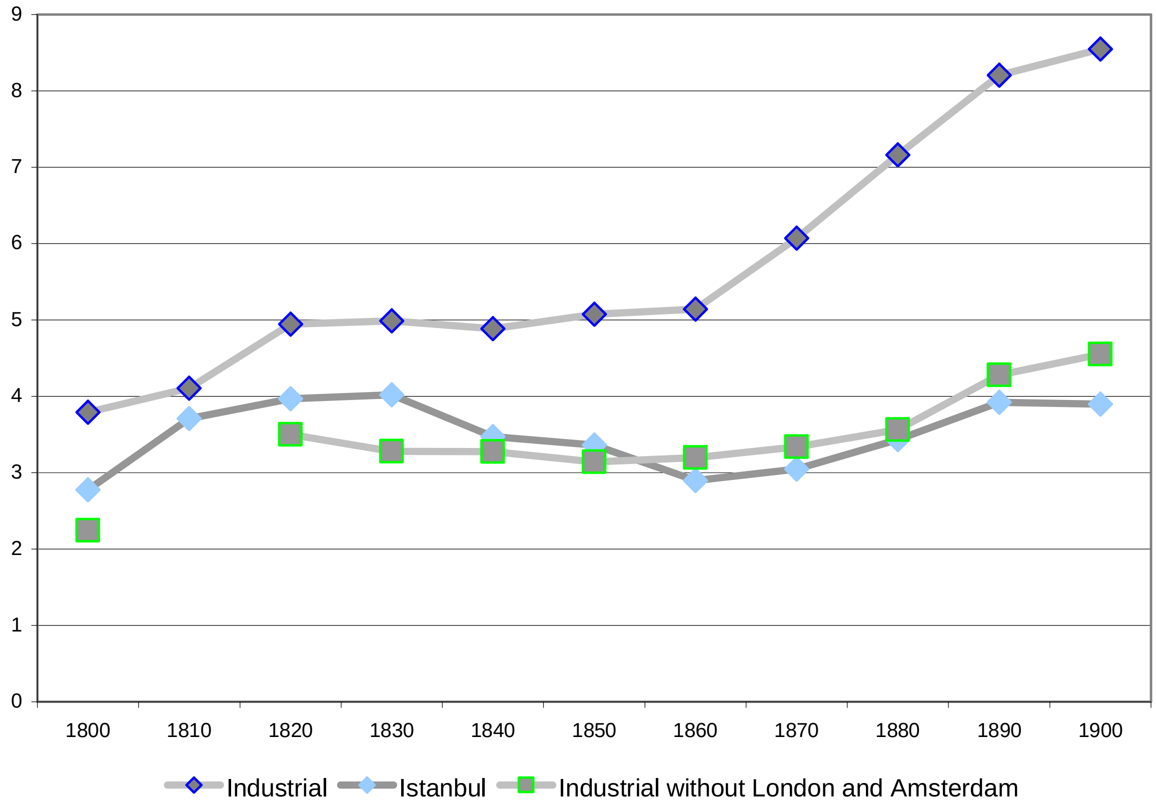
Sources: for 1850-1910: see Table 2; for 1940-1980: Baten (2006), based on Demographic and Health surveys (DHS); Janghorbani et al. (2007). The 1920s and 1930s for Middle East are interpolated.

Figure 6: GDP per capita in 1990 PPP Dollars - weighted by population size



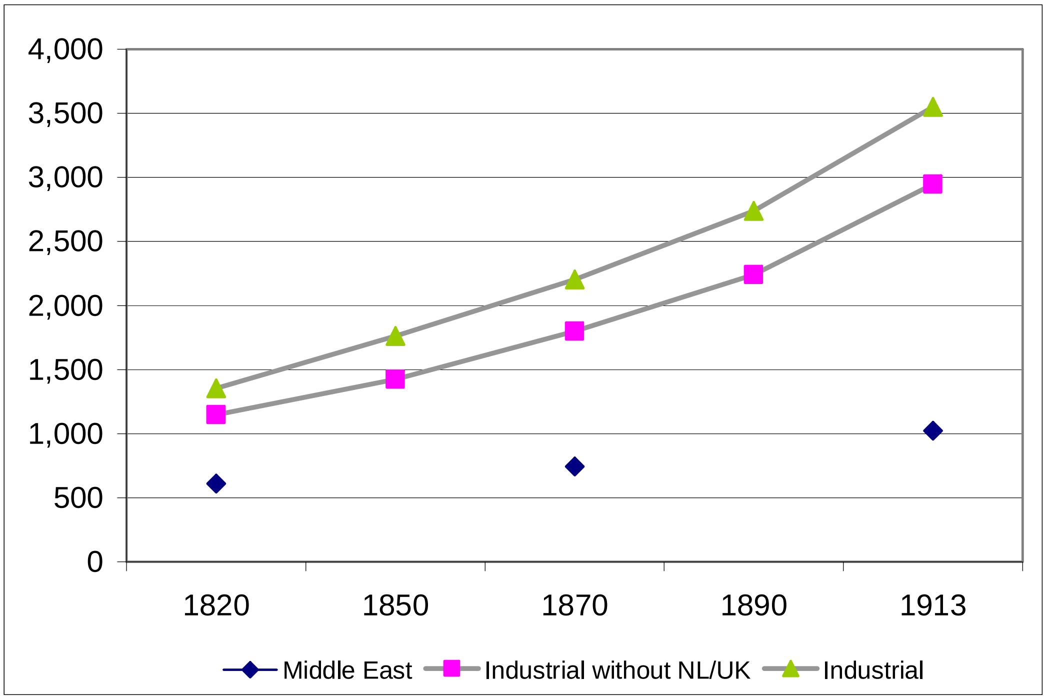
Source: S. Pamuk (2006)

