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

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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.

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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-19th 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, Vignerova 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, Woenno-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 Coclanis 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.

A'Hearn, Brian (1998) "On the Puzzle of Falling Heights in Antebellum America: A Fresh Look at the Stature of Union Army Recruits." in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner.

A'Hearn, Brian (2003). "Anthropometric Evidence on Living Standards in Northern Italy, 1730-1860." Journal of Economic History 63, pp. 351-381.

A'Hearn, Brian and Boris Mironov (2008). "Anthropometric # Saratov", Journal of Economic History.

Alter, Georg/Neven, Muriel/Oris, Michel (2004). „Stature in Transition in Nineteenth Century Belgium", Social Science History 28-2, pp. 231-248

Arora, S., 2001. Health, Human Productivity, and Long-Term Economic Growth. Journal of Economic History, 61-3, pp. 699-749.

Australian Bureau of Statistics (1998). How Australians Measure Up. ABS Cat No. 4359.0. Canberra, Australian Bureau of Statistics. (cited from Moradi 2006)

Bassino, Jean-Pascal (2006). « Inequality in Japan (1892-1941). Physical Stature, Income and Health", Economics and Human Biology 4-1, pp. 62-88.

Bassino, Jean-Pascal and Coclanis, Peter (2005). "Secular Trend and Regional Inequality in Biological Welfare in Burma, 1849-1937". Conference paper proposal for the 3rd Economics and Human Biology Conference (first author agreed that I might use some data from this working paper here).

Baten, Joerg (1999). *Ernährung und wirtschaftliche Entwicklung in Bayern, 1730-1880*. Stuttgart (1999). [Nutrition and Economic Development in Bavaria, 1730-1880]

Baten, Joerg (2000). "Height and Real Wages: An International Comparison," in *Jahrbuch fuer Wirtschaftsgeschichte* 2000-1, pp. 17-32.

Baten, Joerg (2003). "Anthropometrics, Consumption and Leisure: The Standard of Living," in Sheilagh Ogilvie/Richard Overy (eds.), *Germany: A New Social and Economic History*, vol. III: 1800-1989. London: Edward Arnold, 2003, pp. 383-422

Baten, Joerg/Fertig, Georg (2006). "After the Railway Came: Was the Health of Your Children Declining?", working paper Muenster/Tuebingen.

Baten, Joerg/Hira Sandew, "Anthropometric Trends in Southern China, 1830-1864", *Australian Economic History Review* 48-3 (2008) 209-226.

Baten, Joerg/Komlos, John (1998). "Height and the Standard of Living", *Journal of Economic History* 57, No. 3 (1998), pp. 866-870.

Baten, Joerg/Debin Ma, Stephen Morgan and Qing Wang "The Long Run Evolution of Historical Living Standards and Human Capital in China", Working Paper Tübingen/LSE/Nottingham.

Baten, Joerg/Murray, John "Heights of Men and Women in Nineteenth Century Bavaria: Economic, Nutritional, and Disease Influences," in *Explorations in Economic History* 37 (2000), pp. 351-369

Baten, Joerg/Ines Pelger and Linda Twrdek „The Anthropometric History of Brazil, Lima (Peru), and Argentina during the 19th – 20th Centuries" Working Paper Tuebingen 2008

Baten, Joerg/Bas van Leeuwen "The Biological Standard of Living in Early 19th Century West Africa: New Anthropometric Evidence" Working Paper Univ. Tuebingen/IISG Amsterdam

Bielicki, T./Hulanicka, B. (1998). „Secular Trend in Stature and Age at Menarche in Poland", in Bodzar, B.E. and Susanne, C. (eds.) Secular Growth Changes in Europe. Budapest: Eötvö Univ. Press, pp. 263-279.

Bodzar, B.E. and Susanne, C. (eds.) Secular Growth Changes in Europe. Budapest: Eötvö Univ. Press, pp. 263-279. (cited from Lintsi/Kaarma 2005).

Bogin, Barry (1988) *Patterns of Human Growth.* Cambridge: Cambridge University Press.

Bogin, Barry/Keep, Ryan (1998). Eight Thousand Years of Human Growth in Latin America: Economic and Political History Revealed by Anthropometry, in *Komlos, John/Baten, Joerg, eds. (1998)*The Biological Standard of Living in Comparative Perspective,. *Stuttgart 1998.*

Brennan, L., MacDonald, J., Shlomowitz, R. (1994a). The Heights and Economic Wellbeing of North Indian under British Rule. Social Science History 18, 271-307.

Brennan, L., McDonald, J., Shlomowitz, R. (1994b). Trends in the economic well-being of South Indians under British rule: the anthropometric evidence. Explorations in Economic History 31, 225–260.

