World Income Inequality 1820-2000[1]

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1. Introduction

The aim of this paper is to present a new dataset of global inequality between 1820 and the present, based on the available historical evidence, and to tentatively analyse some of the results that emerge from these data. The importance of the subject hardly needs to be stressed: the enormous increase of inequality on a global scale is one of the most significant – and worrying - features of the development of the world economy in the past 200 years. For this reason, the subject has become one of the most discussed topics in the social sciences; in particular the debate on the measurement and interpretation of recent trends in global inequality – is it still increasing? and why or why not? – has attracted considerable attention (Deininger and Squire, 1996; Jones, 1997; Bourguignon and Morrison, 2002; Milanovic, 2007 for a review of the debate). Economic historians have also intensely discussed the long term trends in the world that lead to the growing income disparities between nations and changed patterns of inequality within nations, although often using other concepts (such as 'the Great Divergence'). We argue, however, that we lack the historical data to really analyse these patterns of changing global inequality in detail. The one paper that has attempted to do this, Bourguignon and Morrison's seminal AER 2002 article, is for the period before 1950 largely based on the assumption that income inequality within countries is unchanging. They extrapolate their estimates of income inequality in certain periods to cover much longer time periods, as a result of which, we think, changes in income inequality within countries are clearly underestimated. For large parts of the world the result is that estimates from the post 1914 or even the post 1945 period are used to infer income inequality in the 19th century, and that, in other words, inequality within countries is assumed to have remained constant. For Latin America and Africa B & M rely completely on 20th century data to estimate inequality in the 19th century; for Asia they have in total four historical estimates (in fact often very partial estimates): one for China in 1890, two for Indonesia and one for Japan. The dataset for Europe and North America is somewhat better, but also uses only part of the evidence available. For a large majority of the world's population, and almost all people living in the 'developing countries', their estimates are based on almost no historical evidence, implying that we really cannot rely on their work to analyse the long term patterns of global inequality. Moreover, scholars interested in the question whether

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different levels of inequality may have affected the way in which countries participated in the Great Divergence, cannot use this dataset to analyse such a possible link, as it simply does not have sufficient historical observations to make such an analysis feasible.
For these reasons, we have set out to try to create a new dataset of global inequality focused on improving the estimates of inequality within countries through the use of the results of (old and) recent research on this topic, and through the application of a number of indirect ways of measuring (changes in) income inequality in the past. In reviewing their work, we saw no reasons to modify the other pillar of the Bourguignon and Morrison paper, the estimates by Maddison of inter-country inequality (although we used an updated version of his estimates, Maddison 2003); there has been some discussion about, in particular, his 19th century estimates, which have been criticised for a number of reasons, such as underestimating GDP per capita (or more in general, welfare levels) in China (and India, and Japan) at the beginning of the 19th century (Pomeranz 2001, but see Van Zanden 2002); for underestimating GDP per capita of the US during much of the 19th century (Ward and Devereux 2005); and more fundamentally, because of possible fundamental flaws in the methodology, which uses 1990 benchmark estimates of PPP-corrected GDP per capita, which are then extrapolated back in time using time series of GDP and population (Prados de la Escosura 2000). We think that for the 19th and 20th century the Maddison framework is the best on offer, and probably catches the overall changes in inter-country inequality rather well. Perhaps Chinese income per capita at the beginning of the 19th century is underestimated somewhat and the decline sketched by Maddison is perhaps even larger than he envisaged; the relative position of the US versus the UK is still a matter of considerable debate (Broadberry 2003), but it is not clear that this will affect the overall pattern of global inequality very much – as a different assessment of the Chinese growth record would clearly do.[2] We consider the within country estimates of income inequality to be the weaker part of the estimates of global inequality, where in view of ongoing research in this area, much more progress could be made, and we therefore concentrated on this part of the story.

How did we enlarge the dataset? Basically, in three ways: firstly, by incorporating new research done since the 1990s and collecting the results of older research overlooked by B & M. This, however, does not really solve the problem of the data gap between rich and poor – probably the gap even widens, as much more evidence is available and much more work has been done on Europe and the Americas than on Africa or large parts of Asia. Therefore, in order to get a more balanced set of estimates, we had to apply two alternative ways of estimating (changes in) income inequality suggested in the literature. The first one, which we particularly used for the 19th century (and for a few countries also to the interwar period), was to infer changes in income inequality from the development of the ratio between GDP per capita and wages of unskilled labourers . The idea, initially suggested by Jeffrey Williamson (1998, 2000), and recently tested by Leandro Prados de la Escosura (2008) is that if wages lag behind income per capita, inequality is probably increasing; conversely, if wages grow faster than GDP per capita, this may point to a decline in inequality. We tested this relationship for a set of countries for which we had independent estimates of inequality of income distribution, and found a small but (just) significant effect, which we used to extrapolate (or intrapolate) estimates of the Ginis of

[2] At some point we hope to experiment with the alternative set of estimates produced by Prados de la Escosura 2000.

income distribution. The second ‘new’ approach that we applied is to use data on the distribution of heights of the population that can be derived from different sources to estimate the Gini of the income distribution. Again, for a subset of countries for which we have both independent Gini coefficients of income distribution and data on the distribution of heights, we could establish the link between the two measures of socio-economic disparities; the found relationship was then used to estimate income inequality for those countries and periods for which other data were lacking. This procedure has been developed by Baten (1999) and Moradi and Baten (2005), and has now been extended to a much broader sample of countries (all details below).
Moreover, we identified a group of 30 countries – most of them relatively large, but spread more or less equally over the globe (with an inevitable over-representation of Western Europe, however) – for which we tried to get consistent estimates of income inequality for all the benchmark years, starting in 1820. These countries were: (in Europe) Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Poland, Portugal, Russia/USSR, Spain, Sweden, Czechoslovakia, UK; (in Asia) China, India, Indonesia, Japan, Thailand, Turkey; (in the Americas) Argentina, Brazil, Canada, Chile, Mexico, Peru, USA; (in Africa) Egypt, Ghana; and Australia. Together, these countries represent 70-80% of the world’s population (according to the Maddison estimates). We think this dataset is more or less representative of global trends, although it is handicapped by the underrepresentation of in particular Africa in it (and the overpresentation of Western Europe). In a second step, we considered all countries with 500,000 and more inhabitants. To this were added all countries, even those for which we have only a few – and sometimes only one – datapoint (Botswana in 1990, or Sudan in 1910, 1929, and 1970, for example).

