PRE-INDUSTRIAL INEQUALITY*

Branko Milanovic, Peter H. Lindert and Jeffrey G. Williamson

Is inequality largely the result of the Industrial Revolution? Or, were pre-industrial incomes as unequal as they are today? This article infers inequality across individuals within each of the 28 pre-industrial societies, for which data were available, using what are known as *social tables*. It applies two new concepts: the *inequality possibility frontier* and the *inequality extraction ratio*. They compare the observed income inequality to the maximum feasible inequality that, at a given level of income, might have been 'extracted' by those in power. The results give new insights into the connection between inequality and economic development in the very long run.

1. Exploring Inequality in Pre-industrial Societies

As the knowledge about the last century's movements in within-country income inequality has reached a scholarly consensus,[1] our lack of similar knowledge about evolution of income inequality in earlier time-periods has become more glaring. In light of the recent emphasis on the role of institutions, including inequality-generating institutions (Engerman and Sokoloff, 1997; Engerman *et al.*, 2000; Acemoglu *et al.*, 2001), the lack of past data on income distribution places severe limitations on our ability to understand the roots of economic growth, arguably one of the most important questions in economics. A number of relevant questions can be asked in that respect: did currently developed countries acquire their early twentieth-century inequalities only after their Industrial Revolutions, or were their rich and poor residents just as far apart many centuries earlier? How does inequality in today's least developed, agricultural countries compare with that in agricultural societies dating back to the Roman Empire? Was inequality more or less stable over time in given societies?

Such questions have yet to be answered, for want of sufficient data. The chief objective of this article is to provide a fresh and, in most cases, the first set of inequality

[1] On the great twentieth-century levelling, see Kuznets (1955) and Lindert and Williamson (1985). The late-century rise of inequality is best revealed in the large international project on top incomes summarised in Piketty (2005) and Piketty and Saez (2006). For income distributions from developing countries, see Deininger and Squire (1996), with updated data available from http://econ.worldbank.org/projects/inequality.

estimates for pre-industrial societies and to compare inequality in those societies with the modern ones. We define as pre-industrial, the future developed societies prior to the beginning of the Industrial Revolution (our convenient cut-off date is the end of the Napoleonic wars) and all other societies up to the early twentieth century.[2] Those were obviously not times when countries conducted household income surveys, the main source of income distribution data that we have today. We have had therefore to resort to less precise, but reasonable, sources of data that have already been used in a few cases for this purpose: social tables where salient economic classes are listed with their estimated average incomes and population sizes.[3] We have assembled and processed such data from 28 pre-industrial societies ranging from the first-century Roman Empire to 1947 British-ruled India. Section 2 introduces two new inequality concepts, the *inequality possibility frontier* and the *inequality extraction ratio*, the latter relating actual inequalities to the maxima allowed by each society's surplus above subsistence. Although the new concepts have general validity, they are particularly useful for a study of inequality in relatively poorer societies. The *inequality possibility frontier* and the *inequality extraction ratio*, both measurable concepts, open the door to fresh interpretations of inequality in the very long run. In Section 3, we discuss our data in some detail, present estimates of income inequality across individuals for each of the 28 pre-industrial societies and apply the two concepts empirically. The full dataset used in the article is, due to its size, available only as an on-line Appendix.[4] In Section 4, we present our conclusions.

2. The Inequality Possibility Frontier and the Extraction Ratio

The workhorse for our empirical analysis of early inequalities is a concept we call the *inequality possibility frontier*. Suppose that each society has to distribute income in such a way as to guarantee subsistence minimum for its poorer classes. The remainder of the total income is the surplus that is shared among the richer classes. When average income is very low and barely above the subsistence minimum, the surplus is small. Under those primitive conditions, the level of inequality will be quite modest. But as average income increases with economic progress, this constraint on inequality is lifted; the surplus increases and the maximum possible inequality compatible with that higher average income is greater. In other words, the maximum attainable inequality is an increasing function of mean overall income. Whether the elite fully exploit that maximum or allow some trickle-down is, of course, another matter entirely. Surely there are both political reasons (e.g. rebellion) and economic reasons (policing costs) that will limit their ability to extract all surplus.

It is worth measuring, however, what share of the surplus the powerful have extracted and what share they did not. To fix ideas intuitively, suppose that a hypothetical society consists of 100 people, 99 of whom are lower class. Assume further that the subsistence minimum is 10 units, and total income 1050 units. The 99 members of the lower class receive 990 units of income and the only member of the upper class receives 60. The

---

[2] The only exception is pre-independence India in 1947.

[3] These sources have been used mostly for England, the country that was historically the pioneer in their definition (Lindert and Williamson, 1982). They have never, or very seldom, been used for other countries.

[4] Available at http://gpih.ucdavis.edu/ early income distributions.

Gini coefficient corresponding to such a distribution will be only 4.7%.[5] If total income doubles over time to 2000 units, then the sole member of the hypothetical upper class will be able to extract 1010 units, and the corresponding Gini coefficient will leap to 49.5. If we chart the locus of such maximum possible Ginis on the vertical axis against mean income levels on the horizontal axis, we obtain the *inequality possibility frontier* (IPF).[6] Since any progressive transfer must reduce inequality measured by the Gini coefficient, we know that a less socially segmented society would have a lower Gini.[7] Thus, IPF is indeed a *frontier*.

The *inequality possibility frontier* can be derived more formally. Define s = subsistence minimum, μ = overall mean income, N = number of people in a society and ε = proportion of people belonging to a (very small) upper class. Then the mean income of upper class people (y_h) will be

$$y_h = \frac{\mu N - sN(1 - \varepsilon)}{\varepsilon N} = \frac{1}{\varepsilon}[\mu - s(1 - \varepsilon)] \qquad (1)$$

where we assume as before that the $(1 - \varepsilon)N$ people belonging to lower classes receive subsistence incomes.

Once we document population proportions and mean incomes for both classes and assume further that all members in a given class receive the same income,[8] we can calculate any standard measure of inequality for the potential distribution. Here we shall derive the IPF using the Gini coefficient.[9]

The Gini coefficient for n social classes whose mean incomes (y) are ordered in an ascending fashion ($y_j > y_i$ for $j > i$), with subscripts denoting social classes, can be written as in (2)

$$G = \sum_{i=1}^{n} G_i p_i \pi_i + \frac{1}{\mu} \sum_{i}^{n} \sum_{j>i}^{n} (y_j - y_i) p_i p_j + L \qquad (2)$$

where π_i = proportion of income received by i-th social class, p_i = proportion of people belonging to i-th social class, G_i = Gini inequality among people belonging to i-th social class, and L = the overlap term which is greater than 0 only if there are members of a lower social class (i) whose incomes exceed those of some members of a higher social class (j). The first term on the right-hand side of (2) is the within component (total inequality due to inequality within classes), the second term is the between component (total inequality due to differences in mean incomes between classes) and L is, as already explained, the overlap term.