Brennan, L., McDonald, J., Shlomowitz, R., (1997). Towards an anthropometric history of Indian under British rule. Research in Economic History 17, 185–246.
Brennan, L., McDonald, J., Shlomowitz, R., (2000). Change in the stature of North Indians from British rule. Jahrbuch fuer Wirtschaftsgeschichte, 129–148.
Cameron, Noel (2003) “Physical growth in a transitional economy: the aftermath of South African apartheid.” Economics and Human Biology 1: 29-42.
Carrion, J.M.M. (1994) “Stature, Welfare, and Economic Growth, in Nineteenth-Century Spain: The Case of Murcia.” In John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in anthropometric History. Chicago: The University of Chicago Press, pp. 76-92.
Carson, Scott A. (2005). The Biological Standard of Living in 19th Century Mexico and in the American West, Economics and Human Biology 3-3, pp. 405-419.
Coclanis, Peter and John Komlos (1995) "Nutrition and Economic Development in Post-Reconstruction South Carolina: an Anthropometric Approach." Social Science History 19 (Spring): 92-115.
Costa, Dora (1993). “Height, Waelth, and Disease Among the Native Born in the Rural Antebellum North” Social Science History 17.
Craig, Lee and Weiss, Thomas (1998) "Nutritional Status and Agricultural Surpluses in the Antebellum United States," in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner, pp. 190-207.
Crayen, Dorothee (2006). Heights in South Africa (thanks to the author for providing me her data)
Cuff, Timothy (1998) "Variation and Trends in the Stature of Pennsylvanians, 1820-1860," in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner, pp. 208-35.
Dangour, A.D./Farmer, A./Hill., H.L./Ismail, S.J. (2003). Anthropometric Status of Kazakh Children in the 1990s, Economics and Human Biology 1-1, pp. 43-54.
Dasgupta, P. and Hauspie, R. (eds.), Perspectives in Human Growth, Development and Maturation. Dordrecht: Kluwer.
Demographic and Health Surveys, various years and countries.
Drukker, J.W. and V. Tassenaar (1997) "The Case of the Shrinking Dutchmen: another Example of the "Early-Industrial-Growth Puzzle'," in R. Steckel and R. Floud (eds.) Health and Welfare during Industrialization. Chicago: University of Chicago Press, pp. 331-378.
Eiben, Otto G./Németh, A. (2001). „Somatypes of Budapest Children”, in: Dasgupta, P. and Hauspie, R. (eds.), Perspectives in Human Growth, Development and Maturation. Dordrecht: Kluwer, pp. 301-312. (cited from Linsti/Kaarma 2006).
Eltis, David (1982) "Nutritional Trends in Africa and the Americas: Heights of African, 1819-1839." Journal of Interdisciplinary History 12: 453-475.
Eveleth, P.B., Tanner, J.M., 1990, Worldwide Variation in Human Growth, 2nd edition (Cambridge University Press, Cambridge).
Eurobarometer 1996, cited from Moradi 2006
Eurostat (2006). Online version of current European Height Data.
Field, Henry (1956). Ancient and Modern man in Southwestern Asia, Coral Gables: Univ. of Miami Press. I.
Floud, Roderick (1994) "The Heights of Europeans since 1750: A New Source for European Economic History," in John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in anthropometric History. Chicago: The University of Chicago Press, pp. 9-24.
Floud, Roderick and Harris, Bernard (1997) "Health, Height, and Welfare: Briatin 1700-1980," in Richard Steckel and Roderick Floud (eds.) Health and Welfare during Industrialization. Chicago: University of Chicago Press, pp. 91-126.
Floud, Roderick and Kenneth Wachter (1982) „Poverty and Physical Stature: Evidence on the Standard of Living of London Boys 1770-1870.“ Social Science History 6: 422-452.
Floud, Roderick, Wachter, Kenneth and Annabel Gregory (1990) Height, Health and History. Nutritional Status in the United Kingdom, 1750-1870. Cambridge: Cambridge University Press.
Fogel, Robert (1994) “Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy.” American Economic Review 84: 369-95.
Fogel, Robert W. Stanley L. Engerman, James Trussell, Roderick Floud, Clayne L. Pope, and Larry T. Wimmer (1978) „The Economics of Mortality in North America, 1650-1910: A Description of a Research Project.“ Historical Methods 11: 75-108.
Fogel, Robert W., Engerman, Stanley L., and James Trussell (1982) "Exploring the Uses of Data on Height: The Analysis of Long-Term Trends in Nutrition, Labor Welfare, and Labor Productivity." Social Science History 6: 401-421.
Fukao, F., Ma, D., Yuan, T., 2007. Real GDP in Pre-war Asia: A 1934-36 Benchmark Purchasing Power Parity Comparison with the U.S.. Review of Income and Wealth 53 (3), pp. 503-523.