2. Data

2.1 Income inequality in post 1945 period

Data on income inequality is relatively scattered. However, for the twentieth century two important sources may be distinguished that contain direct information on income inequality. First, there are the direct Gini-coefficients. One major source is the WIID (2008). These cover most of the period after 1950. However, these estimates are not completely consistent. As pointed out by François and Rojas-Romagosa (2005), three broad groups can be distinguished based on gross household income, net household income and expenditure data. These are not mutually exchangeable because the trend in these data is different (François and Rojas-Romagosa 2005). The major actor causing a different trend is income/expenditure smoothing: progressive taxation, extra earnings from by-employment, and the black economy all contribute to some kind of smoothing of expenditure and net income. In addition, the wealthy are expected to save a larger share of their income, and therefore the observed expenditures are far from being a linear function of income. Finally, François and Rojas-Romagosa (2005, 17) point out that expenditure measures are subject to bias caused by borrowing or lending. These factors are especially prevalent in the post World War II period when many countries expanded their income taxation. However, as suggested by Van Leeuwen and Foldvari (2008) for Indonesia, it seems that there is only a relative short transition phase when income taxes gain ground. This means that, after (and also before) a relatively short transition period after WWII, the trends in the net hh/expenditure Ginis and the gross household income gini are again similar. We test this hypothesis for a larger sample of countries in regressions, where we regress the gross household Gini prior to 1980 (and after 1980) on the net household income Gini, a trend, a cross effect of trend and net household income Gini.

	prior to 1980	after 1980
constant	19.62 (1.66)	9.420 (1.55)
Net household income Gini	0.367 (0.91)	0.788 (4.45)
Net houdehold income Gini x time trend	0.003 (0.50)	0.002 (7.41)
time trend	-0.059 (-0.26)	-0.073 (-5.16)
R^2	0.462	0.730
N	114	82

LSDV fixed-effect panel specification, country dummies are not reported. Robust t-statistics in parentheses.

In the period prior to 1980, the cross-sectional effect is significant and positive, implying that (combined with the coefficient of the net household Gini), that the net household Gini grows slower than the gross household Gini. If we compare the same regression from the period after 1980, where we may reasonably assume that there is a linear relationship between the gross and net household Gini, we indeed find none of the coefficients significant.

2.2 Direct estimates for pre 1945 period

Reworking the WIID dataset is a first step. A lot of new work has recently been done on the estimation of income inequality in the past that can also be included in the dataset. This consists of two things: direct Gini coefficients can be obtained from several other, mostly scattered publications. A good overview of a lot of the historical work is supplied by Milanovic, Lindert and Williamson (2007), and on the Global Income and Prices website at UCDavis (http://gpih.ucdavis.edu/Distribution.htm). New work has also been done (and old work has gone unnoticed), by Bertola et al. (2009) for parts of South America, Rossi et al. (2001) for Italy, Soltow and Van Zanden (1998) for the Netherlands.

A separate category of new work is related to income share estimates, in particular the project focused on estimating the historical development of the share of the richest 1 or 5 % in total income, inspired by the work of Piketty and Atkinson. Studies are available for Australia (1921-2003) (Atkinson and Leigh 2007a), Canada (1920-2000) (Saez and Veall 2005), France (1905-1998) (Piketty 2007), Germany (1925-1998) (Dell 2007), India (1922-1999) (Bannerjee and Piketty 2003), Indonesia (1920-2004) (Leigh and Van der Eng 2007), Ireland (1922-2000) (Nolan 2007), Japan (1886-2002) (Moriguchi and Saez 2006), Netherlands (1914-1999) (Salverda and Atkinson 2007), New Zealand (1921-2002) (Atkinson and Leigh 2005), Spain (1981-2002) (Alvaredo and

Saez 2006), Sweden (1903-2004) (Roine and Waldenström 2006), Switzerland (1933-1996) (Dell, Piketty, and Saez 2007), UK (1908-2000) (Atkinson 2007b) and the USA (1913-2004) (Piketty and Saez 2006b).

One problem, however, is how to convert these income shares, which are nothing more than just one point on the Lorenz curve, into Ginis. The only way this can be done is by assuming a distribution. Two distributions are normally used: a log-normal, and a Pareto distribution (see Soltow 1998). We use the log-normal distribution in this paper. Lopez and Servén (2006) shows that the Lorenz-curve, under the assumption of log-normality, can be expressed as follows:

$$L(p) = \Phi(\Phi^{-1}(p) - \sigma)$$

Where p denotes the poorest pth quantile of the population, and σ is the standard deviation of the log income and Φ(.) denotes the cumulative normal distribution.

The Gini coefficient (G) can be expressed as:

$$\sigma = \sqrt{2}\Phi^{-1}\left(\frac{1+G}{2}\right)$$

In the end, it turned out that on average the difference between both methods was limited. Van Leeuwen and Foldvari (2008, 16-17) claim that their level slightly differs. More interesting is the question if the movement over time of the estimated Gini is really independent of using a Pareto or lognormal distribution. As the Gini in both cases is estimated using only one point at the Lorenz curve (mostly of the upper quintiles), this is actually the question as to whether the relative distribution of the upper quintiles versus the lower quintiles changes over time. Clearly, this is a bold assumption, but there is some evidence in its favor. First, Soltow (1998, 17) argues that at max the distribution of the top 33% richest person resembles a Pareto distribution while the log-normality assumption may work fine otherwise. Hence, the suggestion is to use the lowest possible quintile to calculate the Gini coefficient using a log-normal distribution. Second, another way of looking at this issue is by the extraction ratio (Milanovic *et al.* 2007). This indicates how much of the above-subsistence income is extracted by the rich. Although it therefore does not say much about the distribution *sec*, it can be considered as an indication of the shape of the Lorenz curve. As indicated by Milanovic *et al.* (2007, Table 2 and Figure 4), with the exception of some very poor countries, this changes relatively little over time in the twentieth century. Consequently, the relative position of the upper and lower quintiles also does not change much over time meaning that using either a Pareto or lognormal distribution does not bias the change of the estimated Gini coefficients over time. Indeed, as most income shares are calculated for Western countries in the twentieth century, we may accept this assumption. Finally, and most importantly, empirical results seem to confirm this finding.