Continuing with our illustrative case, where all members of the two social classes (upper and lower) have the mean incomes of their respective classes, (2) simplifies to

---

[5] Throughout this article, we report Ginis as percentages and thus here as 4.7 rather than 0.047.
[6] The IPF concept was first introduced in Milanovic (2006).
[7] The reader can verify this by letting one subsistence worker's income rise above subsistence to 20, and by letting the richest person's income be reduced to 1000. The new Gini would be 49.49.
[8] This is already assumed for the lower classes but that assumption will be relaxed later for the upper classes.
[9] The same approach is, of course, possible with other inequality measures like the Theil indexes, standard deviation of logs etc. These results are available from the authors on request.

$$G = \frac{1}{\mu}(y_j - y_i)p_i p_j. \tag{3}$$

Substituting (1) for the income of the upper class, and s for the income of lower class, as well as their population shares, (3) becomes

$$G^*(\mu) = \frac{1}{\mu}\left\{\frac{1}{\varepsilon}[\mu - s(1 - \varepsilon)] - s\right\}\varepsilon(1 - \varepsilon) \tag{4}$$

where G^* denotes the maximum feasible Gini coefficient for a given level of mean income (μ). Rearranging terms in (4), and re-expressing mean income as a multiple of the subsistence minimum, $\mu = \alpha s$ (where $\alpha \geq 1$), yields a simple formula

$$G^*(\mu) = \frac{1 - \varepsilon}{\alpha s}s(\alpha - 1) = \frac{\alpha - 1}{\alpha}(1 - \varepsilon). \tag{5}$$

As the size of the elite tends towards zero ($\varepsilon \to 0$), that is, at the extreme when elite consists of one person only, (5) becomes

$$G^*(\mu) = \frac{\alpha - 1}{\alpha}. \tag{6}$$

Equation (6) represents our final expression for the maximum Gini (given α), which will chart IPF as α is allowed to increase from 1 to higher values. For example, when $\alpha = 1$ all individuals receive the same subsistence income and (6) reduces to 0, while when $\alpha = 2$, the maximum Gini becomes 0.5 or 50%. The hypothetical IPF curve generated for α values ranging between 1 and 5 is shown in Figure 1. As can be seen, the IPF is concave, and thus the percentage change in the maximum Gini in response
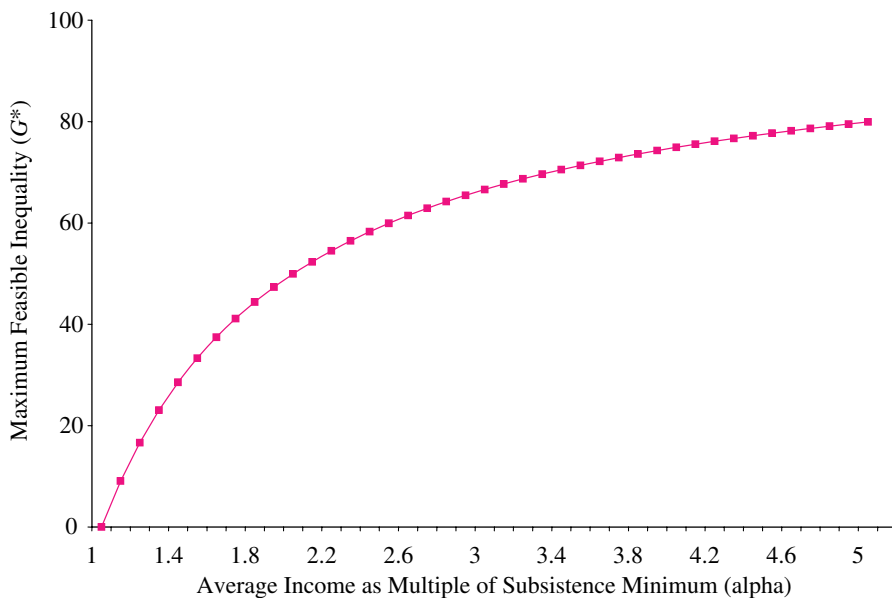

Fig. 1. *Inequality Possibility Frontier*

© 2010 The Author(s). The Economic Journal © 2010 Royal Economic Society.

to a given percentage change in mean income approaches zero at higher levels of mean income.[10]

The *inequality possibility frontier* sharpens the definition of measures of inequality. Normally, such measures reach their extreme values when one individual appropriates the entire income (not simply all the surplus). Such extreme values are obviously just theoretical and devoid of any economic content since no society could function in such a state. That one person who appropriated the entire income would soon be all alone (everyone else having died) and after his death inequality would fall to zero and the society would cease to exist. The inequality possibility frontier avoids this irrelevance by charting maximum values of inequality compatible with the maintenance of a society (however unequal) and thus represents the maximum inequality that is sustainable in the long run. Of course, those at subsistence may revolt and overturn the elite, suggesting that the subsistence level is itself endogenous to more than just equilibrating Malthusian physiological forces.[11, 12]

3. The Data: Social Tables and Pre-Industrial Inequality

Income distribution data based on large household surveys are almost never available for any pre-industrial society. The two main options for gathering fresh inequality data are to measure inequality of non-income indicators of living standards and to seek previously unused measures of income. The first option is already beginning to bear fruit. Scholars are charting the inequality of mortality and of heights. These health inequality measures are valuable in their own right, even though they do not always correlate closely with income inequality.[13]

This article explores the second option, the opportunity to add early data sets on the distribution of income itself. In lieu of surveys, we derive 18 of our 28 estimates of pre-industrial inequalities from what are called *social tables* (or, as William Petty (1690) called them more than three centuries ago, *political arithmetick*) where various social classes or social groups – we use the terms interchangeably – are ranked from the richest to the poorest with their estimated population shares and average incomes.[14] Social tables are particularly useful in evaluating societies where classes were clearly delineated, and the differences in mean incomes between them substantial. Theoretically, if class alone determined one's income and if income differences between classes were large while income differences within classes were small, then all (or almost all) inequality would be explained by the between-class inequality (see the Gini decomposition in (2)). One of the best social table examples is offered by Gregory King's

---

[10] For a more formal proof, see Milanovic *et al.* (2007, Section 2).

[11] Note that in the special case where subsistence is zero, G^* rises to the maximum value of 1 (or 100 in percentage terms). To see this, let $\alpha \to \infty$ in (5) (which is the case if $s = 0$) and apply L'Hospital's rule. Thus the 'usual' Gini is shown to be the special case of our maximum feasible Gini when subsistence is zero.

[12] In the empirical analysis below, we take actual income values for all social classes, including the poorest. The poorest class can, and in some cases will be, above the subsistence.

[13] See Steckel (2009, especially pp. 13–14) and Baten (2000), for examples.

[14] As far as we can determine, the compilers of the social tables did include income in kind produced by the consuming households themselves. Looking at the English source materials in particular, we find that Gregory King and others sought to know what different people consumed and tied their income estimates to that. In addition, the tax returns they often used for their estimates seem to include assessments of owner-occupied housing.

famous estimates for England and Wales in 1688 (Barnett, 1936; Lindert and Williamson, 1982). King's list of classes is fairly detailed (31 social classes) ranging from cottagers and paupers and vagrants, through farmers, lesser and greater traders all the way to temporal lords. King (and others listed in Table 1) did not report inequalities within each social class, so we cannot identify within-class inequalities.

