**Working Paper CLIO-INFRA: Income inequality**

1. Title

 - Gross household income gini, 1820-2000

2. Author(s)

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 - Gini coefficient.

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9. Abstract (200 words)

- gross household income gini is given for benchmark years for the period 1820-2000.

10. Time period

 - 1820-2000.

11. Geographical coverage

 - Entire World.

12. Methodologies used for data collection and processing

- Bibliographical research, research of published and Online Databases, and cross-analysis of various datasets

13. Data quality

 i. Central statistical agencies

 ii. Historical reconstructions

 iii. Estimates

 iv. Conjectures

Virtually all benchmark data after 1960 are derived indirectly from Central Statistical Agencies and therefore probably better classify as historical reconstructions. The remaining data are estimates and, further back in time, conjectures..

14. Period of collection

 - October/2010 and January/2014.

15. Data collectors

 - Michalis Moatsis, Jan Luiten van Zanden, Joerg Baten, Peter foldvari, and Bas van Leeuwen

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16. Sources

See next Section.

17. Text

1. INTRODUCTION

# Here we will provide a brief description as well as the references on the data for the estimates of world inequality belonging tot he paper “The Changing Shape of Global Inequality 1820-2000. Exploring a new dataset.” The data is subdivided into four sections. First we will discuss income inequality in the post-1945 period for which a relative abundance of data is available and our main challenge consisted in making the data internationally comparable. For the pre-1945 period we distinguish three different approaches. We start in Section 3 with direct estimates of inequality followed in Section 4 by GDP divided by wage (also called the Williamson-index) as a measure of inequality. In Section 5 we than discuss a new method of calculating income inequality by using the distribution of heights in a population. We end with a list of references of the sources used.

2. INCOME INEQUALITY IN THE 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 due to different measurement concepts (e.g. Atkinson and Brandolini, 2001, Gruen and Klasen, 2001, 2008). Even though several authors have applied different methods for addressing these inconsistencies, they basically all agree on the problems. Indeed, as pointed out by **François and Rojas-Romagosa (2005) and Solt (2009, 235),** 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, 16)**. Hence, they classify the data from the WIID according to these three classes. The major actor causing a different trend in these classes 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 (2012) for Indonesia, it seems that there is only a relative short transition phase when income taxes gain ground. This means that, as a general rule, both before and after a relatively short transition period after WWII, the trends in the net household income, 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.

In the period prior to 1980, the cross-sectional effect is significant and positive, implying that the net household Gini grows slower than the gross household Gini (Table 1). If

TABLE 1

The relationship between gross and net household Gini

|  |  |  |
| --- | --- | --- |
|  | before 1980 | after 1980 |
| constant | 9.420(1.55) | 19.62(1.66) |
| Net household income Gini | 0.788(4.45) | 0.367(0.91) |
| Net household income Gini x time trend | 0.002(7.41) | 0.003(0.50) |
| time trend | -0.073(-5.16) | -0.059(-0.26) |
| R2 | 0.730 | 0.462 |
| N | 82 | 114 |

*Notes:* The dependent variable is the gross household Gini coefficient. LSDV fixed-effect panel specification, country dummies are not reported. Robust t-statistics in parentheses.

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. We prefer to use the gross household Ginis as these are the most abundant (61% of the sample consist of gross household Ginis). However, when such data are unavailable, we apply the regressions of Table 1 to transform net household and expenditure Ginis into their gross household equivalents.

3. DIRECT ESTIMATES FOR THE 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, Bergson (1984) for the Soviet Union and 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.[[1]](#footnote-1) 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 have been proposed - a log-normal and a Pareto distribution – but the literature suggests that when the whole distribution is covered, the log-normal is to be preferred (see Soltow 1998). It is known that the Lorenz-curve, under the assumption of log-normality, can be expressed as follows:

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 (Lopez and Servén (2006).

The Gini coefficient (G) can be expressed as:

1. 

In the end, it turned out that on average the difference between an assumed lognormal and a Pareto distribution was limited. Van Leeuwen and Foldvari (2012, appendix A.2) point out that their level slightly differs but, since the results are benchmarked on actual Ginis, this does not pose a problem. More interesting is the question if the movement of the Ginis estimated based on the income shares follows the actual development of Ginis. Leigh (2007) shows that this indeed is the case for a sample of countries during the post-war period (see also Van Leeuwen and Foldvari (2012)).[[2]](#footnote-2) As pointed out already, we prefer the log-normal distribution for transformation of these estimates of the share of 1% or 5% in total income into Gini coefficients.

