"Global Height Trends in Industrial and Developing Countries, 1810-1984: An Overview"

Abstract

This study is based on a large data set project that aims at collecting heights for 165 countries around the world between 1810 and 1984, for five year birth cohorts. The first finding is that the anthropometric divergence between rich and poor countries started around 1880, right in the middle of the first globalization period. However, height differences between rich and poor did not diminish in the deglobalization period 1914-1945. Secondly, we find that Latin America and the Middle East had better anthropometric values than Europe around mid-19th century, but those world regions lost ground during the late 19th and early 20th century. Africa had a relatively successful development during the early 20th century, but turned into an anthropometric tragedy after the 1960s.

JEL: O40, N31, N33, I20

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Introduction

This paper is an early version of a study on world height trends. 165 countries are taken into account (all countries with more than 400,000 inhabitants). For many of those, height trends have been estimated in the recently literature, but for some are only documented by one or two height estimates. The idea of this project is that subsequently additional information is entered to improve this database of world-wide height estimates over the next years.

Human stature is now a well-established indicator for the biological standard of living. Heights are mainly influenced by the quality of nutrition and the disease environment, which are mostly, but not only determined by purchasing power. Therefore, recent research found that heights are also in some cases positively related to the availability of non-traded foodstuffs (such as milk, meat of low quality, and offal) and health resources.

This method has a number of specific advantages for the study of a broad concept of welfare trends. Anthropometric values are typically correlated with health, longevity, and nutritional quality. Hence we can gain important insights about “biological” components of welfare. There are, however, a few exceptions to this correlation, such as the Japanese who consumed very little protein before the economic boom of the 1960s and had short statures. But the Japanese achieved relatively high longevity values by investing in personal hygiene and health-related education. For most other countries, the correlation between height and life expectancy is relatively close.

A large number of studies have been conducted on heights around the world, but no attempt has yet been made to compile and standardize all available sources, and to interpolate the missing values with reasonable assumptions. The series on individual countries will clearly contain a fair bit of measurement error, even when measurements are available and can be based on sufficient numbers of cases: often the regional and social composition of height samples cannot be perfectly assessed for being representative or not (and then perhaps adjusted). The basic strategy to cope with this is to collect data for a large number of
countries. Hence measurement errors will cancel out on a global scale. And even trends for world regions and a number of individual countries can be reliable (especially for those for which sufficient independent measurements are available).

Such a work can also be important for further data collection efforts, as it is helpful to have a realistic range to compare new height estimates to (for example, if the conversion of historical measures is ambiguous). This compilation will help to approach some of the most important questions in economics: When did the divergence between today’s rich and poor countries begin? Did globalisation cause this global inequality of countries? For example, was the divergence movement particularly fast when international markets integrated in the 1850-1913 period, and did it come to a stop when globalisation broke down 1914-45 (O’Rourke and Williamson 1999)? Hence the first hypothesis to be discussed is

(1) Did globalisation coincide with the divergence of anthropometric indicators?

Our approach can provide additional insights to this debate, as heights are not fully correlated with national incomes or real wages that had been used to assess these questions before. For example, heights are also influenced by the availability of non-traded food stuffs (such as milk, meat of low quality, and offals) and health resources. When globalisation boomed, the Latin American food exporting economies could, for example, have lost some of their initial height advantage. Similarly, Stegl and Baten (2008) recently argued that the Middle East had a height advantage over Europe around mid-19th century, because population density was still low and a large fraction of the population lived as cattle-herding bedouins in the desert. They enjoyed advantages of proximity in protein production in a period when perishable proteins (milk) or protein contained in inferior goods (offal and unpopular meat) could not be shipped to the big and rich cities of Europe. Those large cities suffered additionally from urban disease penalties (Srzeter and Mooney 1998). Only after the late 19th
centuries, the Latin American and Middle-Eastern world regions lost ground in anthropometric welfare indicators, which can be compared in global perspective here for the first time, hence the second hypothesis that will be discussed is

(2) Latin America and the Middle East had a height advantage around mid-19\textsuperscript{th} century over other world regions, but fell back thereafter.

Finally, Moradi (2005) has observed relatively favourable height levels in the 1950s, but a height decline in many African countries after the 1960s. Discussing this important result on a global scale leads us to the third hypothesis:

(3) Africa had a relatively favourable development until the 1950s, but a catastrophic development thereafter.