However, within-class inequalities can be roughly gauged by calculating two Gini values: a lower bound Gini1, which estimates only the between-group inequality and assumes within-group or within-social class inequality to be zero; and a higher Gini2, which estimates the maximum within-class inequality compatible with social-tables given mean class incomes still under the assumption that all individuals from a higher social group are richer than any individual from a lower social group. In other words, where class mean incomes are such that $y_j > y_i$, it is also assumed that $y_{kj} > y_{mi}$ for all members of group j, where k and m are subscripts that denote individuals. Thus, in addition to between-class inequality Gini2 includes some within-class inequality but under the strong assumption that all members of a given social class are poorer or richer than those respectively above or below them.[15] (The overlap component L from (2) is thus by construction assumed to be zero.) The differences between the two Ginis are in most cases very small, as the lion's share of inequality is accounted for by the between-class component (see Table 2). This means that our Ginis will be fairly good estimates of inequality for

 (*i*) class-structured societies and
 (*ii*) societies whose social tables are fairly detailed, that is include many social classes.

If (*i*), then the overlap should be expected to be fairly small, as (say) all members of nobility are richer than all artisans, and the latter than all farmers. Similarly, when social tables are detailed (a topic we discuss below), the definitions become fairly precise, and the overlap is less. At the extreme, a social table such that each individual represents a 'social class' would make the overlap equal to zero.

Our Gini would be downward biased in cases where social tables presented only a few classes but in reality each class spanned much of the overall income spectrum. In that case, both Gini1 and Gini2 would miss lots of 'overlap' inequality. However, we believe that such cases are unlikely. When authors of social tables created these tables, their interest was in the salient income cleavages they observed around them. If a society was clearly stratified, it seems likely that these observers would present estimated average incomes for only a few groups; if in contrast, a society was less stratified, it seems likely that the observers would tend to supply estimates for many more social groups (as Gregory King and Joseph Massie did for England and Wales). Thus, the number of salient social groups is likely to vary across societies, and the co-existence of a finely class-gradated society with a social table containing only a few social classes is unlikely.

For ten other societies, we use professional censuses (with provided estimates of mean income per profession), an expenditure survey and data derived from tax censuses.

---

[15] Gini2 is routinely calculated for contemporary income distributions when the data, typically published by countries' statistical offices, are reported as fractiles of the population and their income shares. In that case, however, any member of a richer group must have a higher income than any member of a poorer group. This is unlikely to be satisfied when the fractiles are not income classes but social classes as is the case here. The Gini2 formula is due to Gastwirth (1972) and Kakwani (1980).

Table 1

Data Sources, Estimated Demographic Indicators and GDI Per Capita

Country/Territory	Type of data	Year	Number of classes	Estimated urbanisation rate (in %)	Population (in 000)	Area (in km²)	Population density (person/km²)	Estimated GDI per capita
Roman Empire	Social tables	14	11	10	55,000	3,300,000	16.7	633
Byzantium	Social tables	1000	8	10	15,000	1,250,000	12.0	533
England and Wales	Social tables	1290	7	14.5	4,300	130,000	33.1	639
Tuscany	Professional census	1427	9,780					978
Holland	Tax census dwelling rents	1561	10	45	983	21,680	45.3	1129
England and Wales	Social tables	1688	31	13	5,700	130,000	44.0	1418
Holland	Tax census dwelling rents	1732	10	39	2,023	21,680	93.3	2035
Moghul India	Social tables	1750	4	11	182,000	3,870,000	47.0	530
England and Wales	Social tables	1759	56	16	6,463	130,000	49.7	1759
Old Castille	Income census	1752	33	10	1,980	89,061	22.2	745
France	Social tables	1788	8	12	27,970	550,100	50.8	1135
Nueva España	Social tables	~1790*	3	9.1	4,500	1,224,433	3.7	755
England and Wales	Social tables	1801–3	44	30	9,277	130,000	71.4	2006
Bihar (India)	Monthly census of expenditures	1807	10	10.5	3,362	108,155	31.1	533
Netherlands	Tax census of dwelling rents	1808	20	36.9	2,100	41,865	50.2	1800
Kingdom of Naples	Tax census	1811	12	15	5,000	82,000	61.0	752
Chile	Professional census	1861	32	29	1,702	756,950	2.2	1295
Brazil	Professional census	1872	813	16.2	10,167	8,456,510	1.2	721
Peru	Social tables	1876	15	15	2,469	1,285,000	1.9	653
China	Social tables	1880	3	7	377,500	9,327,420	40.5	540
Java	Social tables	1880	32	3	20,020	126,700	158.0	661
Maghreb	Social tables	1880	8	14.5	5,002	1,074,800	4.7	694
Japan	Tax records	1886	–	15	38,622	377,835	102.2	916
Kenya	Social tables	1914	13	3.9	3,816	582,600	6.5	456
Java	Social tables	1924	14	3	35,170	126,700	277.6	909
Kenya	Social tables	1927	13	4.3	3,922	582,600	6.7	558
Siam	Social tables	1929	21	10	11,605	514,000	22.6	793
British India	Social tables	1947	8	16.5	346,000	3,870,000	89.4	617

* More exactly, 1784–99.

Note. GDI per capita is expressed in 1990 Geary-Khamis PPP dollars (equivalent to those used by Maddison (2003; 2004)). Population density is people per square kilometer. Observations ranked by year.

Sources. For the data sources and detailed explanations, see Appendix Table 1 here; Milanovic *et al.* (2007) or online Appendix available at *http://gpih.ucdavis.edu/ early income distributions.*

© 2010 The Author(s). The Economic Journal © 2010 Royal Economic Society.

Table 1 lists 28 pre-industrial societies for which we have calculated inequality statistics. Appendix Table A1 gives more detailed information on our sources and provides a brief description of their key features. (As already mentioned, the entire dataset is available as an on-line Appendix.) These societies range from early first-century Rome (Augustan Principate) to India in the year of independence from Britain in 1947. Since we assume, somewhat conservatively, an annual subsistence minimum of $PPP 300[16] and, with gross domestic income (GDI) per capita ranging in our sample from about $PPP 450 to just above $PPP 2000, α ranges from about 1.5 to 6.8.[17] A GDI per capita of $PPP 2000 is a level of income not uncommon today, and it would place 1732 Holland or 1801–03 England and Wales in the 40th percentile in the world distribution of countries by per capita income in the year 2000. With the possible exception of 1732 Holland and 1801–3 England, countries in our sample have average incomes that are roughly comparable with contemporary pre-industrial societies that have not yet started significant and sustained industrialisation. The urbanisation rate in our sample ranges from 3% (Java 1880) to 45% (Holland 1561). Population size varies even more, from an estimated 376,000 in 1561 Holland to 350 million or more in India 1947 and China 1880.[18]

The number of social classes into which distributions are divided, and from which we calculate our Ginis, varies considerably. They number only three for 1880 China and for 1784–99 Nueva España (comprising the territories of today's Mexico, parts of Central America, and parts of western US). In most cases, the number of social classes is in the double digits. Understandably, large numbers of groups are found in the case of occupational censuses. Thus, the data from the 1872 Brazilian census include 813 occupations. The largest number of observations is provided in the famous 1427 Florentine (Tuscan) census where income data for almost 10,000 households are available. These large differences in the numbers of groups have little effect on the measured Gini1 and Gini2 values.