In this paper we will use the log-normal distribution given the situation that the log-normal is most widely used and is applicable both on higher and lower classes in society. Since this only provides a trend of inequality, we can use benchmark Ginis to bring the Gini estimates back in time using the income share estimates.

2.3 GDP divided by unskilled wages as a proxy

Above two methods give us a reasonable complete picture of income distribution among countries in the twentieth century. Except for some direct estimates of income inequality available for a limited number of countries not much is known for the earlier period. For

earlier periods (and for countries with less abundant data) we therefore have to rely on proxies for income inequality. Several options exist, for example, the economic distance between the landed elite and landless labour or the ratio of average family income (y) to that of an unskilled rural labourer (w). Both methods draw heavily on the extraction rate (Milanovic et al.). This ratio indicates what share of potential surplus can be taken from the poorer groups, hence increasing inequality.
The basic equation used by Milanovic et al is:

$$G_t^* = \frac{1-\varepsilon}{\mu_t}(\mu_t - s_t)$$

where G^* is the possible maximum Gini, ε is the share of higher class people (assumed constant), μ the mean income (per capita GDP) and s the unskilled income. When taking logarithm of both sides, this becomes:

$$\ln G_t^* = \ln(1-\varepsilon) - \ln \mu_t + \ln(\mu_t - s_t)$$

If we assume that the expropriation of the incomes of lower classes by the elite is not complete we can have a more general form:

$$\ln G = \ln(1-\varepsilon) + \lambda \ln \mu_t + \gamma \ln(\mu_t - s_t)$$

where $-\lambda=\gamma=1$ is the basic case, with the maximum income diversion. We assume that the share of the elite within the population may change across country, but remains constant over time. Also, the term $\ln(\mu_t - s_t)$ is proxied by the log of the Williamson index (y/w^{un}). This results in a panel model with fixed effects, the log of GDP per capita and wage premium being independent variables:

$$\ln G_{it} = \beta_1 \ln\left(y_{it}/w_{it}^{un}\right) + \beta_2 \ln y_{it} + \eta_i + u_{it}$$

The sources used for the real wage series were Williamson (1999a, 1999b, 2000), Mitchell (1998 a, b, c), Allen (2001), Mironov (2004), and Allen *et al.* (2005); the GDP estimates were again taken from Maddison.

	Coefficient
Constant	3.657 (6.11)
$\ln\left(y_{it}/w_{it}^{un}\right)$	0.212 (2.25)
$\ln y_{it}$	-0.158 (-3.08)
R^2	0.599

LSDV panel regression, N=136, country dummies are not reported, robust t-statistics in parentheses

2.4 The distribution of heights as a proxy

A completely independent method of looking at early inequality is by looking at the relation between inequality in heights and income inequality. For example Baten (1999, 2000, 2000a), Pradhan et al. 2003, Moradi and Baten (2005), Sunder (2003), Guntupalli and Baten (2006) have argued that the coefficient of variance of the height of individuals may be a proxy for income distribution. The idea is that growth takes place especially between age 0 and 5, that there are no genetic population differences in height. As wealthier people have better food and shelter and less illnesses, they tend to be taller. Hence, the variation of height at the present of a certain cohort may be indicative of income distribution during the decade of their birth.[3]

Heights offer a good complement to conventional inequality indicators and constitute perhaps an even better indicator in some respect. If the distribution of food and medical goods in an economy becomes more unequal, heights should also become more unequal. Yet while a correlation with income does exist, this correlation is only partial. Some important inputs are not traded on markets but are provided as public goods, such as public health measures or food supplements for schoolchildren. Public goods lead to modest deviations between purchasing power-based and height-based inequality measures. Moreover, income totally neglects transfers within households. This is a major argument in favor of height-based inequality measures: heights are an outcome indicator, whereas real income represents an input to human utility. Deaton (2001) and Pradhan et al. (2003) have argued convincingly that measures of health inequality are important in their own right, not only in relation to income. Heights do capture important biological aspects of the standard of living (Komlos, 1985; Steckel, 1995), irrespective of the fact that some problems regarding the stature variable may exist.

Anthropometric methods are even more advantageous for studying developing countries of the 20th and the generally poorer countries of the 19th century. To date, the development of inequality within LDCs could not be sufficiently explored because reliable data were lacking. The well-known Deininger and Squire data set (1996), for example, provides only eight gini coefficients of income for Subsahran Africa for the period before 1980, labeled as "acceptable". Atkinson and Brandolini (2001) convincingly pointed to serious flaws in the income inequality data collected by Deininger and Squire, arising from insufficient consistency across countries and over time. For those countries, height inequality measures can provide important additional insights. We do not claim that height is the only accurate measure of inequality, but argue that it generates new insights on inequality while serving as a useful countercheck for other indicators, thereby leading to more meaningful results overall.

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[3] One question to be adressed is whether this measure is vulnerable to survivor bias, as only survivors could be included. But actually, thinking also of gini coefficients of income inequality, there are only inequality measures which measure survivors. To become an income earner in any inequality measure, you have to service to the age in which people earn incomes. In other words, also the gini coefficient only relates to the living population, and does not reflect inequality of newborn babies who might have died during their first year of life.

Moradi and Baten (2005) actually tested whether countries with higher infant and child mortality might have had a systematically different height CV. They found indeed the expected negative effect. However, only a very small part of the CV's variance could be explained by mortality differences between the countries.