**World height trends**

How can we estimate roughly a world height trend over the period 1810-1980? As always in global comparisons, we know some series for some individual countries, and we know little for other countries. Especially the poor and less literate countries tend to be poorly documented for the period before the middle of the 20th century. After about 1950, the availability of sources changes dramatically, because the Demographic and Health surveys and similar sources provide a large amount of height data on women (and partly men) born between the 1950s and 1980s. After the mid-1980s, there is again a shift, as adult heights are no longer available. Some preliminary estimates might be possible by comparing children’s height to standard growth curves 1985-2005. For this, we have to assume – or test as far as possible - a roughly similar distribution of nutrition and medical resources between children and adults. Then we can estimate how tall those children would have been as adults, using the
standard growth charts. In this study, we only used this approach for the Middle Eastern countries on which other sources for the 1970s and 1980s were particularly scarce.

Male and female heights
For the 1950-1984 period, much more data is available on women than on men, whereas for most of the previous period the opposite is the case. The reason is the demographic and health interest in mothers, and in female behaviour in general. Certainly, male and female heights are not perfectly correlated, but to a certain extent they are related (Baten and Murray 1999, Moradi and Guntupalli 2006). Hence we estimated the relationship between male and female height. Even if there are theories such as the “female resiliency” (see Guntupalli 2007), which says that women’s height might be more robust in famine periods, the data justify assumption that height trends were broadly similar, with correlation coefficients close to 0.9 or 1 for all world regions. This allows to transform female heights into male height equivalents or vice versa, where heights for only one of the genders are available. As most historical height estimates are for males, we mostly transform into male equivalents.

Individual world regions
Quite a few countries can be documented with long time series now, although for some countries, only one or two benchmark years are available, and we have to use interpolation techniques. The most attractive interpolation strategy is to use the time variation of other, nearby countries with similar characteristics. Basing this on a benchmark for each country allows to obtain levels that are close to true levels. We refer to today’s borders of countries wherever possible to allow long-run comparisons, following the Maddison (2001) strategy. The availability of country-specific long-run trend studies is different for world regions, but has improved over the last decade:
Industrial countries have been assessed by many studies cited in the long list of references. There are even some survey pieces on this group (among others, Floud 1994, Baten and Komlos 1998, Steckel and Floud 1997). In our study, we took care to adjust heights of still growing individuals to their most likely adult height level, following the method explained in Baten and Komlos (1998, notes to table 1). For example, an 20-year-old conscript in a population that was relatively short certainly had some remaining growth to expect.

For Eastern Europe and Central Asia, Mironov (1999, 2004) has done extremely important anthropometric work, both with archival and contemporary anthropological data (see also recently A’Hearn and Mironov 2008). His Russian height trend and the height levels reported for many regions in Eastern Europe provide a good picture for this world region. For the 1950-80 period, DHS surveys are available for several central Asian countries, and the 1960s to 1980s are well-documented by anthropological work (for example, Bielicki and Hulanicka 1998, Vignirova and Blaha 1998, see the references for a more complete list). Komlos (1985, 1989, 2006) has, among so many other countries studied by him, provided data on Southeastern Europe (the parts of the Habsburg Monarchy). Poland was recently documented in Kopczynski (2006). The Russian military-statistical handbook provided additional data on the early 19th century (Russia 1871, Woeno-Statistitscheskii Sbornik).

For Latin America before 1950, we have studies on Argentina to approximate the wider Southern Cone (Argentina, Chile, Uruguay, Paraguay), and studies on Mexico and Colombia for the Northern part (see Salvatore 1998, 2006, 2008, Salvatore and Baten 1998, López-Alonso and Porras 2003, Meisel and Vega 2004a, 2004b, Carson 2008a and b). For Brazil, Peru and Argentina see the recent study by Baten, Pelger, and Twrdek (2008). López-Alonso et al. (2003) arrived at about 161 cm for Mexican recruits and height estimates based on skeleton samples in the mid-18th century. The skeleton samples were mostly from central Mexico, and they reported also the difference to the taller North Mexican height, hence we
adjust this figure to approximately 163 cm for the late 18th century. In Mexico of the 1840s heights were around 165 cm (Carson 2005). Moreover there is some scattered evidence for these and other countries on American Indians (see Bogin and Keep 1998).