The estimated inequality statistics are reported in Table 2. The calculated Gini2s display a very wide range: from 24.5 in China 1880 to 63.5 in Nueva España 1784–99 and 63.7 in Chile 1861. The latter figure is higher than the inequality reported for some of today's most unequal countries like Brazil and South Africa. The average Gini2

---

[16] All dollar data, unless indicated otherwise, are in 1990 Geary-Khamis PPP dollars.

[17] The subsistence minimum of $PPP 300 is less than Maddison's (1998, p.12) assumed subsistence minimum of $PPP 400 which, in principle, covers more than physiological needs. Note that a purely physiological minimum 'sufficient to sustain life with moderate activity and zero consumption of other goods' (Bairoch, 1993, p.106) was estimated by Bairoch to be $PPP 80 at 1960 prices. Using the US consumer price index to convert Bairoch's estimate to international dollars yields $PPP 355 at 1990 prices. Our minimum is also consistent with the World Bank absolute poverty line which is 1.08 per day per capita in 1993 $PPP (Chen and Ravallion, 2007, p. 6). This works out to be about $PPP 365 per annum in 1990 international prices. Since more than a billion people are calculated to have incomes less than the World Bank global poverty line, it is reasonable to assume that the physiological minimum income must be less. One may recall also that Colin Clark (1957, pp. 18–23), in his pioneering study of incomes, distinguished between international units (the early PPP dollar) and oriental units, the lower dollar equivalents which presumably hold for subtropical or tropical regions where calorie, housing and clothing needs are considerably less than in temperate climates. Since our sample includes a fair number of tropical countries, this gives us another reason to use a conservatively low estimate of the physiological minimum.

[18] Income (GDI per capita) data are from Maddison (2003, 2004), and most of urbanisation data from Bairoch (1985). We are aware that both sources are controversial but they simply provide the most consistent single source of the data. Since the objective of this article is different, we do not enter here into a discussion of their merits or defects.

Table 2

Inequality Measures

Country/Territory year	Gini1	Gini2	Mean income in terms of s (s = $300)	Maximum feasible Gini (IPF)	Inequality extraction ratio (in %)*
Roman Empire 14	36.4	39.4	2.1	52.6	75.0
Byzantium 1000	41.0	41.1	1.8	43.7	94.1
England & Wales 1290	35.3	36.7	2.1	53.0	69.2
Tuscany 1427		46.1	3.3	69.3	66.6
Holland 1561		56.0	3.8	73.4	76.3
England & Wales 1688	44.9	45.0	4.7	78.8	57.1
Holland 1732	61.0	61.1	6.8	85.2	71.7
Moghul India 1750	38.5	48.9	1.8	43.4	112.8
Old Castile 1752	52.3	52.5	2.5	59.7	88.0
Eng1and & Wales 1759	45.9	45.9	5.9	82.9	55.4
France 1788	54.6	55.9	3.8	73.5	76.1
Nueva España ~1790		63.5	2.5	60.2	105.5
England & Wales 1801	51.2	51.5	6.7	85.0	60.6
Bihar (India) 1807	32.8	33.5	1.8	43.7	76.7
Netherlands 1808	56.3	57.0	6.0	83.3	68.5
Naples 1811	28.1	28.4	2.2	52.9	53.7
Chile1861	63.6	63.7	4.3	76.8	83.0
Brazil 1872	38.7	43.3	2.4	58.3	74.2
Peru 1876	41.3	42.2	2.2	54.0	78.1
Java 1880	38.9	39.7	2.2	54.6	72.8
China 1880	23.9	24.5	1.8	44.4	55.2
Maghreb 1880	57.0	57.1	2.3	56.7	100.6
Japan 1886		39.5	3.1	67.2	58.8
Kenya 1914	33.1	33.2	1.5	34.2	96.8
Java 1924	31.8	32.1	3.0	66.9	48.0
Kenya 1927	41.6	46.2	1.9	46.2	100.0
Siam 1929	48.4	48.5	2.6	62.1	78.1
British India 1947	48.0	49.7	2.1	51.3	96.8
Average	*44.8*	*45.7*	*3.1*	*61.2*	*76.8*
Modern counterparts					
Italy 2000		35.9	62.5	98.3	36.5
Turkey 2003		43.6	22.0	95.4	45.7
United Kingdom 1999		37.4	66.1	98.4	38.0
Netherlands 1999		28.1	72.0	98.5	28.5
India 2004		32.6	6.4	84.2	38.7
Spain 2000		33.0	50.9	97.9	33.7
France 2000		31.2	69.4	98.4	31.7
Mexico 2000		53.8	24.1	95.7	56.2
Chile 2003		54.6	33.7	96.6	56.4
Brazil 2002		58.8	13.9	92.7	63.4
Peru 2002		52.0	12.3	91.8	56.7
Kenya 1998		44.4	4.5	77.6	57.2
Indonesia 2002		34.3	10.7	90.5	37.9
China 2001		41.6	11.5	91.2	45.6
Japan 2002		26.0	70.2	98.5	26.4
Thailand 2002		50.9	21.3	95.2	53.5
Average		*41.1*	*34.6*	*93.8*	*44.1*
Other contemporary countries					
South Africa 2000		57.3	14.7	93.1	61.6
United States 2000		39.9	77.7	98.6	40.5
Sweden 2000		27.3	52.2	98.0	27.9
Germany 2000		30.3	62.0	98.3	30.8

Table 2
(*Continued*)

Country/Territory year	Gini1	Gini2	Mean income in terms of s (s = $300)	Maximum feasible Gini (IPF)	Inequality extraction ratio (in %)*
Nigeria 2003		42.1	3.0	66.7	63.1
Congo, D.R., 2004		41.0	1.5	33.3	123.1
Tanzania 2000		34.6	1.8	44.4	77.9
Malaysia 2001		47.9	26.0	96.1	49.9

* Calculated using Gini2, and dividing by maximum feasible Gini.
Note. Modern counterpart Ginis (except for Japan and China) calculated from individual-level data from national household surveys obtained from Luxembourg Income Survey and World Income Distribution (WYD) database benchmark year 2002 (see *http://econ.worldbank.org/projects/inequality*). Ginis for Japan and China calculated from published grouped data. Pre-industrial societies ranked by year.
Sources. See Table 1.

from these 28 data points is 45.7, while the average Gini from the modern counterpart countries is 41.1.[19] These are only samples, of course, but there is very little difference on average between them, 45.7 (pre-industrial) – 41.1 (modern counterparts) = 4.6.[20] In contrast, there are very great differences within each sample: 58.8 (Brazil 2002) – 26.0 (Japan 2002) = 32.8 among the modern counterparts, while 63.5 (Nueva España 1784–99) – 24.5 (China 1880) = 39 among the pre-industrial economies. In short, inequality differences within the pre-industrial and modern samples are many times greater than are differences between their averages.