*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 often based on ‘social tables’ not much is known for the earlier period. For estimates of within country inequality before 1914 we therefore often have to rely on proxies for income inequality. Several options have been suggested, such as the income gap between the landed elite and landless labor, or the ratio of average family income (y) to the annual wage earnings of an unskilled rural laborer (w). Both methods draw heavily on the concept of the extraction rate (Milanovic et al. 2007). This rate is defined as the share of total income that is above the subsistence level, which can be assumed to be equal to the earnings of an unskilled labourer. A high extraction rate – in other words, a large surplus above subsistence – implies that potentially income inequality can be very high. The question is which share of this surplus is acquired by the elite.

The basic equation used by Milanovic *et al.* is:

1. 

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:

1. 

If we assume that the expropriation of surplus income by the elite is not complete we can have a more general form:

1. 

where -λ=γ=1 is the basic case, with the maximum income diversion. We assume that the share of the elite within the population may differ across countries, but remains constant over time. Also, the term is proxied by the log of the Williamson index (y/wun). This results in a panel model with fixed effects, the log of GDP per capita and wage premium being independent variables (see the results in Table 2):

1. 

To estimate changes in Gini coefficient, we used the regression from Table 2 (including country specific effects) and the fitted values to estimates Ginis for countries/years where we did have the Williamson index but no Ginis.[[3]](#footnote-3)

TABLE 2

How to estimate Gini coefficients based on the Williamson method of wage to GDP ratios

|  |  |
| --- | --- |
|  | Coefficient |
| Constant | 3.657(6.11) |
|  | 0.212(2.25) |
|  | -0.158(-3.08) |
| R2 | 0.599 |

*Notes:* 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 analyzing the relation between the distributions of heights and of income. For example Baten (1999, 2000), 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. 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 is indicative of income distribution during the decade of their birth.[[4]](#footnote-4)

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 will also become more unequal.[[5]](#footnote-5) 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. Because they do not assume the existence of a market economy, anthropometric methods can also be used very well for studying developing countries.

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 resources A and B after birth:

1. All individuals receive the same quantity and quality of resources (nutritional and health inputs). This case refers to a situation of perfect equality.
2. 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 question of what role genetics, as well as nutrition, may play in determining a given population's average height was often raised in the early years of anthropometric research. It turns out that while genes are a key determinant of an individual's height, when it comes to groups of individuals genetic deviations from the mean cancel each other out. Moreover, there is considerable evidence that it is environmental conditions, not genes, which account for today's height gap between rich and poor populations, including those inhabiting a single nation. Habicht et al. (1974), for example, found that the height gap between the rich and poor sectors of a less-developed country (LDC), Nigeria, was even wider than that between an LDC's elite and a reference population in the United States.Fiawoo (1979), in his study of Ghana, reached the same conclusion as Habicht, as did Eksmyr (1970), working with data on several Ethiopian ethnic groups, and Graitcer and Gentry (1981), when they considered Egypt, Haiti, and Togo.What is more, the height-distribution percentiles for children from rich families in this last study are in line with those for a rich country, namely the United States. Of course, not all height differentials are due exclusively to environmental conditions: African bushmen and pygmies, for example, spring to mind, and there might be a modest intergenerational transfer limit in the Japanase case. However, those observations account of the total sample, and for Japan we rely on other indicators.

The coefficient of variation (CV) is the measure most often used in this research. 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.[[6]](#footnote-6)

In order to compare the height CVs and the income Ginis within our sample, we calculated all the potential country-year combinations for which both sources were available. We arrived at 129 observations which we could compare. In OLS regressions, there is correlation between both indicators of inequality, whether we include time fixed effects or not (Column 1 and 2 of Table 3). As expected, there is quite a bit of noise which leads to an only modestly sized R-square, as we compare height inequalities and income inequalities for so many different countries and periods. Of course, there are also the conceptual differences between the two variables: we would expect height inequality to be larger in countries with a very limited amount of public goods such as hospitals and schools; poorer people cannot benefit from those public goods, hence height and health inequality should be higher. In contrast, income inequality might be particularly high in relatively rich countries which are