Greil, Holle (1998). „Age- and Sex-specifity of the Secular Trend in East Germany" in Komlos, John/Baten, Joerg, eds. (1998)*The Biological Standard of Living in Comparative Perspective*,. Stuttgart 1998, pp. 483-496.
Guntupalli, Aravinda Meera (2006). Height Inequalities in India. Working Papers, Tuebingen.
Guntupalli, Aravinda Meera/Baten, Joerg (2006). "The Development and Inequality of Heights in North, West and East India, 1915-44", with, forthcoming: *Explorations in Economic History*.
Haines, Michael R. (1998) "Health, Height, Nutrition, and Mortality: Evidence on the ‚Antebellum Puzzle' from Union Army Recruits for New York State and the United States," in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner, pp. 155-80.
Harris, Bernard (1994) "Health, Height, and History: An Overview of Recent Developments in Anthropometric History." Social History of Medicine 7: 297-320.
Harris, Bernard (1998) "The Height of Schoolchildren in Britain, 1900-1950." In John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in anthropometric History. Chicago: The University of Chicago Press, pp. 25-38.
Heintel, Markus and Jörg Baten (1998) "Smallpox and Nutritional Status in England, 1770-1873: On the Difficulties of Estimating Historical Heights." Economic History Review 51: 360-371.
Heintel, Markus, Sandberg, Lars and Richard Steckel (1998) "Swedish Historical Heights Revisited. New Estimation Techniques and Results," in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner, pp. 449-458.
Honda, G., 1997, Differential Structure, Differential Health: Industrialization in Japan, 1868-1940. In: Steckel, R., Floud, R. (Eds.), Health and Welfare during Industrialization. University of Chicago Press, Chicago, pp. 251-284.
Huard, P. and Bigot, A. (1938). Les caractéristiques Anthropobiologiques des Indochinois, Travaux de l'Institut Anatomique de l'Ecole de Médecine de l'Indochine, Section Anthropologique, tome IV, Hanoi: IDEO.
Johnson, Paul, and Stephen Nicholas (1995) "Male and Female Living Standards in England and Wales, 1812-1857: Evidence from Criminal Height Records." Economic History Review 48 (3):470-481.
Johnson, T.O. (1970). "Height and Weight Patterns of an Urban African Population Sample in Nigeria", in Tropical and Geographical Medicine 22, pp. 65-76.
Juergens, Hans W./Aune I.A./Pieper, U (1990). International Data of Anthropometry. Geneva: ILO.
Kimura, Mitsuhiko (1993). Standards of Living in Colonial Korea: Did the Masses Become Worse Off or Better Off Under Japanese Rule?, Journal of Economic History, 53-3, September, 629-652.
Kopczynski, Michal (2006). Wielka Transformacja. Warshaw: Mowiaweki.
Komlos, John (2001) "On the Biological Standard of Living of Eighteenth-Century Americans: Taller, Richer, Healthier." Research in Economic History 20: 223-248.
Komlos, John (1985) "Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development in the Eighteenth Century." American Historical Review 90 (5): 1149-61.
Komlos, John (1987) "The Height and Weight of West Point Cadets: Dietary Change in Antebellum America." Journal of Economic History 47: 897-927.
Komlos, John (1989) Nutrition and Economic Development in the Eighteenth-Century Habsburg Monarchy: An Anthropometric History. Princeton: Princeton University Press.
Komlos, John (1992) "Toward an Anthropometric History of African-Americans: The Case of the Free Blacks in Antebellum Maryland," in Claudia Goldin and Hugh Rockoff (eds.) Strategic Factors in Nineteenth Century American Economic History. A Volume to Honor Robert W. Fogel. Chicago: The University of Chicago Press, pp. 297-331.
Komlos, John (1993) "The Secular Trend in the Biological Standard of Living in the United Kingdom." Economic History Review 46 (1): 115-44.
Komlos, John (1994a) "The Nutritional Status of French Students." Journal of Interdisciplinary History 24 (3):493-508.
Komlos, John (1996) "Anomalies in Economic History: Reflections on the Antebellum Puzzle." Journal of Economic History 56 (1): 202-214.
Komlos, John (1998) "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution." Journal of Economic History 58 (3): 779-802.
Komlos, John (1999). "On the Biological Standard of Living in Russia and the Soviet Unio", Slavic Review. Vol. 58. No. 1. Spring 1999, pp. 71-79.
Komlos, John (ed.) (1994b) Stature, Living Standards, and Economic Development. Essays in Anthropometric History. Chicago: The University of Chicago Press.
Komlos, John (ed.) (1995a) The Biological Standard of Living on Three Continents: Further Essays in Anthropometric History. Boulder: Westview Press.
Komlos, John (ed.) (1995b) The Biological Standard of Living in Europe and America 1700-1900. Studies in Anthropometric History. Aldershot, England: Variorum Press

Komlos, John/Cuff, Timothy (1998). Classics of Anthropometric History: A Selected Anthology. St.Katharinen: Scripta.

Komlos, John (2004). "How to (and How Not to) Analyze Deficient Height Samples", Historical Methods 37-4, pp. 160-173.

Komlos, John (2006). Anthropometric Evidence on Economic Growth, Biological Well Being, and Regional Convergence in the Habsburg Monarchy, 1850 – 1910. Working Paper Munich (Author was asked for permission to cite his data).

Komlos, John and Peter Kriwy (2003) "The Biological Standard of Living in the Two Germanies," German Economic Review, forthcoming.

Komlos, John and Timothy Cuff (eds.) (1998) Classics of Anthropometric History: A Selected Anthology. St. Katharinen, Germany: Scripta Mercaturae.

Komlos, John/Baten, Joerg "Looking Backward and Looking Forward: Anthropometric Research and the Development of Social Science History,", in *Social Science History* (2004), pp. 1-24

Komlos, John/Baten, Joerg, eds. (1998)*The Biological Standard of Living in Comparative Perspective*,. Stuttgart 1998.

Lang, Stefan and Marco Sunder (2003) "Non-parametric regression with BayesX: a flexible estimation of trends in human physical stature in 19th century America." Economics and Human Biology 1: 77-89.

Le Roy Ladurie, Emmanuel and M. Demonet (1980) "Alphabétisation et stature: un tableau comparé." Annales ESC 35:1329-32.

Lintsi, Mart/Kaarma, Helje (2006). „Growth of Estonian Seventeen-year-old Boys During the Last Two Centuries". Economics and Human Biology 4-1, pp. 89-103.

López-Alonso, Moramay/Marquez-Morfin, Lourdes/Gomez-Santana, Laura (2003) Living Standards in Pre-Industrial Mexico: Evidence from Seventeenth and Eighteenth Centuries Statures. conference paper Yale preindustrial economic history workshop 2003.