For **Asia, the Middle East and North Africa**, the Japanese and Indian cases are relatively well-documented, Indian height data going back to the birth cohorts of the early 19th century (see Brennan, McDonald, and Shlomowitz 1994a, 1994b, 1997, 2000, BMS for short. On the early 20th century, see Guntupalli and Baten 2006, on Japan Mosk 1996, Bassino 2006, Shay 1994, Honda 1997). However, Indian height data until 1900 rest on the assumption that labour migrants had similar heights as the general population, for which BMS found convincing arguments. For China, the work of Stephen Morgan and others has now established good trend estimates (Morgan 2006, 2008, Baten and Hira 2008, Baten, Ma, Morgan, and Wang 2008). Indonesian, Thai, and Vietnamese data is available to a certain extent (Vietnam: Bassino and Cocolanis 2005; Indonesia: van der Eng 1995). For the Philippines there is a study by Murray (2002). The Middle East and North Africa of the late 19th/early 20th century has been documented by an astonishing number of anthropological studies reported in Stegl/Baten (2008). For Turkey and Egypt 1950-80, DHS data allow a trend estimate for this region, and the 1970/80s has been documented by a number of anthropological studies.

**African** heights are available for the 1945-1984 period, Moradi (2005) clarified how to use those data sets, given potential survivor bias. For the early 19th century, heights can be approximated to a certain extent with data on freed slaves and military recruits (Eltis 1982, Baten and van Leeuwen 2008, Austin, Baten and Moradi 2008). Eltis (1982) has strongly argued that the bias between freed slaves and the underlying populations was small or negligible. He argued, for example, that there were no slave price differences observed between regions with tall and short slaves. This should have been the case if height was a prominent selection criterion. Moreover, by the 19th century physically strong (and tall)
Africans were also demanded in colonial Africa’s plantations. Finally he observed that height
distributions from all regions were quite normal. If there would have been something like a
minimum height requirement of slaves, those from the regions of shorter stature should have
displayed some shortfall. By comparison with soldier’s heights, we can now gain some
evidence that the slave heights were not strongly distorted (Baten and van Leeuwen 2008,
Austin, Baten and Moradi 2008).

Eltis described the African regions from which the slaves embarked in certain ports
originated. For example, he found that freed slaves embarked in the ports of Senegambia
represent the semiarid Sahel zone countries. Finally, for the late 19th and early 20th century
some anthropological studies are available. For Kenya and Nigeria, for example, some data on
the 1890-1930 period is available. For Kenya, the Orr and Gilks (1931) study focused on
Kenyan Kikuyu and Massai, which were born after the early 1890s (Moradi 2008). No matter
whether we look at Kikuyus alone or create an index of both ethnicities, there was a strong
height increase up to the late 1960s. Afterwards Kenyan heights started to stagnate (see also
Moradi 2005). Nigerian heights are available since the 1920s, and display a similar height
increase, and a stagnation thereafter. Heights in Senegal were substantially higher. Finally, the
South African height development has been documented by Crayen (2006). Given the
similarity of the Kenyan and Nigerian height series, we estimate an African trend for the post-
1890 period (which we adjust for height levels using post-1950 data). It is obvious that
African historical heights are a particular desideratum.

The very first estimates of a world height trend 1810-1984
Taking all those and many more data sets together, Figure 1 has the first estimates of a world
height trend 1870-1984, and a number of world region trends for the 1810-1984 period. Those
are arithmetic averages of 165 countries. Figure 2 presents weighted averages (note though
that China and India obtain a strong weight in the global series). But the result looks relatively
plausible, comparing the individual world regions with the existing available literature for individual countries.

In general, we can distinguish four groups of world regions.

(1) The industrial countries and those Eastern European and central Asian countries that were socialist at some point in time had a strong upward trend after the 1880s. It is remarkable, however, that after the First World War (when the Soviet Union was created), the differential between those two winner groups increased (Komlos 1999; Mironov 2006). However, in the weighted series Eastern Europe did relatively well, which is caused partly by the relatively modest development in the U.S. after the 1960s.

(2) In contrast, the Latin American countries and those in the Near East and North Africa started at relatively high levels in the 19th century, but had only a modest height growth during the 20th century (Salvatore 2005). Figure 3 display those world regions at higher resolution.

(3) East Asia and Sub Saharan Africa started on a relatively low level in the 19th century (Figure 1 and 2), and ended up not far from the global average. Remarkably, Africa is the only world region with a consistent height decline over the last two decades (Moradi 2005, see also Figure 3)

(4) Finally, two world regions that started low and ended on a low level are South and Southeast Asia. Especially the former had almost no upward trend since the late 19th century, whereas Southeast Asia started at lower height levels which subsequently increased somewhat (Brennan/McDonald/Shlomowitz 1994a, 1994b, 1997, 2000, Guntupalli/Baten 2006). The lacking protein (and milk in particular) might have played a special role, whereas in East Asia there was a growing consumption in Northern and Eastern China and South Korea, for example.