TABLE 3

Relationship between Income Gini and CV of heights

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | (1) | (2) | (3) | (4) | (5) | (6) |
| Estimation method | OLS | OLS | OLS | OLS | FE | FE |
| Period | Full period | Full period | 1820-1929 | 1950-1975 | 1820-1929 | 1950-1975 |
| Height CV | 10.46\*\*\* | 11.42\*\* | 10.64\* | 12.17\*\*\* | 8.71 | 12.77\* |
|  | -0.006 | -0.031 | -0.078 | -0.005 | -0.468 | -0.08 |
| Time fixed effects | Yes | No | Yes | Yes | No | No |
| Constant | 9.25 | -1.61 | 8.52 | -4.99 | 9.19 | -8.6 |
|  | -0.587 | -0.937 | -0.737 | -0.747 | -0.837 | -0.743 |
| Observations | 129 | 129 | 60 | 52 | 60 | 52 |
| Rsq.(between) |  |  |  | 0.237 | 0.0696 |
| Rsq.(within) |  |  |  | 0.0325 | 0.178 |
| Rsq.(overall) | 0.26 | 0.13 | 0.28 | 0.18 | 0.071 | 0.124 |

Robust p-values in parentheses. WLS, weighted with population

Sources: heights studies used: <http://www.wiwi.uni-tuebingen.de/cms/fileadmin/Uploads/Schulung/Schulung5/Joerg/ref_anth.pdf>

still in the rapid process of industrial development, as Kuznets hypothesized.

We were curious whether this significant correlation between height and income inequality remains significant if we subdivide into an early and a late period (Column 3 and 4 of Table 3). This is indeed the case -- the coefficient and R-square is slightly larger for the early period between 1820 and 1950. But also for the following period, we observe a statistically significant correlation.

Finally, we wanted to estimate including country fixed effects, even if Durlauf et al. (2005) suggest that fixed effects estimation might overestimate standard error if variables are used that may contain a substantial amount of measurement error, especially when it comes to changes over time. Under the fixed effects specification, the correlation between height and income inequality is robust for the more recent period, for which the measurement quality is probably somewhat better (Column 5 and 6 of Table 3). For the early period, the coefficient is still positive, but not statistically significant. The size of the coefficient is not close to zero, however.

Does the statistical insignificance imply that for the early period, the correlation between the two variables is quite weak? Well, the fixed effects specification put much more emphasis on the variation over time, and much less on the cross-sectional variation between countries. If we compare the early values in a scattergram, the correlation is still obvious (Figure 1). Again, we see that height inequality relative to income inequality tends to be larger in countries with few public goods such as Brazil in 1820. In contrast, income

FIGURE 1

Scatterdiagram of Income Gini and Height CV



inequality was higher than height inequality in France in 1929 which was in the rapid process of industrial development, but which was already equipped with hospitals and water sewers in the 1920.

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 (see Section 4.2 for a list of references), 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 the regression results of Table 3, column (1), into income Gini equivalents.

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# *4.2 References: sources of anthropometric inequality estimates*

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1. 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, 2010) (please note: after 2000 the inequality based on income shares goes down while inequality based on Susenas data increases), 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, 2009), 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). [↑](#footnote-ref-1)
2. Leigh though does not ascertain that the share of the top percentile is a reliable proxy of distribution because the sample of Leigh includes only developed countries after 1950. The taxation data are reliable for this period in these countries, but it was not necessarily the case for developed countries one or two centuries ago and it is not always the case in most developing countries until today. If mesurement error in these data would be too large, the transformation into Gini coefficients would be debatable. [↑](#footnote-ref-2)
3. The sources used for the real wage series were Williamson (1999, 2000a, 2000b), Mitchell (1998 a, b, c), Allen (2001), Mironov (2004), and Allen *et al.* (2011); the estimates of the growth of GDP per capita were again taken from Maddison (2003). [↑](#footnote-ref-3)
4. One question to be addressed 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 survive 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. [↑](#footnote-ref-4)
5. The following review of the literature is based on Moradi and Baten (2005). [↑](#footnote-ref-5)
6. 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). [↑](#footnote-ref-6)