Figure 7: Real wages in Istanbul and industrialized countries in grams of silver per day - weighted by population size



Sources: Istanbul: S. Özmucur, S. Pamuk (2002), Industrial: Allen (2001)

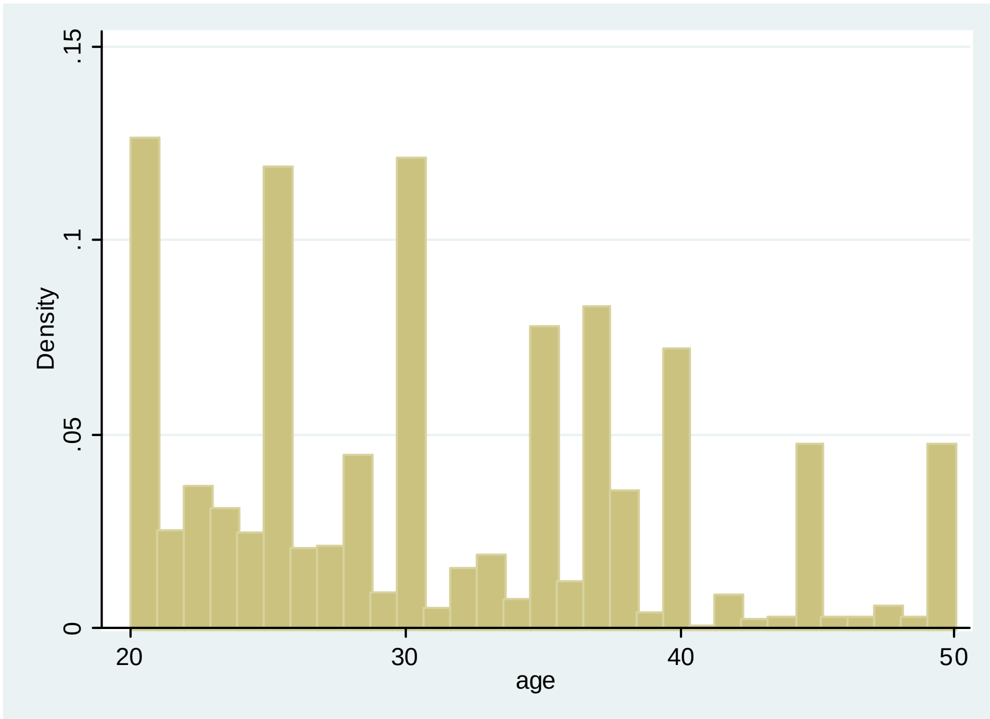
Figure 8: GDP per capita Per Capita GDP (1990 International Geary-Khamis dollars)



Source: Maddison (2001); Pamuk (2006).

Appendix Figures and Tables should not be included in the article, only for the editor's and referee's information.

Appendix Figure A-1: Distribution of age



Source and Abbreviations: Table 2.

Appendix Table A-1:

	(1)	(2)
COEFFICIENT	eg	iq
age20		1.822***
		(0.59)
eg1850	-1.384*	
	(0.72)	
eg1870	-0.766*	
	(0.44)	
eg1880	-4.161***	
	(0.87)	
jews		-2.887*
		(1.66)
coast	0.575*	2.136
	(0.34)	(2.32)
largeurb	-1.041***	-0.455
	(0.37)	(0.59)
otherrural	0.0703	-1.251***
	(0.49)	(0.43)
iq1870		0.530
		(1.56)
iq1890		-1.342**
		(0.65)
iq1900		-0.0626
		(0.68)
iq1910		-3.998***
		(1.29)
Constant	167.7***	169.1***
	(0.57)	(0.66)

Observations	288	707
R-squared	0.10	0.18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Constant: born in desert
Source and Abbreviations: Table 2.