How closely is height correlated with GDP?
A somewhat preliminary analysis can be performed on the relationship between purchasing power and height. Originally, the literature had assumed a close correspondence between those two variables (Fogel et al. 1982). In the literature of the past two decades, some important deviations between height and GDP were found (see Margo and Steckel 1983, Komlos 1996). However, even within the group of industrial countries (today), there was a strong focus on two important cases, the UK and the United States of America. In many other countries, the relation between purchasing power indicators and heights was actually much closer (on real wages and heights, see Baten 2000, Koepke and Baten 2005). Our new data set allows a much broader view on the global economy.

The economic theory behind national income as a height determinant is probably clear: more income can usually buy more nutritional quality, and in the 20th century more health. In a simple scattergram, there is some positive correlation between real GDP per capita and height (Figure 4). In general, there is only a modest number of cases between 155 and 160 cm (mostly in central America and South East Asia), and a limited number of heights above 180 cm. The most solid block of observations is between 160 and 172 cm, indicating that those values were typical in the past two centuries. The deviation to the lower right is Japan, but for the Japanese values alone there was also a positive correlation between GDP and height over time. Deviations on the upper left include some East European, Caribbean, and North African countries. In the 1925-49, also some East Asian miracles (Taiwan, South Korea) had higher height levels than expected, before their GDP grew in the subsequent period (Figure 5). Recently, new estimates have been presented for exactly those East Asian economies, adjusting their GDP downward (Fukao et al. 2007). This moves them actually closer to an imagined regression line. In a similar vein, Japan’s high GDP in the second of the 20th century consisted partly of excessive military production, which might reduce the value of GDP per capita as a welfare indicator. After the 1950s, Japanese anthropometric values strongly increased, moving them closer to the imagined regression line. Guatamalan GDP
collapsed directly after the period shown in Figure 5, when the country fell into a terrible and long-lasting civil war.

Some of the omitted variables are here the proximity to protein production, relative prices of high-quality food, the disease environment, inequality, generation transmission effects (for example, short Japanese mothers might have shorter children), or dietary customs (in Northern Europe and the Netherlands, people still drink more milk than in Italy, although the latter could afford more today), and other variables. We also need to consider whether either GDP or height estimates contain such an amount of bias that this could act as an omitted variable.

**Conclusion**

This study was a first step to introduce a new data set on global height trends, and height trends by world region. The data appendix will be made available and updated subsequently, so that the interpolation decisions become transparent in detail.

We find that most of the anthropometric divergence between today’s industrial and developing countries took place after the 1880s. The Eastern European and Central Asian countries also experienced some height increase 1880-1917 (before they became socialist in two major waves). The height increase continued later, although they achieved slightly lower levels and growth rates than the Western industrial countries. South Asia had a disappointing development, and also South East Asia grew only modest.

Discussing the GDP and height relationship, we find it to be astonishingly strong, but it clearly does not explain all of the variation in heights. Some important deviations remain, which might be partially caused by protein availability, generation transmission effects, dietary customs, and other factors.

Coming back to our main initial hypotheses, did globalization cause this global height inequality of countries? We actually find that the divergence movement started when
international markets integrated in the 1850-1913 period. But it did not come to a stop when globalization broke down 1914-45 (O’Rourke and Williamson 1999). Divergence in height was strong in the 1914-45 period. The second and third hypotheses can be confirmed in global perspective: Latin America and the Middle East were ahead of the world average around mid-19th century, but then lost ground. Finally, our estimates suggest that the relatively good anthropometric values of Africa during the 1950s were only created during the early 20th century. The still very thinly populated continent might actually have benefited from some spread of medical and hygienic knowledge and schooling, even if the colonial regimes had otherwise mostly negative consequences for the colonized countries. Perhaps a part of the anthropometric tragedy was caused by the fact that African elites could not sufficiently develop during the colonial period.
References

Most of the references refer to the data used in the underlying global data set. The exact correspondence between references and individual height estimates used in this study are explained in a separate appendix that will be made available to the reader soon.

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Figure 1: Preliminary height trend estimates for all world regions, each country weighted equally.

Notes: "Prev. socialist" are those countries which Eastern Europe and central Asia which were socialist at some point in time. Sources: see data source appendix http://www.wiwi.uni-tuebingen.de/cms/fileadmin/Uploads/Schulung/Schulung5/Paper/baten_globalsource.pdf
Figure 2: Preliminary height trend estimates for all world regions, weighted by population size.
Figure 3: Africa, the height winner of the 1880-1960, and two losers: Near East and Latin America (weighted by population size)
Figure 4: Height and Log GDP per capita, all periods
Figure 5: Height and Log GDP per capita, period 1925-1949

Note: multiple entries per country represent various birth quinquennials