The Gini estimates are plotted in Figure 2 against the estimates of GDI per capita. They are also displayed against the *inequality possibility frontier* constructed on the assumption of a subsistence minimum of $PPP 300 (solid line). In most cases, the calculated Ginis lie fairly close to the IPF. In terms of absolute distance, the countries farthest below the IPF curve are the most 'modern' pre-industrial economies: 1561–1808 Holland and the Netherlands, 1788 France, and 1688–1801 England and Wales.

How do country inequality measures compare with the maximum feasible Ginis at their estimated income levels? Call the ratio between the actual inequality (measured by Gini2) and the maximum feasible inequality the *inequality extraction ratio*, indicating how much of the maximum inequality was actually extracted: the higher the *inequality extraction ratio*, the more (relatively) unequal the society.[21] The median and mean inequality extraction ratios in our pre-industrial sample are 75.5% and 76.8%, respectively. Thus, three-quarters of maximum feasible inequality was actually 'extracted' by the top income groups in our pre-industrial sample. The countries with the lowest ratios are 1924 Java and 1811 Kingdom of Naples with extraction ratios of 48% and 54%, respectively.

---

[19] The modern counterpart countries are defined as countries that currently cover approximately the same territory as the pre-industrial countries (e.g., Turkey for Byzantium, Italy for Rome, Mexico for Nueva España, modern Japan for pre-industrial Japan, and so on).

[20] The hypothesis of equality of the two means is accepted (t-test significant at 16% only).

[21] The term 'relative' is used here, *faute de mieux*, to denote conventionally calculated inequality in relation to maximum possible inequality at a given level of income, not whether the measure of inequality itself is relative or absolute.
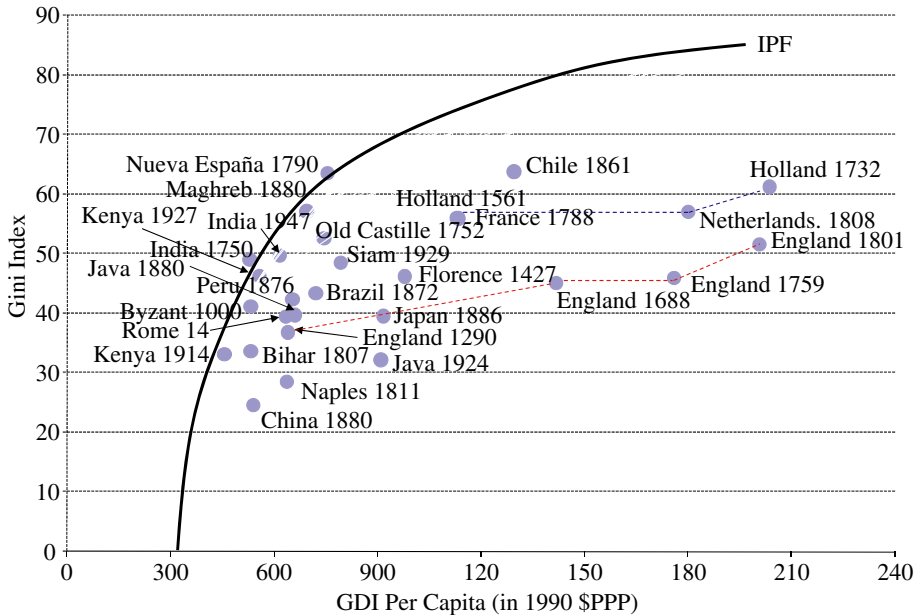
© 2010 The Author(s). The Economic Journal © 2010 Royal Economic Society.

Fig. 2. *Pre-industrial Inequalities: Estimated Gini Coefficients, and the Inequality Possibility Frontiers*

Note. The solid IPF line is constructed on the assumption that $s = \$PPP\ 300$. The Gini index is estimated by Gini2.

Four estimated Ginis are equal to or slightly greater than the maximum Gini implied by the IPF: Moghul India 1750 (an extraction ratio of 113%), Nueva España 1790 (an extraction ratio of 106%), and Kenya in 1927 and Maghreb in 1880 (an extraction ratio of almost exactly 100%). All four were colonies ruled by four different powers. These violations of the 'maximum feasible' definition of the IPF might be due to measurement errors or might reflect the possibility that some people can live below subsistence temporarily. The measurement errors could be of three types: mis-measuring national product per capita, mismeasuring inequality or applying the wrong (too high) subsistence to these few cases.[22] In the case of Moghul India and Nueva España, a portion of the population might have been expected to die from hunger, exhaustion due to forced and underpaid labour or lack of elementary shelter. Poor people's income often does, in any given month, or even year, fall below the minimum and they survive by borrowing or selling their assets. Still, the same individuals cannot, by definition, stay below subsistence for long. The fact that the only two societies in our sample exhibiting a ratio higher than 100%, 1750 Moghul India and 1790 Nueva España, were notoriously exploitative seems consistent with this explanation.

---

[22] The measurement error is made more likely by the fact that the extraction ratio is a ratio of two numbers each calculated with significant amount of uncertainty: Gini, and maximum Gini which depends on estimate of mean income.

The observations for England and Wales, and Holland/Netherlands – the only countries for which we have at least three pre-industrial observations – are connected to highlight their historical evolution of inequality relative to the IPF (see Figure 2). Between 1290 and 1688, and particularly between 1688 and 1759, the slope of the increase of the Gini in England and Wales was significantly less than the slope of the IPF. The English inequality extraction ratio dropped from about 69% in 1290, to 57% in 1688 and to about 55% in 1759. However, between 1759 and 1801, the opposite happened: the extraction ratio rose to almost 61%. Or consider Holland/Netherlands between 1732 and 1808. As average income decreased (due to the Napoleonic wars), so too did inequality but the latter even more so. Thus, the extraction ratio decreased from around 72% to 68%.

The *inequality possibility frontier* allows us to situate these pre-modern inequality estimates better in the modern experience. Using the same framework that we have just applied to earlier societies, the bottom panel of Table 2 provides estimates of inequality extraction ratios for 25 contemporary societies. Brazil and South Africa have often been cited as examples of extremely unequal societies. Indeed, both countries display Ginis comparable to those of the most unequal pre-industrial societies. But Brazil and South Africa are several times richer than the richest pre-industrial society in our sample, so that the maximum feasible inequality is much higher than anything we have seen in our pre-industrial countries sample. Thus, the top income groups in both countries have extracted only a little more than 60% of their countries' maximum inequality and their inequality extraction ratios are about the same as what we found among the *less* exploitative pre-industrial societies (1801–3 England and Wales, and 1886 Japan).

In the year 2000, countries near the world median GDI per capita (about $PPP 3500) or near the world mean population-weighted GDI per capita (a little over $PPP 6000), had maximum feasible Ginis of 91 and 95 respectively. The median Gini in today's world is about 35. Thus a 'representative' country has extracted just a bit less than 40% of feasible inequality, vastly less than did pre-industrial societies. For the modern counterparts of our pre-industrial societies, the ratio is 44% (Table 2). China's present *inequality extraction ratio* is almost 46%, while that for the US is near 40% and that for Sweden is less than 28%. Only in the extremely poor countries today, with GDI per capita less than $PPP 600, do actual and maximum feasible Ginis lie close together (2004 Congo Democratic Republic, and 2000 Tanzania).[23] Compared with the maximum inequality possible, today's inequality is *much* smaller than that of pre-industrial societies.