López-Alonso, Moramay/Condey, Rául Porras (2003). The Ups and Downs of Mexican Economic Growth: the Biological Standard of Living and Inequality 1870-1950, Economics and Human biology 1-2, pp. 169-186.

Maddison, A., 2001. The World Economy: A Millenial Perspective. OECD, Paris.

Margo, Robert, and Richard H. Steckel (1982) "The Height of American Slaves: New Evidence on Slave Nutrition and Health." Social Science History 6: 516-38.

Margo, Robert, and Richard H. Steckel (1983) "Heights of Native Born Northern Whites during the Antebellum Period." Journal of Economic History 43: 167-74.

Meisel, Adolfo/Vega, Margarita (2004a). "A Tropical Success Story: a Century of Imporvements in the Biological Standard of Living, colombia 1910-2002. Conference Paper 5th World Conference Anthropometrics Venice 2004. (First author agreed that I might use some of his data).

Meisel, Adolfo/Vega, Margarita (2004b). "The Stature if the Colombian Elite Before the Onset of Industrialization, 1870-1910. Working Paper Banco de la Republica, Colombia. (First author agreed that I might use some of his data).

Mielke, Sven, Konvergenz von Köroegrößen. Unpubl. Diploma thesis Tuebingen.

Miklashevskaja, N.N./, Solovjova, V.S./Godina, E. (1988). "Growth of Children and Youth", Moscow: M Univ. Press (in Russian, cited from Lintsi/Kaarma).

Mironov, Boris N. "New Approaches to Old Problems: The Well-Being of the Population of Russia from 1821 to 1910 as Measured by Physical Stature," Slavic Review. Vol. 58. No. 1. Spring 1999. P. 1-26.

Mironov, Boris N. (2004) "Zhiznennyi uroven' Sovetskoi Rossii pri Staline po antropometricheskim dannym," in Ekonomicheskaia istoria. Ezhegodnik. 2004. Moskva: ROSSPEN, 2004. S. 565-588. [B. N. Mironov, "The Nutrition Standard of Life in the Soviet Russia under Stalin on the Anthropometric Data," in The Economic History. A Year-book. 2004. Moscow: ROSSPEN, 2004, pp. 565-588.: data on those measured 1927, born 1907. Author friendly provided data]

Mokyr, Joel and Cormac O'Grada (1994) "The Heights of the British and the Irish c. 1800-1815: Evidence from Recruits to the East India Company's Army." In John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in Anthropometric History. Chicago: The University of Chicago Press, pp. 39-59.

Mokyr, Joel/O'Grada, Cormac (1996). Height and Health in the United Kingdom 1815-1860: Evidence from the East India Company Army. In: Explorations in Economic History 33-2 (1996), p. 141-168.

Moradi, Alexander (2005). Height, Political Violence and Economic Development in Africa 1950-2000, Ph.D. thesis Tuebingen, available on UB Tuebingen Server.

Moradi, Alexander (2006): Table on the Coefficient of Variation. Unpublished Personal Communication.

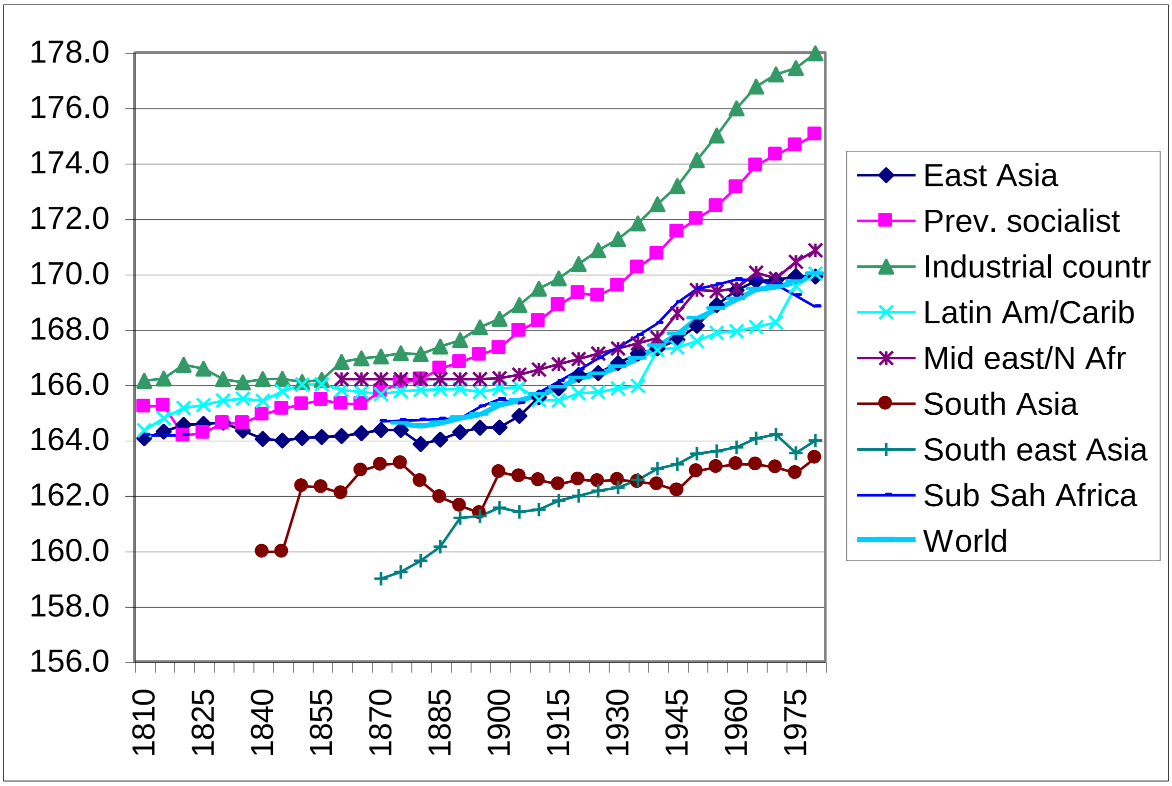
Moradi, Alexander/Baten, Joerg (2005). "Inequality in Sub-Saharan Africa 1950-80: New Estimates and New Results, ", *World Development* Volume 33, Issue 8 (2005), pp. 1233-1265.