The retrospective height CV measure might suffer from an additional bias, namely the mortality between age 20 and 49 (heights are typically restricted to those ages, in order to exclude young and growing as well as very old and shrinking persons). When comparing the development of height and income inequality in Kenya, they found that this measure was not biased in the expected direction. This might have been caused by offsetting factors, and/or by the fact that selective mortality between ages 20 and 49 was too small to influence the measurement

The effects of inequality on heights are best understood by comparing the likely outcomes of a hypothetical situation, in which a population is exposed to two alternative allocations of ressources A and B after birth:

(A) All individuals receive the same quantity and quality of resources (nutritional and health inputs). This case refers to a situation of perfect equality.

(B) Available resources are allocated unequally (but independently of the genetic height potential of the individuals).

In the case of A, the height distribution should only reflect genetic factors. Despite perfect equality, we observe a *biological variance* of (normally distributed) heights in this case. Yet how does the height distribution respond to an increase in inequality (B)? The unequal allocation of nutritional, medical and shelter resources allows some individuals to gain and grow taller, while others lose and suffer from decreasing nutritional status. In comparison with the situation of perfect equality, the individual heights of the rich strata shift therefore to the right, the poor strata shift to the left. Thus rising inequality should lead to higher height inequality, although this effect is weakened by the fact that the genetic height variation accounts for the largest share of height variation. Even a bimodal height distribution could result if the resource endowment differed extremely between groups. In practice, since the biological variance continues to contribute a large share to the total variance, most height distributions are normally distributed or very close to normal, but with a much higher standard deviation than A (but see A'Hearn 2004, Jacobs, Katzur and /Tassenaar 2008 on late teenagers).

The standard deviation is not a satisfactory measure of inequality, since anthropologists argue that the *biological v*ariance increases with average height (Schmitt and Harrison 1988). The coefficient of variation (CV) takes this effect into account and is a consistent and robust estimate of inequality. For a country i and a five-year-age birth decade t, the CV is defined as:

(1) $$CV_{it} = \frac{\sigma_{it}}{\mu_{it}} \cdot 100$$

Thus, the standard deviation σ is expressed as a percentage of the mean μ. Baten (1999, 2000a) compared height differences between social groups using the CV for early 19th century Bavaria, since an ideal data set was available for this region and time period, with nearly the entire male population measured at a homogeneous age and the economic status of all parents recorded. The measures turned out to be highly correlated. Therefore, high CVs sufficiently reflect social and occupational differences without relying on classifications. The CV of a totally equal society is yet unknown and can only be empirically approximated. For decomposing world health inequality, Pradhan et al. (2003) tried to standardise height inequality by assuming that the height distributions in OECD countries reflect the genetic growth potential of individuals only. However, this would mean that no nutritional and health inequality exists in OECD countries, which seems highly implausible. In Germany during the 1990s, for example, height differences between social groups were as large as two centimeters (Baten and Boehm 2009; Komlos and Kriwy 2003). Even in egalitarian Scandinavia, some height inequality remains between regions (Sunder 2003).

Moradi and Baten (2005) have estimated the relationship between income inequality and height CV for 14 African countries and 29 five-year periods. They controlled for the differences in income definition and population coverage by including dummy variables. In addition, country fixed-effects were included (Table 1, model 1 and 3) which implies that their analysis focused mainly on intertemporal effects.

They found that height CV was significant and positively correlated with the gini coefficients of income (Table 1). An increase in the CV by one unit corresponded with a rise in the gini coefficient by 13.2 points in the fixed-effects specification. It is noteworthy that the relationship between the CV and the gini coefficient is not sensitive to country fixed-effects in general. In another regression without country fixed effects (2), they obtained a coefficient between nutritional and income inequality of 20.9. Both coefficients were very close to Baten and Fraunholz's (2004) estimate for Latin America, which reported a significant coefficient of 15.5 based on gini coefficients whose underlying data are of the highest possible quality. Additional robustness tests including weighting for sample quality confirmed the relationship. Moradi and Baten (2005) recommended the following formula for translating height CVS into income ginis:

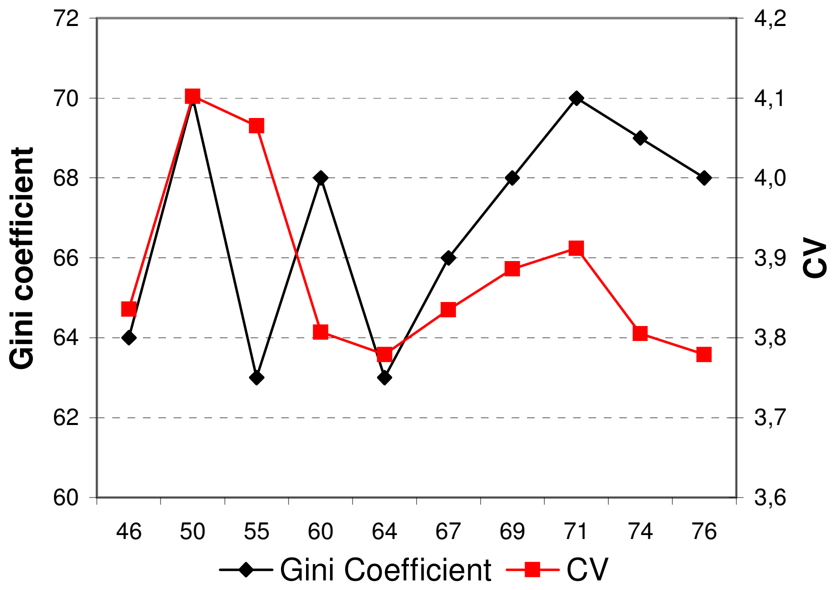
(2) $$Gini_{it}=-33.5+20.5*CV_{it}$$

Table 1: Relationship between income (gini) and height inequality (CV)