It could be argued that our new *inequality extraction ratio* measure reflects societal inequality, and the role it plays, more accurately than any actual inequality measure. For example, Tanzania (denoted TZA in Figure 3) with a relatively low Gini of about 35 may be less egalitarian than it appears since measured inequality lies fairly close to its *inequality possibility frontier* (Table 2 and Figure 3). On the other hand, with a much higher Gini of almost 48, Malaysia (MYS) has extracted only about one-half of maximum inequality and thus is farther away from the IPF. This new view of inequality

---

[23] Actually, the extraction ratio for Congo is in excess of 100%. It is very likely that Congo's real income ($PPP 450 per capita) is underestimated. But even so, the extraction ratio would be close to 100%.
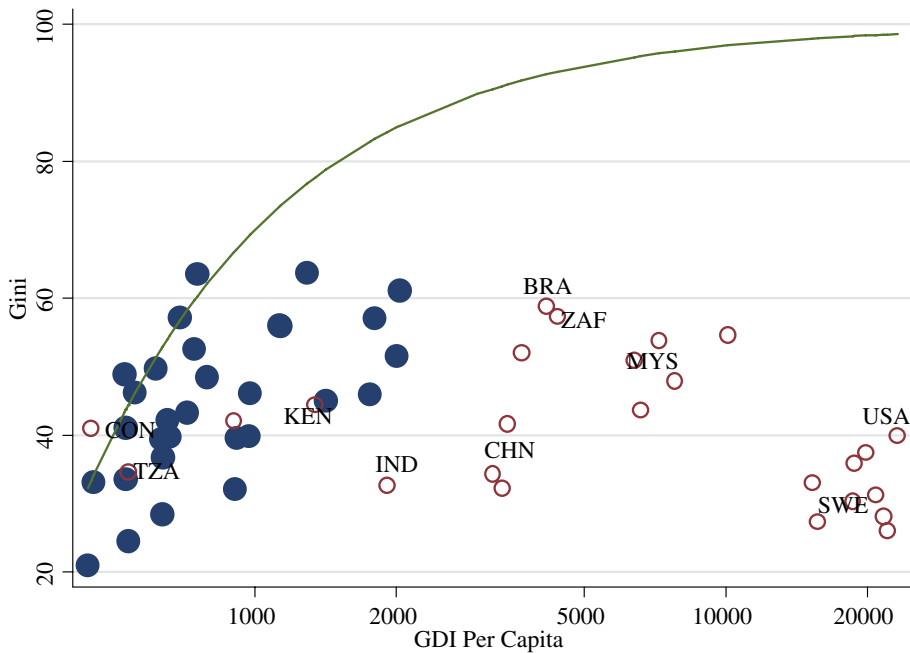
Fig. 3. *Ginis and the Inequality Possibility Frontier for the Pre-industrial Society Sample and Selected Modern Societies*
Note. Modern societies are drawn with hollow circles. IPF drawn on the assumption of $s = \$PPP\ 300$ per capita per year. Horizontal axis in logs.

may be more pertinent for the analysis of power and conflict in both pre-industrial and modern societies.

Another implication of our approach is that it considers inequality and development jointly. As a country becomes richer, its feasible inequality expands. Consequently, even if recorded inequality is stable, the *inequality extraction ratio* must fall; and even if recorded inequality goes up, the extraction ratio may not. This can be seen in Figure 4 where we plot the inequality extraction ratio against GDI per capita for both pre-industrial societies and their modern counterparts. Economic development offers this positive message: the *inequality extraction ratio* will fall with GDI per capita growth even if measured inequality remains constant. However, economic decline offers the opposite message: a decline in GDI per capita, like that registered by Russia in the early stages of its transition from communism, drives the country's maximum feasible inequality down. If the measured Gini had been stable, the *inequality extraction ratio* would have risen. If the measured Gini rose (as was indeed the case in Russia), the *inequality extraction ratio* would have risen even more sharply. Rising inequality may be particularly socially disruptive under these conditions.

4. Conclusions

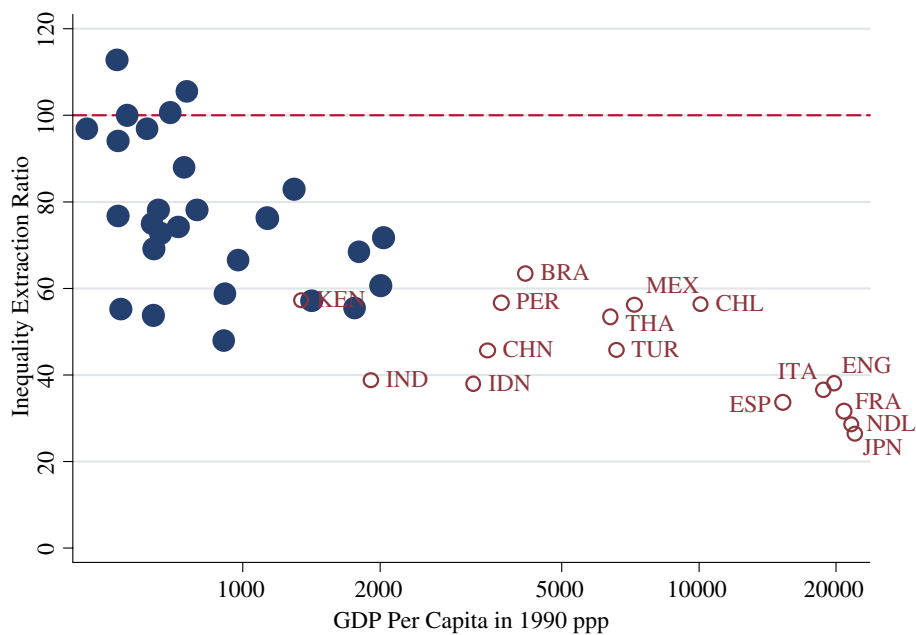Our exploration of pre-industrial history has uncovered two key aspects of early inequality.

Fig. 4. *Inequality Extraction Ratio for the Pre-industrial Society Sample and their Counterpart Modern Societies*

Note. Modern societies are drawn with hollow circles. Horizontal axis in logs. Inequality extraction ratio shown in percentages.

First, income inequality in pre-industrial countries today is not very different from inequality in distant pre-industrial times.[24] In addition, the variance of inequality among countries then and now is similar, and this variance is much greater than any difference in average inequality between them then and now. Simply put, both the dispersion and the mean of inequality statistics across countries, at pre-industrial times and today, are similar.

Second, the *extraction ratio* – how much of potential inequality was converted into actual inequality – was significantly bigger then than now. We are persuaded that much more can be learned about inequality in the past *and* the present by looking at the *extraction ratio* rather than just at actual inequality. The ratio offers a different perspective on how powerful, repressive and extractive were the ruling groups, their institutions and policies. In growing economies, the extraction ratio can fall even as Gini or Theil-measured inequality increases. But in a declining economy, a given measured inequality translates into greater extraction ratio. By a different route, we thus reach again the conclusion about the indispensability of economic growth for social stability.