Morgan, Stephen (1998) „Biological Indicators of change in the Standard of Living in China during the 20th Century," in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner.

Morgan, Stephen (2006) "The biological standard of living in South China during the 19th century: Estimates using data from Australian immigration and prison records. Paper prepared for the Asia/Pacific Economic and Business History Conference, QUT, Brisbane, 16-18 February 2006
Morgan, S.L., 2004, Economic growth and the biological standard of living in China, 1880-1930. Economic and Human Biology 2(2), 197-218.
Mosk, Carl (1996), Making Health Work; Human Growth in Modern Japan, Berkeley: University of California Press.
Murray, John (1997) "Standards of the Present for People of the Past: Height, Weight, and Mortality among Men of Amherst College, 1834-1949." Journal of Economic History 57: 585-606.
Murray, John E. (2002). "Height and Weight of Early 20th Century Filipino Men", Annals of Human Biology 29-3, pp. 326-333.
Nicholas, Stephen and Deborah Oxley (1993) "The Living Standards of Women during the Industrial Revolution, 1795-1820." Economic History Review 46: 723-49.
Nicholas, Stephen and Richard Steckel (1991) "Heights and Living Standards of English Workers During the Early Years of Industrialisation, 1770-1815." Journal of Economic History 51:937-57.
Nicholas, Stephen and S. Kimberley (1998) "The Welfare of Indigenous and White Australians, 1890-1955." in John Komlos and Jörg Baten (eds.) The Biological Standard of Living in Comparative Perspective, Stuttgart: Franz Steiner.
Nicholas, Stephen and Steckel, Richard H. (1997) "Tall but Poor: Living Standards of Men ad Women in Pre-famine Ireland." Journal of European Economic History, Spring 26(1): 105-36.
Nummela, Ilkka (2000). Pätkä Vai Ei? Suomalaisen Pituuskasvun Historiaa. Jyväskylä: Kansi.
Oesterreich. Militaer-Statistisches Jahrbuch fuer das Jahr... (annual yearbook, 1870-1910), Vienna k. k. Hof- und Staatsdruckerei, 1873-1913 (cited from Komlos).
Olds, Kelly B. (2003). The biological standard of living in Taiwan under Japanese occupation. Economics and Human Biology, 1, 187-206.
O'Rourke and Williamson (1999). Globalization and History.
Orr, J. B. and J. L. Gilks (1931). Studies of Nutrition: The Physique and Health of Two African Tribes. London, Medical Research Council, Special Report Series No. 155 (thanks to A. Moradi for providing this).
Oxley, Deborah (2004). "Living Standards of Women in Prefamine Ireland", Social Science History 28-2, pp. 271-296.
Padez, Christine (2003). Secular Trend in the Portuguese Population. Annals of Human Biology 30-3, pp. 262-278.
Padez, C. and F. Johnston (1999). Secular Trends in Male Adult Height 1904-1996 in Relation to Place of Residence and Parent's Educational Level in Portugal. Annals of Human Biology 26(3): 287-298. (cited from Moradi 2006).
Pak, Sunyoung (2004). "The Biological Standard of Living in the Two Koreans. Economics and Human Biology 2-2, pp. 511-621.
Pehlavanli, Alper (2006). Konvergenz udn Divergenz des Biologischen Lebensstandards. Unpubl. Diploma thesis Tuebingen.
Quiroga Valle, Gloria (1998). "Height Evolution in Spain, 1893-1954. An Analysis by Regions and Professions. in Komlos, John/Baten, Joerg, eds. (1998)*The Biological Standard of Living in Comparative Perspective*, Stuttgart 1998, pp. 359-383.
Riggs, Paul (1994) "The Standard of Living in Scotland, 1800-1850." In John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in Anthropometric History. Chicago: The University of Chicago Press, pp. 60-75.
Rosenbaum, S., R. K. Skinner, I. B. Knight and J. S. Garrow (1985). A Survey of Heights and Weights of Adults in Great Britain, 1980. Annals of Human Biology 12: 115-127.
Russia (1871). Woenno-Statistitscheskii Sbornik, IV, Rossija, Spb..
Salvatore, Ricardo (2004), "Stature, Nutrition, and Regional Convergence: The Argentine Northwest in the Twentieth Century", Social Science History 28-2, pp. 231-248
Salvatore, Ricardo and Jörg Baten, "A Most Difficult Case of Estimation: Argentinian Heights, 1770-1840," in John Komlos and Jörg Baten, eds., *The Biological Standard of Living in Comparative Perspective*, Stuttgart: Franz Steiner, 1998, pp. 90-96.
Sandberg, L. and R. Steckel. 1987. "Heights and Economic History: The Swedish Case," Annals of Human Biology 14: 101-10.
Sandberg, Lars and Richard Steckel (1987) "Heights and Economic History: the Swedish Case." Annals of Human Biology 14:101-110.
Sandberg, Lars and Richard Steckel (1997) "Was Industrialization Hazardous to Your Health? Not in Sweden!" In Richard Steckel and Roderick Floud (eds.) Health and Welfare during Industrialization. Chicago: University of Chicago Press, pp. 127-160.
Sapounaki-Dracaki, Lydia (1998). "Heights and Nutritonal Status in Greece", in Komlos, John/Baten, Joerg, eds. (1998)*The Biological Standard of Living in Comparative Perspective*,. Stuttgart 1998, pp. 408-412.