Gini-coefficient of income	(1)	(2)	(3)	(4)
Constant	-23.429 (-0.80)	-65.912 (-2.06)	19.235 (0.23)	-33.557 (-0.70)
CV	13.182 (1.72)	20.932 (2.87)	8.988 (0.42)	20.547 (1.67)
Coverage of female population (in %)	0.016 (0.20)		0.024 (0.13)	
Age group 20-24 (1=yes, 0=no)	-2.073 (-0.85)			
Age group 45-49 (1=yes, 0=no)	-2.343 (-0.60)			
Gabon		19.582 (4.22)		21.167 (3.01)
Country fixed-effects [p-value]	[0.000]		[0.387]	
Fixed effects for population coverage and income definition [p-value]	[0.000]	[0.000]	[0.810]	[0.026]
Fixed effects for primary source [p-value]	[0.000]	[0.052]		
Weighted by	share of female population		multiple country-periods	
R^2-adj.	0.812	0.521	0.324	0.436
N	78	78	29	29
Degrees of freedom	42	58	6	19

Source: Moradi and Baten (2005). Notes: Gini coefficients which were not based on a national coverage were excluded; t-values in circular parentheses. Number of countries: 14. The reference category represents a gini based on gross income, which covers the total population and persons as reference units. When dummies for countries and the source of gini are included, the reference category additionally represents Kenya and Bigsten (1986). The population coverage controlled for refers to households, economically active population, income recipients and taxpayers, with the income definitions referring to expenditure, net income and income not nearer specified. In cases where two DHS-surveys offer information on the same birth cohort, we took the average weighted by the female population they cover. The gini coefficients were derived from twelve primary sources listed in Deininger and Squire (1996). **Coverage/Age:** Additionally, we would have expected a negative coefficient for the percentage of the female population measured, correcting for the somewhat higher CV when based on more women. Obviously, however, the impact is almost zero. Similarly, age effects have the expected negative sign but do not introduce a significant bias.

Figure 1: Development of income and nutritional inequality in Kenya



Source: Moradi and Baten (2005). Notes: The gini coefficients are from Bigsten (1985) with a national coverage but based on national accounts of income groups, although Deininger and Squire (1996) label them as being based on taxpayers. Bigsten (1985) admits that his estimation technique overestimates the gini coefficients by about 20 percentage points. Birth cohorts were averaged from Kenya II and Kenya III, weighted by the coverage of female population.

Moradi and Baten argued that an excellent case for comparing the development of both income and height-based inequality measures is Kenya, for which the estimates by Bigsten (1985) offer a consistent source with a sufficient number of data points (Figure 1). The development of both inequality measures is nearly identical, except for the sudden fall of the gini coefficient in 1955 with which the CV does not correspond. It is actually not clear which of the two inequality measures describes the development better, but at least it seems that the CV's movement is somewhat smoother and less volatile (the CV might moreover be less volatile due to some consumption smoothing, as people reduce their savings in harder times to smooth their consumption). However, both the strong rise of inequality in Kenya during the early 1950s and the more gradual rise of the late 1960s are clearly visible in both series. Similarly, the decline in inequality thereafter is confirmed by both measures. Summing up, the development of CVs over time serves as a promising measure of inequality, even more so because in periods and countries in which other data on inequality are either non-existent or unreliable.

Taking the formula of Moradi and Baten (2005) and translating height CVs into income ginis, we compared the resulting gini coefficients with income based gini coefficients. Actually, most estimates between height CV and income gini have been performed for the period after 1950s when the budgets started to increase and a smaller part of that budget was allocated to food and shelter. This might bias the correlation between height CV and gini coefficient of income downwards because in many regions a lower portion of income was spend on food and shelter in the later period. Our main interest is the period prior to 1950, and especially the poorer countries. In that period budgets were relatively small, and the proportion spent on food and shelter high, so height CV and income ginis should be closer correlated than in the post-1950 period.

In sum, the relationship between gini coefficient of income and height CV seems quite well-established. Hence we collected all available data from hundreds of previously published articles (a list of references is available upon request), and benefited from scholars who provided us with their original height data sets. We excluded cases with very small numbers of height measurements, or if only one special group within a country was included. We took care that late teenage year / early twenties samples, military truncation, gender, prison selectivity and other factors did not distort our samples. Finally, we calculated the height CV for each country and birth decade not covered by the income ginis and converted the CV with formula (2) into income gini equivalents.

3. Description of inequality: regions and countries

Table 2 gives a summary of the sources of the newly constructed dataset. The overall dataset consists of about 1000 estimates of gini coefficients of income inequality, spread over more than 130 countries. The greatest number of new estimates is produced by using the heights data, but because these often refer to relatively small countries, the total impact on the estimates of global inequality that will be presented is more limited. The other new sources of estimates – 'new' direct estimates of income inequality, and indirect estimates derived from the GDP/wage ratio – are used for the larger countries (on which we focused this part of the research). When more than one estimate for a country was available, we applied the following rules: a direct estimate of income inequality superseded all indirect estimates, which were in that case ignored; when we had two different indirect estimates, based on heights and on the GDP/wage ratio, we used more or less arbitrarily the unweighted average of the two, which happened in 54 cases (Col. 6 of Table 2). Changing this assumption does not have a big impact on the final results, however. To get a systematic set of estimates for the core-group of 30 countries, we had to interpolate some of the estimates for those countries.[4]

[4] Estimates are complete for following countries: Belgium, Brazil, China, Spain, France, UK, Indonesia, Italy, Netherlands, Portugal, Sweden, USA, Germany, India, Poland, Norway, Ghana

Table 2: Overview of the sources of the dataset of income inequality, 1820-2000

	1 All	2 WIID	3 'New' ginis	4 GDP/wage ratio	5 Heights	6 Both 4&5 (50/50)	7 Interpolations
1820	38	0	6	7	20	5	0
1850	39	0	1	9	17	8	4
1870	45	0	9	6	19	10	1
1890	47	0	7	6	21	11	2
1910	54	0	12	9	25	6	2
1929	55	0	16	12	19	7	1
1950	75	13	11	9	37	5	0
1960	89	53	3	2	30	1	0
1970	97	62	2	2	30	1	0
1975	53	48	1	0	4	0	0
1980	84	73	0	0	11	0	0
1985	70	69	1	0	0	0	0
1990	105	104	1	0	0	0	0
1995	93	92	1	0	0	0	0
2000	64	64	0	0	0	0	0
Total	1008	578	71	62	233	54	10