---

[24] However, it seems likely that any measure of lifetime income inequality (as opposed to annual income inequality used here) would confirm that past pre-industrial inequalities were higher than modern pre-industrial inequalities. There has been an immense convergence in mortality and morbidity by social class in even poor countries since the First Industrial Revolution in Britain, and most of this was induced by policy directed towards cleaner cities and public health.

© 2010 The Author(s). The Economic Journal © 2010 Royal Economic Society.

Appendix

Table A1

More Detailed Information about the Data Sources

Country/ Territory	Type of data	Year	Authors and/or source	Short description of the dataset
Roman Empire	Social tables	14	Scheidel and Friesen (2009), based also on Goldsmith (1984), Temin (2003, 2006).	Full social table with estimated incomes and population. More reliable income estimate for the top income classes thanks to wealth census requirements for senators and others.
Byzantium	Social tables	1000	Milanovic (2006)	Full social table with incomes and population.
England and Wales	Social tables	1290	Campbell (2007)	Full social table with estimated incomes and population.
Tuscany	Professional census	1427	Lindert's elaboration based on Herlihy and Klapisch-Zuber (1985).	Based on a large contemporary census. Capital incomes obtained from the census data, labour incomes estimated from de la Roncière (1982), Goldthwaite (1980), and Malanima (2002).
Holland	Tax census by dwelling rents	1561	van Zanden (1995)	Income estimates derived from housing rents.
England and Wales	Social tables	1688	Lindert and Williamson (1982) based on Gregory King social table	Full social table with estimated incomes and population.
Holland	Tax census by dwelling rents	1732	de Vries and van der Woude (1997)	Income estimates derived from housing rents.
Moghul India	Social tables	1750	Maddison (1971, 2003, 2004)	A short social tables with estimated incomes and population. Includes colonisers' incomes.
England and Wales	Social tables	1759	Lindert and Williamson (1982) based on Messie's social table.	Full social table with estimated incomes and population.
Old Castille	Income census	1752	Yun Casalilla (1987), Ramos Palencia (2001) and Álvarez-Nogal and Prados de la Escosura (2006)	Detailed survey of family incomes from five provinces (Patredas, Palencia, Frechilla, Villarramiel and Villalpando).
France	Social tables	1788	Morrisson and Snyder (2000)	Full social table with estimated incomes and population.
Nueva España	Social tables	~1790*	Abad y Queipo (1813/1994)	Short social table; includes colonisers' incomes.
England and Wales	Social tables	1801–3	Lindert and Williamson (1982) based on Colquhoun's social table	Full social table with estimated incomes and population.
Bihar (India)	Monthly census of expenditures	1807	Martin (1838)	Contemporary household survey of expenditures.
Netherlands	Tax census of dwelling rents	1808	Soltow and van Zanden (1998, ch. 6)	Incomes estimates derived from housing rents. An expanded sample made available to us by the authors.

Table A1
(*Continued*)

Country/ Territory	Type of data	Year	Authors and/or source	Short description of the dataset
Kingdom of Naples	Tax census	1811	Malanima (2006)	Based on contemporary tax census which placed population in pre-determined income brackets.
Chile	Professional census	1861	Rodríguez Weber (2008)	Detailed census of professions with their estimated incomes and population shares. Differentiates incomes within professions by gender.
Brazil	Professional census	1872	Bértola *et al.* (2006)	Very detailed census of professions with their estimated incomes and population shares.
Peru	Social tables	1876	Berry (1990)	Full social table with estimated incomes and population.
China	Social tables	1880	Chang (1962)	Heavy focus on the richest classes, much less detail about the poor.
Java	Social tables	1880	Booth (1988), van Zanden (2003), with alternative estimates in Leigh and Van der Eng (2009)	Full social table with estimated incomes and population. Includes colonisers' incomes.
Maghreb	Social tables	1880	Amin (1966)	Full social table with estimated incomes and population. Includes colonisers' incomes.
Japan	Tax records	1886	Moriguchi and Saez (2005)	Tax data with the focus on top income groups.
Kenya	Social tables	1914	Bigston (1986, 1987)	Full social table with estimated incomes and population, Includes colonisers' incomes.
Java	Social tables	1924	Booth (1988), van Zanden (2003), with alternative estimates in Leigh and Van der Eng (2009)	Full social table with estimated incomes and population. Includes colonisers' incomes.
Kenya	Social tables	1927	Bigston (1986, 1987)	Full social table with estimated incomes and population. Includes colonisers' incomes.
Siam	Social tables	1929	Zimmerman (1931/1999)	Detailed data by income class. Includes colonisers' incomes.
British India	Social tables	1947	Maddison (1971, 2003, 2004)	A short social table with estimated incomes and population. Includes colonisers' incomes.

* More exactly, 1784–1799.

Note. We use the description 'full social table' for social tables that are well-diversified and include at least ten social groups. 'Short' social table denotes social tables that have only 3 to 5 broad social or income categories. 'Very detailed' indicates the presence of several dozen to several thousand observations on respectively social classes or households' incomes.

For full dataset used in the article please consult on-line Appendix available at http://gpih.ucdavis.edu/early income distributions.

World Bank and University of Maryland
University of California – Davis
Harvard University and University of Wisconsin

References

Abad y Queipo, M. (1813/1994). *Colección de los escritos más importantes que en diferentes épocas dirigió al gobierno* (1813, reprinted in 1994 with an introduction and notes by Guadalupe Jiménez Codinach, México, D. F.: Consejo Nacional para la Cultura y las Artes).

Acemoglu, D., Johnson, S. and Robinson, J. (2001). 'The colonial origins of comparative development: an empirical investigation', *American Economic Review*, vol. 91(5), pp. 1369–401.

Álvarez-Nogal, C. and Prados de la Escosura, L. (2006). 'Searching for the roots of Spain's retardation (1500-1850)', Madrid: Universidad Carlos III Working Papers in Economic History.

Amin, S. (1966). *L'économie de Maghreb*, Paris: Editions de Minuit.

Bairoch, P. (1985). *De Jéricho à Mexico: Villes et Economies dans l'Histoire*, Paris: Arcades, Gallimard.

Bairoch, P. (1993). *Economics and World History: Myths and Paradoxes*, New York: Harvester Wheatsheaf.

Barnett, G.E. (1936). *Two Tracts by Gregory King*, Baltimore: Johns Hopkins University Press.

Baten, J. (2000). 'Economic development and the distribution of nutritional resources in Bavaria, 1797-1839', *Journal of Income Distribution*, vol. 9, pp. 89–106.

Berry, A. (1990). 'International trade, government and income distribution in Peru since 1870', *Latin American Research Review*, vol. 25(2), pp. 31–59.

Bértola, L., Castelnovo, C., Reis, J. and Willebald, H. (2006). 'Income distribution in Brazil, 1839–1939', paper presented at XIV International Economic History Congress, Helsinki, Finland 21-25 August.

Bigston, A. (1986). 'Welfare and economic growth in Kenya, 1914–76', *World Development*, vol. 14(6), pp. 1151–60.