Schultz, T. Paul. “Productive Benefits of Improving Health: Evidence from Low-Income Countries”
Shay, Ted. (1994), “The level of Living in Japan, 1885-1938: New Evidence”in Komlos, John (ed) Stature, Living Standards, and Economic Development: Essays in Anthropometric History (Chicago: The University of Chicago Press).
Silventoinen, K., E. Lahelma and O. Rahkonen (1999). Social Background, Adult Body-Height and Health. International Journal of Epidemiology 28: 911-918. (cited from Moradi 2006).
Sokoloff, Kenneth and Georgia Villaflor (1982) ”The Early Achievement of Modern Stature in America.” Social Science History 6: 453-481.
Statistics Netherlands (2004). Statistical Yearbook of the Netherlands 2004. Voorburg / Heerlen: Statistics Netherlands. (cited from Moradi 2006).
Steckel Richard H. and Roderick Floud (eds.) (1997) Health and Welfare during Industrialization. Chicago: The University of Chicago Press.
Steckel, R. 1995. “Stature and the Standard of Living,” Journal of Economic Literature 33: 1903-40.
Steckel, Richard (1979) “Slave Height Profiles from Coastwise Manifests.” Explorations in Economic History 16: 363-380.
Steckel, Richard (1986) "A Peculiar Population: the Nutrition, Health, and Mortality of American Slaves from Childhood to Maturity." Journal of Economic History 46: 721-741.
Steckel, Richard (1995) “Stature and the Standard of Living.” Journal of Economic Literature 33: 1903-40.
Steckel, Richard and D. Haurin (1994) “Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910.” In John Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in anthropometric History. Chicago: The University of Chicago Press, pp. 117-28.
Steckel, Richard and Dora Costa (1977) "Long-Term Trends in Health, Welfare, and Economic Growth in the United States." In R. Steckel and R. Floud (eds.) Health and Welfare during Industrialization. Chicago: University of Chicago Press, pp. 47-90.
Stegl, Mojgan and Joerg Baten "Tall and Shrinking Muslims, Short and Growing Europeans: an Anthropometric History of the Middle East, 1840-2007", *Explorations in Economic History* (2008, forthcoming).
Sunder, Marco (2003) “The Making of Giants in a Welfare State: The Norwegian Experience in the 20th Century.” Economics and Human Biology 1.
Tanner, James M. (1982) „The Potential of Auxological Data for Monitoring Economic and Social Well-Being.“ Social Science History 6: 571-581.
Tanner, James M. 1978. Foetus into Man: Physical Growth from Conception to Maturity. Cambridge: Cambridge University Press.
Twarog, S. 1997. Heights and Living Standards in Germany, 1850-1939: The Case of Württemberg. In Health and Welfare during Industrialization, edited by R Steckel and R. Floud. Chicago: The University of Chicago Press.
Van der Eng, Pierre (1995). An Inventory of secular changes in human growth in Indonesia, in Komlos, John (1995a)
Vignerová, J./ Bláha, P. (1998). “The Growth of the Czech Child During the Past 40 Years”, in Bodzar, B.E. and Susanne, C. (eds.) Secular Growth Changes in Europe. Budapest: Eötvö Univ. Press, pp. 263-279.
Wanner, Martin (2005). Körpergrößen von Nichteuropäern. Unpubl. Diploma thesis Tuebingen.
Weber, G., H. Seidler, H. Wilfing and G. Hauser (1995). Secular Change in Height in Austria: An Effect of Population Stratification? Annals of Human Biology 22(4): 277-288. (cited from Moradi 2006).
Weir, David (1993) “Parental Consumption Decisions and Child Health During the Early French Fertility Decline, 1790-1914.” Journal of Economic History 53: 259-274.
Woitek, Ulrich (2003) Height Cycles in the 18th and 19th Centuries.“ Economics and Human Biology 1.
Wheatcroft, S.G., 1999. The great leap upwards: anthropometric data and indicators of Crises and Secular 944 change in Soviet welfare levels, 1880–1860. Slavic Review 58–1, 27–60.
Whitwell, Greg/de Souza, Christine/Nicholas, Stephen (1997). “Height, Health, and Economic Growth in Australia, 1860-1940”, in Steckel/Floud (1997), pp. 379.422.