Which differences of within-country inequality would we expect for the various world regions? It is well known that in the post-1950 period there are more or less persistent differences in the level of within-country income inequality in different regions of the world; Latin America and Africa have, on average, relatively high levels of inequality, whereas Western Europe and Asia tend to have lower levels (Deiniger and Squire 1998). These patterns actually emerge when we look at the unweighted averages of the ginis of the different countries in the different regions and the world as a whole: Latin America and Africa almost always have a (much) higher average gini than Europe; the Middle East also is often above average, whereas Asia is usually below average. The persistency of these patterns is indeed striking, but large changes can also be observed: perhaps most interesting is the fact that Western Europe moves from above average in the 19th century to below average after 1945. The industrial revolution therefore emerged in a region with rather high levels of income inequality, but levels of income were also high there, as a result of which the extraction ratio was much lower than elsewhere (Milanovic, Lindert and Williamson 2007). This decline of inequality is even more pronounced in (communist dominated) Eastern Europe, which has by far the lowest ginis during the

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and Mexico; interpolations were necessary for Thailand (1850, 1910), Turkey (1850, 1890, 1980), Australia (1820 is assumed to be identical to 1850), Russia/USSR (1850, 1890), Canada (1870), Czechoslovakia (1910), Denmark (1850), Egypt (1890, 1929, and 1820 derived from Turkey) and Peru (1910); for Argentine and Chili in 1820 we did not find a suitable proxy.

1950-1990 period. The 'egalitarian revolution' of the 20th century is also apparent in North America/Australia, and can even be found in the (unweighted) global averages, which decline between 1929 and 1980 (by about 10%). In all regions we see an increase in inequality in the last decade of the 20th century; it is most striking in post communist Eastern Europe.

Table 3 Unweighted averages of the gini coefficients by region and period, 1820-2000

	Western Europe	Eastern Europe	Asia	Middle East	Africa	Latin America	N.America/ Australia	World
	Gini							
1820	49,73	43,42	45,22	41,70	44,60	54,08	45,56	*46,87*
1850	46,16	44,70	44,05	64,00	65,70	49,09	45,43	*46,69*
1870	49,19	46,52	42,38	46,49	55,50	53,20	43,95	*47,74*
1890	44,35	37,74	40,80	42,15	43,72	48,99	43,76	*42,81*
1910	45,80	40,27	41,29	37,35	41,06	44,38	42,24	*42,50*
1929	44,26	34,04	42,03	44,32	47,65	53,28	42,00	*44,26*
1950	40,22	37,79	42,02	45,58	48,43	47,89	37,02	*44,20*
1960	40,71	33,13	41,46	49,75	49,59	48,77	34,55	*43,93*
1970	37,59	32,69	39,25	48,40	47,79	49,38	35,86	*42,99*
1980	35,52	27,85	39,07	42,76	47,14	46,55	37,39	*40,91*
1990	35,05	27,84	40,35	44,05	45,70	49,58	38,32	*39,68*
2000	37,68	37,01	44,25	47,32	47,56	51,77	41,63	*43,02*
Idem, as percentage of world average								
1820	106	93	96	89	95	115	97	100
1850	99	96	94	137	141	105	97	100
1870	103	97	89	97	116	111	92	100
1890	104	88	95	98	102	114	102	100
1910	108	95	97	88	97	104	99	100
1929	100	77	95	100	108	120	95	100
1950	91	85	95	103	110	108	84	100
1960	93	75	94	113	113	111	79	100
1970	87	76	91	113	111	115	83	100
1980	87	68	96	105	115	114	91	100
1990	88	70	102	111	115	125	97	100
2000	88	86	103	110	111	120	97	100
Sample size								
1820	14	5	5	2	7	2	2	37
1850	14	7	7	1	1	3	3	36
1870	13	7	10	1	3	6	3	43

1890	13	10	8	2	2	7	3	45
1910	13	12	7	2	8	8	4	54
1929	14	7	9	3	11	7	4	55
1950	12	8	12	3	25	12	4	76
1960	16	11	14	4	25	16	4	90
1970	15	9	17	4	27	19	5	96
1980	16	7	15	5	17	19	5	84
1990	17	23	17	7	21	19	4	108
2000	9	17	12	4	8	10	4	64

4. Estimates of Global Inequality

The unit of analysis and comparison so far has been the Gini coefficient of the individual countries. To move from them to global inequality, we again had to assume that the underlying distributions were log-normal, which allows us to translate the Gini-coefficient into an estimate of the whole distribution of income in country X at time Y, which can be linked to the Maddison estimates of the average GDP per capita to get estimates of the distribution of income in 1990 international dollars. These estimates can then be added together, to get a global income distribution in 1990 international dollars.

What are the results of our estimates for the development of global inequality? Table 4 gives the most important results: the development of the gini of the global income distribution. It increases from .47 in 1820 to .62 in 1929 and .65 in 1950, after which its more or less stabilizes at that (extremely high) level during the second half of the 20th century. The table also demonstrates that we cover between 85 and 94 percent of global population, which is (we think) quite high; this percentage tends to increase somewhat during the period under study. On the basis of the Maddison dataset we estimate that the average income of this 85 to 94 share is only slightly higher than that of the world as a whole, but the average income of the uncovered rest is clearly lower than of the countries covered by this experiment (for example, in 1820, the average income of 'the rest' can be estimated to be about 500 dollars). We therefore more or less consistently underestimate inequality, but the bias does not change much over time. A comparison with Bourguignon and Morrison (2002) appears to point in the same direction: their Gini estimate of global inequality is during the 19th century consistently higher than ours, by an unchanging 3 points on the Gini scale (their estimates of global inequality increase from .50 in 1820 to .61 in 1910). The difference disappears however in 1929 (B&M: .62), and both sets of estimates are almost identical for the post 1945 period. The disappearance of the gap between these two sets of estimates is somewhat puzzling as B&M are supposedly always based on a total coverage of the global population, whereas we also after 1910 or 1945 still miss 5-15 percent of the global population, who are on average poorer than the average global citizen (that both sets of estimates for the rest are quite similar is not unexpected, of course, given the fact that we both use Maddison's estimates of GDP per capita and the Worldbank's estimates of income inequality).
This bias in our results may also affect our estimates of the development of absolute poverty levels, which is probably also somewhat lower than in reality. Still they point to a

rapid decline of absolute poverty during these two centuries, a process that however seems to come to a halt during the most recent period. The total number of poor people (below 1 dollar) was more or less stable between 1820 and 1929 (when economic growth was apparently strong enough to compensate for the growth of the total population), increased very rapidly between 1929 and 1950 (from 381 to 624 millions), fell rather rapidly after 1950 to its lowest point, 221 million, in 1980, but began to increase again after 1980 – in the fifteen years between 1980 and 1995 the total increase was almost 50%. As a share of the population absolute poverty more or less stabilized between 1980 and 1995 (and it may have fallen somewhat between 1995 and 2000). This result is really different from that published by B&M, who estimated that the number of people living in extreme poverty remained more or less the same between 1960 and 1992. We on the other hand find a strong decline between 1950 and 1980, followed by absolute growth and relative stability. This change in the growth regime at about 1980 may be related to an on average slower growth of GDP per capita in the world economy. Before 1970 GDP per capita expanded at almost 3%, between 1970 and 1980 this was still 1.9%, but the growth record in the next two decades were, in spite of the spectacular advance of China and India, 1,3% per capita growth during the 1980s and 1.6% during the 1990s. Yet, even when per capita growth is slowing down, one would expect, if the income distribution is stable (as suggested by the gini indices) that the share of the absolute poor would continue to decline, which did not happen (at least, not before 1995-2000). This points to the limitation of the Gini index as a measure of inequality.

Table 4. Global Ginis, and data on the coverage of our samples, 1820-1995

	World GINIs	Population covered Millions	Share of global population	Average income covered population*	Average income World*	Ratio coverage/all
1820	**0,47**	918	0,88	689	667	1,03
1850	**0,50**	1030	0,87	804	791	1,02
1870	**0,53**	1086	0,85	921	873	1,05
1890	**0,55**	1266	0,86	1149	1133	1,01
1910	**0,58**	1518	0,87	1535	1465	1,05
1929	**0,62**	1791	0,87	1899	1784	1,06
1950	**0,65**	2298	0,91	2258	2113	1,07
1960	**0,64**	2789	0,92	2898	2775	1,04
1970	**0,65**	3474	0,94	3855	3736	1,03
1980	**0,65**	4142	0,91	4767	4521	1,05
1985	**0,64**	4081	0,86	5266	4763	1,11
1990	**0,64**	4951	0,94	5461	5162	1,06
1995	**0,65**	5099	0,90	5643	5452	1,03
2000	**0,64**	5131	0,84	6578	6029	1,09

- in1990 international dollars

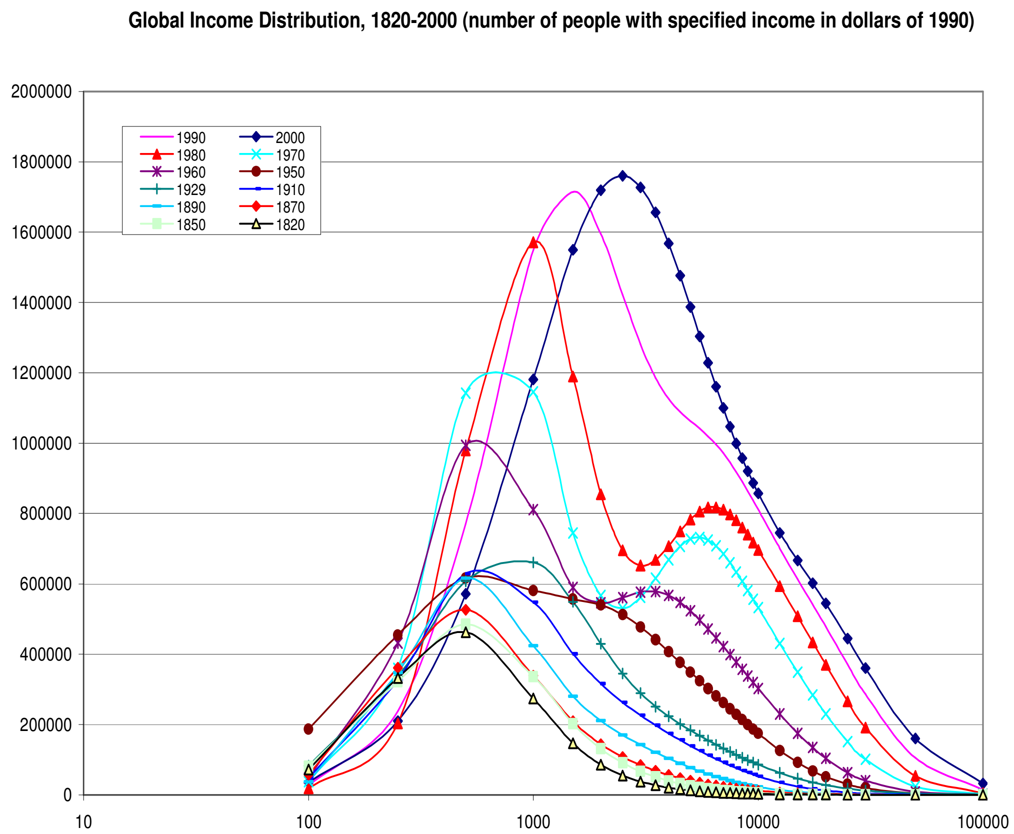
Table 5. Estimates of 'real' poverty: number of people earning less than 1 or 2 USD dollars per day (in 1990 international dollars, and in millions)