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

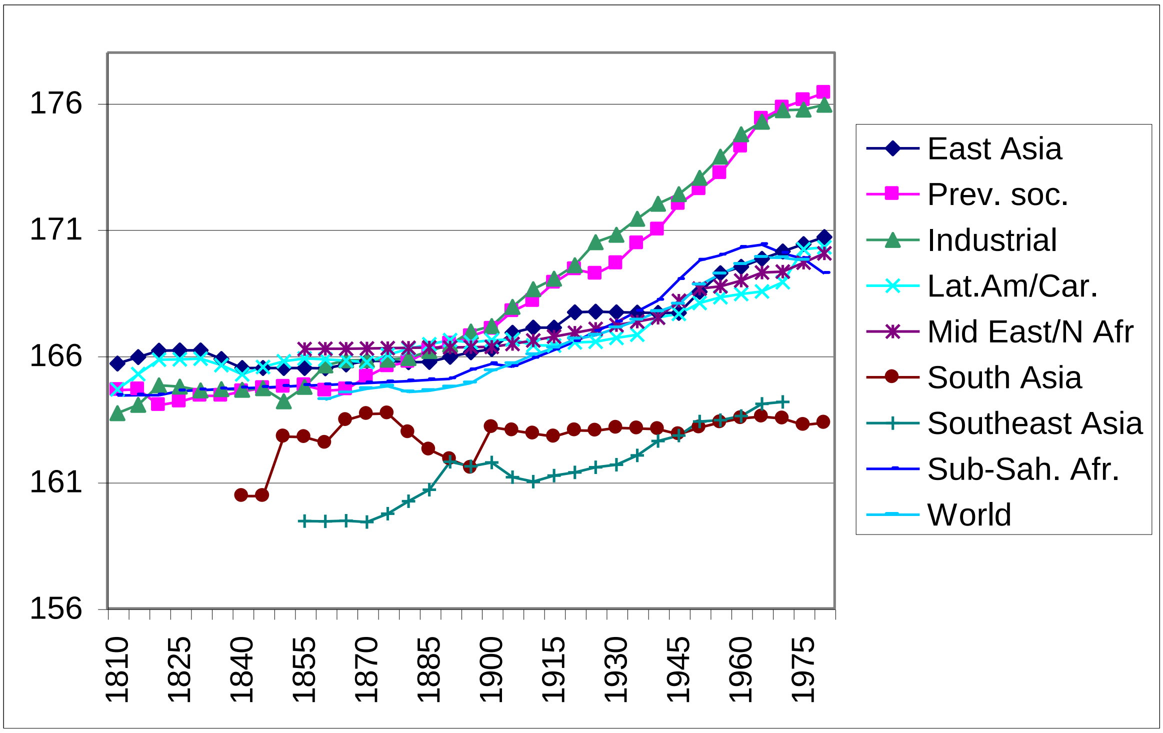


Figure 3: Africa, the height winner of the 1880-1960, and two losers: Near East and Latin America (weighted by population size)