	1 USD day		2 USD day	
	no persons	share of population covered	no persons	share of population covered
1820	362	**0,39**	667	**0,73**
1850	368	**0,36**	692	**0,67**
1870	367	**0,34**	717	**0,66**
1890	338	**0,27**	749	**0,59**
1910	334	**0,22**	763	**0,50**
1929	381	**0,21**	805	**0,45**
1950	624	**0,27**	1047	**0,46**
1960	437	**0,16**	1110	**0,40**
1970	375	**0,11**	1173	**0,34**
1975	319	**0,10**	1078	**0,33**
1980	221	**0,05**	956	**0,24**
1985	229	**0,05**	762	**0,18**
1990	247	**0,05**	835	**0,17**
1995	326	**0,06**	901	**0,18**

2000	234	**0,05**	696	**0,14**

Another way to present these estimates is to chart the different global income distributions in one picture, shown below, which indicates both the increase in income levels, the growth of the population and the changes in its distribution (all in 1990 dollars). What is in particular striking, is the change in the structure of the income pyramid through time (see for similar analyses of the more recent period, see Milanovic 2002). Between 1820 and 1929 world income distribution is unimodal, but in the next few decades a different distribution emerges with two clearly separate 'modes' or peaks – this begins to show a bit in 1950, is more clearly in 1960, and becomes very significant in 1970 and 1980, when indeed a big gap between rich and poor appears. However, in the 1980s the two modes begin to merge, and in 1995 the distribution has become consistently unimodal again.

Figure 6 Global income distributions: number of people with certain level of income (in dollars of 1990), 1820-2000



Another way of analysing these estimates is to make the distinction between within country and between countries inequality. Table 6 below presents the different ginis of within country and between country inequality. Unsurprisingly, the between country inequality is relatively low at the beginning of the period, and increases strongly with the growth of income disparities between countries. The within country inequality does not increase in the very long run, although in the 1950-1980 period there is a fall, followed by an increase in the final decades of the 20th century. Perhaps the most striking results is that we find a deline in between country inequality from about 1970 onwards, from .58 to .51 in 2000. The strong rise of within inequality in the same period (1980-2000) entirely compensated for this still modest fall in between country inequality, however, as a result of which global ineuqality does not change during the era of globalization.

Table 6 also shows the overlap factor; because of the statistical features of the Gini coefficient, the sum of the within country Gini and the between country Gini is larger than the global Gini. The difference between them is the overlap factor, which is in essence nothing more than that share of the within group inequality of country A that overlaps with within group inequality of country B. This has led Milanovic (2002, 70) to claim that "the more important the overlapping component..... the less one's income depends on where she lives" . With the rise of global inequality between 1820 and 1950, the overlap factor increases, but it then declines between 1950 and 1985, a sign of growing polarization of the income pyramid we already noticed (Figure 1). This is followed by an increase between 1985 and 2000, indicating that the dual structure of the incomes pyramid has disappeared again. What both Figure 1 and this analysis demonstrate, is that behind the stability of the global gini index during the 1950-2000 period, major changes in income distribution occurred: strong polarization during the Golden Age of post-war growth leading to a bimodal income distribution, was followed by a convergence process during the 1985-2000 period, leading to appearance of a unimodal distribution in the 1990s. It is striking, however, that this first phase of postwar growth was much more successful in reducing absolute poverty than the periode of globalization after 1980.

Table 6. Within country and between countries inequality, 1820-2000

	Within country inequality	Between country inequality	Sum	Actual world gini	Overlap factor
1820	**0,43**	**0,16**	0,59	0,47	-0,11
1850	**0,41**	**0,25**	0,66	0,50	-0,16
1870	**0,41**	**0,33**	0,74	0,53	-0,20
1890	**0,39**	**0,38**	0,80	0,55	-0,25
1910	**0,40**	**0,41**	0,81	0,58	-0,23
1929	**0,42**	**0,48**	0,90	0,62	-0,28
1950	**0,45**	**0,58**	1,03	0,65	-0,37
1960	**0,38**	**0,56**	0,95	0,64	-0,31
1970	**0,37**	**0,58**	0,96	0,65	-0,30
1980	**0,35**	**0,56**	0,91	0,65	-0,26

1985	**0,37**	**0,52**	0,89	0,63	-0,26
1990	**0,38**	**0,53**	0,91	0,64	-0,27
1995	**0,42**	**0,52**	0,94	0,65	-0,29
2000	**0,45**	**0,51**	0,96	0,65	-0,31

6. Conclusion

We have reconstructed a new dataset of estimates of the inequality of the income distribution for a large set of countries for benchmark years starting in 1820 and ending in 2000. This was, in comparison with the estimates produced by Bourguignon and Morrison (2002), based on the use of new (and old) historical studies of income inequality in different countries, on estimates based on the development of the ratio between wage and income, and on estimates based on heights inequality (or a combination of the latter two approaches). Moreover, these estimates have been used to reconstruct the evolution of global inequality between 1820 and 2000. The long term evolution of global inequality that emerges from this is not very dissimilar from the results presented by B & M. Within country inequality did not change a lot in the very long run, although in many countries inequality tended to decline during the 20th century 'egalitarian revolution', but this was often followed by a rise of inequality after 1980. Between country inequality increased a lot and was the main cause behind the very strong increase in global inequality in these two centuries; this process appears to have come to an end during the second half of the 20th century; we find a modest reduction in between country inequality in the final decades of the 20th century (when within country is on the rise again). Perhaps even more interesting were the changes in the structure of global inequality; it was an almost uniformly uni-modal distribution in the 19th century, because increasingly bi-modal during the 1950-1980 period, and 'suddenly' changed into a bi-modal distribution again between 1980 and 2000. We intend to analyse the underlying dynamics of these changes in more detail in the future.

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