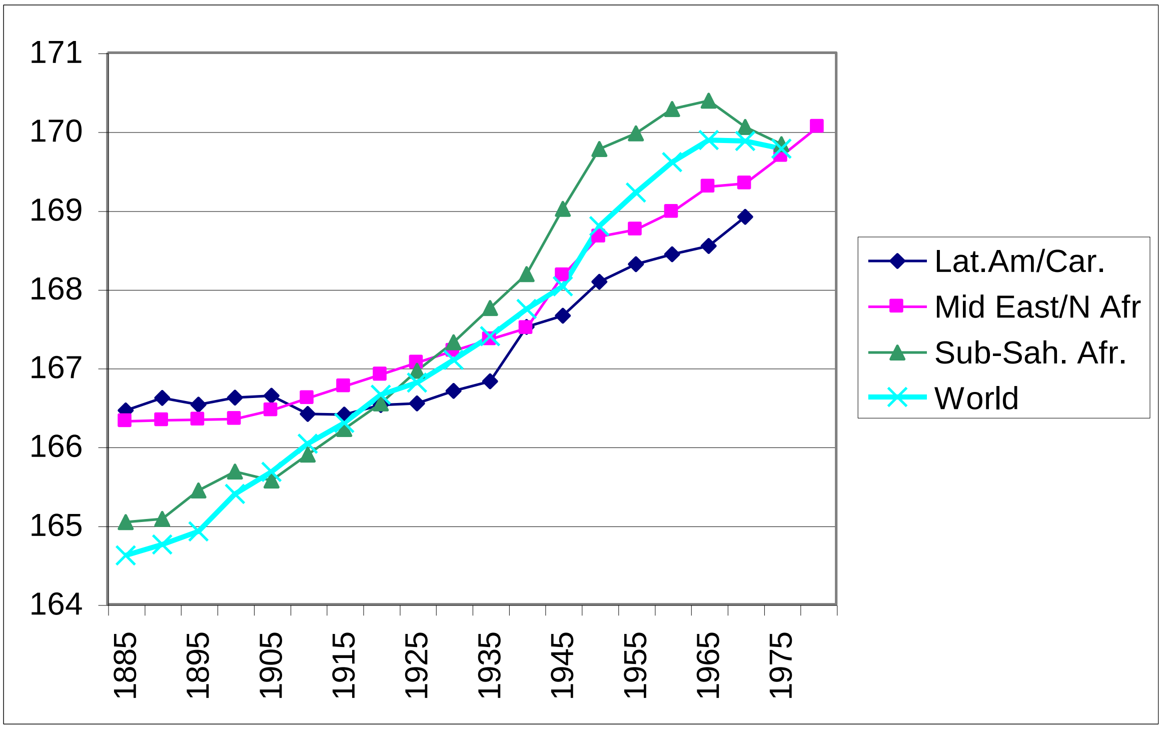


Figure 4: Height and Log GDP per capita, all periods

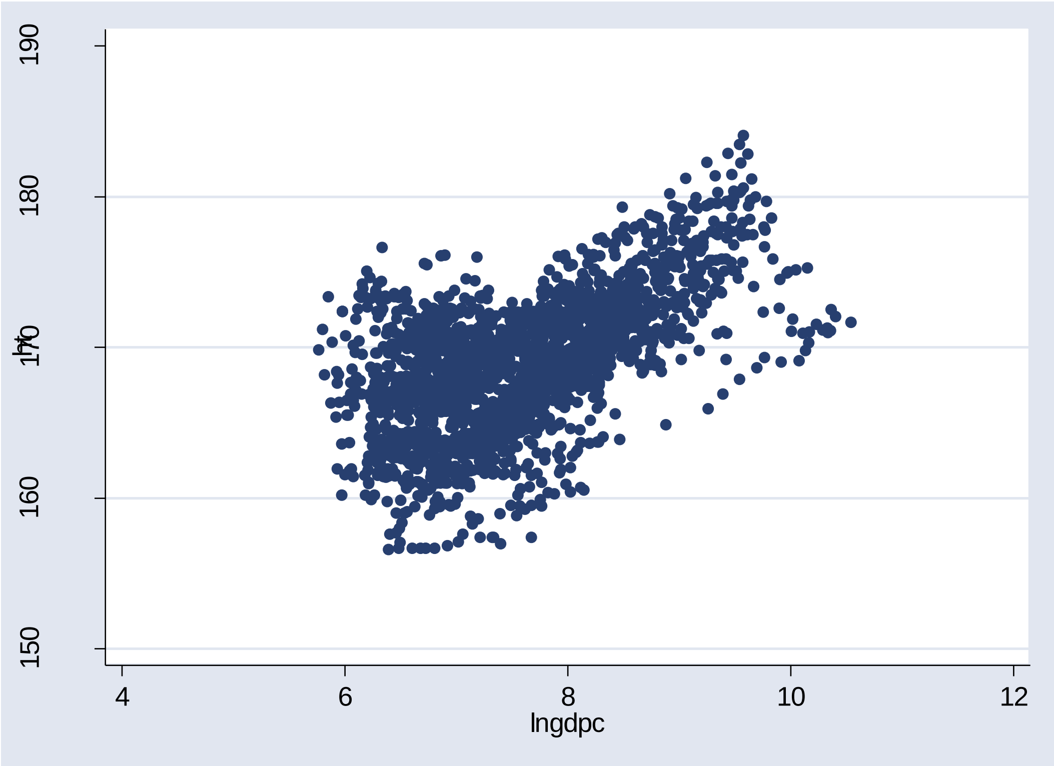
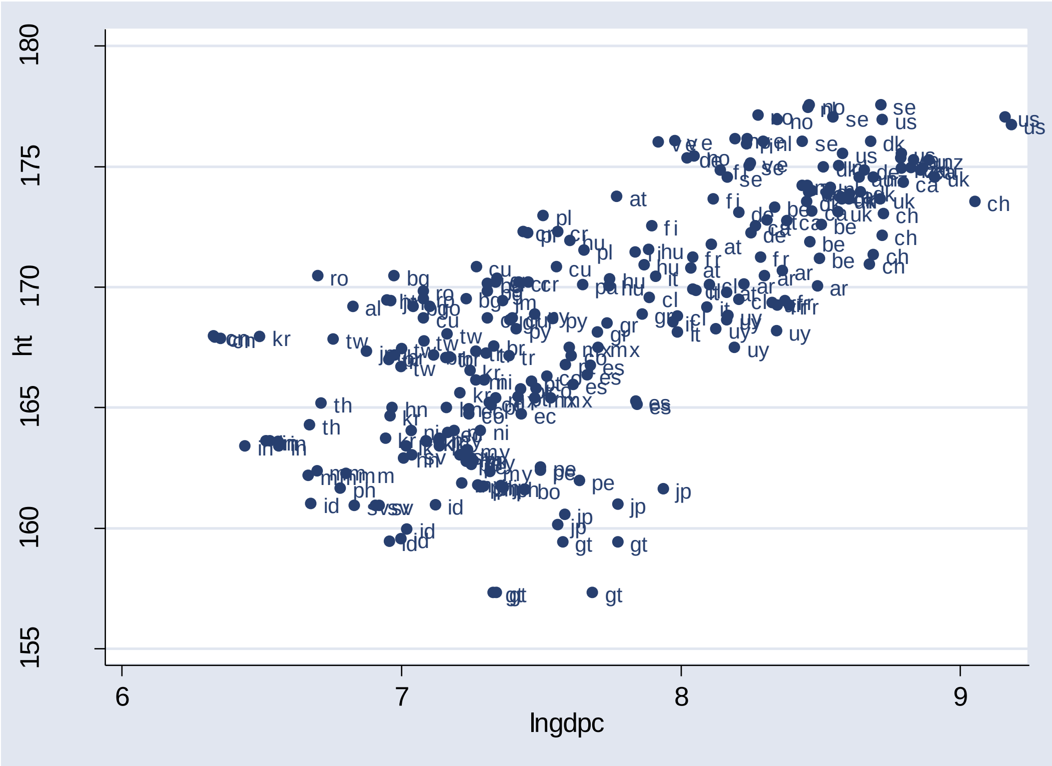


Figure 5: Height and Log GDP per capita, period 1925-1949



Note: multiple entries per country represent various birth quinquennials