Bigston, A. (1987). 'Income distribution and growth in a dual economy: Kenya 1914-1976', Gothenburg University, Department of Economics, Memorandum No. 101.

Booth, A. (1988). 'Living standards and the distribution of income in colonial Indonesia', *Journal of Southeast Asia Studies* vol. 19(2), pp. 310–34.

Campbell, B. (2007). 'Benchmarking medieval economic development: England, Wales, Scotland and Ireland c. 1290', *Economic History Review*, vol. 60(1), pp. 1–50.

Chang, C.-L. (1962). *The Income of the Chinese Gentry*, Seattle: University of Washington Press.

Chen, S. and Ravallion, M. (2007). 'Absolute poverty measures for the developing world, 1981-2005', Washington DC: World Bank Research Development Group, Policy Research Working Paper No. 4211.

Clark, C. (1957). *The Conditions of Economic Progress*, 3rd edition, London: Macmillan and Co.

de la Roncière, C. (1982). *Prix et Salaires à Florence au XIVe Siècle, 1280-1380*, Palais Farnèse: École Française de Rome, pp. 394–5.

Deininger, K. and Squire, L. (1996). 'A new data set measuring income inequality', *World Bank Economic Review* vol. 10(3), pp. 565–91.

de Vries, J. and van der Woude, A. (1997). *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy, 1500–1815*, New York: Cambridge University Press.

Engerman, S., Haber, S. and Sokolof, K. (2000). 'Institutions, factor endowments, and paths of development in the new world', *Journal of Economic Perspectives*, vol. 14(3), pp. 217–32.

Engerman, S. and Sokoloff, K. (1997). 'Factor endowments, institutions, and differential paths of growth among new world economies', in (S. Haber, ed.), *How Latin America Fell Behind*, pp. 260–304, Palo Alto, California: Stanford University.

Gastwirth, J.L. (1972). 'The estimation of the Lorenz curve and Gini index', *Review of Economics and Statistics*, vol. 54(3), pp. 306–16.

Goldsmith, R.W. (1984). 'An estimate of the size and structure of the national product of the early Roman Empire', *Review of Income and Wealth*, vol. 30(3), pp. 263–88.

Goldthwaite, R.A. (1980). *The Building of Renaissance Florence*, Baltimore: The Johns Hopkins University Press.

Herlihy, D. and Klapisch-Zuber, C. (1985). *Tuscans and Their Families*, New Haven: Yale University Press.

Kakwani, N. (1980). *Income, Inequality and Poverty: Methods of Estimation and Policy Applications*, Oxford and Washington DC: Oxford University Press and World Bank.

Kuznets, S. (1955). 'Economic growth and income inequality', *American Economic Review*, vol. 45(1), pp. 1–28.

Leigh, A. and van der Eng, P. (2009). 'Top incomes in Indonesia, 1920–2004', in (A.B. Atkinson and T. Piketty, eds), *Top Incomes Over the Twentieth Century: Volume II – A Global Perspective*, pp. 171–219, Oxford: Oxford University Press.

Lindert, P.H. and Williamson, J.G. (1982). 'Revising England's social tables, 1688-1812', *Explorations in Economic History*, vol. 19(4), pp. 385–408.

Lindert, P.H. and Williamson, J.G. (1985). 'Growth, equality, and history', *Explorations in Economic History*, vol. 22(4), pp. 341–77.

Maddison, A. (1971). *Class Structure and Economic Growth: India and Pakistan since the Moghuls*, London: Allen and Unwin.

Maddison, A. (1998). *Chinese Economic Performance in the Long Run*, Paris: OECD Development Centre.

Maddison, A. (2003). *The World Economy: Historical Statistics*, Paris: OECD Development Centre.

Maddison, A. (2004). 'World population, GDP and per capita GDP, 1-2001 AD', http://www.ggdc.net/Maddison/content.shtml (accessed November 10, 2009).

Malanima, P. (2002). *L'economia Italiana: Dalla Crescita Medievale alla Crescita Contemporanea*, Bologna: Società editrice il Mulino.

Malanima, P. (2006). 'Pre-modern equality: income distribution in the Kingdom of Naples (1811)', paper presented at XIV International Congress of Economic History, August 2006, Helsinki, available at http://www.helsinki.fi/iehc2006/papers3/Malanima.pdf.

Martin, R.M. (1838). *The History, Antiquities, Topography, and Statistics of Eastern India*, London: WH Allen and Co.

Milanovic, B. (2006). 'An estimate of average income and inequality in Byzantium around year 1000', *Review of Income and Wealth*, vol. 52(3), pp. 449–70.

Milanovic, B., Lindert, P.H. and Williamson, J.G. (2007). 'Measuring pre-industrial inequality', NBER Working Paper No. 13550, Cambridge, MA: National Bureau of Economic Research.

Moriguchi, C. and Saez, E. (2005). 'The evolution of income concentration in Japan, 1885-2002: Evidence from income tax statistics', unpublished, University of California, Berkeley.

Morrisson, C. and Snyder, W. (2000). 'The income inequality of France in historical perspective', *European Review of Economic History*, vol. 4, pp. 59–83.

Petty, W. (1690; written circa 1676). *Political Arithmetick, or, A Discourse Concerning the Extent and Value of Lands, People, Buildings . . .* , London: Clavel and Mortlock.

Piketty, T. (2005). 'Top income shares in the long run: an overview', *Journal of European Economic Association*, vol. 3(2-3), pp. 1–11.

Piketty, T. and Saez, E. (2006). 'The evolution of top incomes: a historical and international perspective', NBER Working Paper No. 11955, Cambridge, MA: National Bureau of Economic Research.

Ramos Palencia, F. (2001). 'Pautas de consume familiar en la Castilla Preindustrial: El consume de bienes duraderos y semiduraderos en Palencia 1750–1850', University of Valladolid doctoral thesis.

Rodríguez Weber, J.E. (2008). 'Una aproximación a la distribución del ingreso en Chile para el período 1860-1930, en perspectiva comparada', conference 'Crecimiento económico y distribución del ingreso y la riqueza en América Latina, siglos XIX y XX', Montevideo, Uruguay.

Scheidel, W. and Friesen, S.J. (2009). 'The size of the economy and the distribution of income in the Roman Empire', *Journal of Roman Studies*, vol. 99(1), pp. 61–91.

Soltow, L. and van Zanden, J.L. (1998). *Income and Wealth Inequality in the Netherlands, 16th-20th Century*, Amsterdam: Het Spinhuis.

Steckel, R.H. (2009). 'Heights and human welfare: recent developmentsand new directions', *Explorations in Economic History*, vol. 46(1), pp. 1–23.

Temin, P. (2003). 'Estimating GDP in the early Roman Empire', paper presented at the conference 'Innovazione tecnica e progresso economico nel mondo romano' organized by Elio Lo Cascio (April 13-16).

Temin, P. (2006). 'The economy of the early Roman Empire', *Journal of Economic Perspectives*, vol. 20(1), pp. 133–51.

van Zanden, J.L. (1995). 'Tracing the beginning of the Kuznets curve: western Europe during the early modern period', *Economic History Review*, vol. 48(4), pp. 643–64.

van Zanden, J.L. (2003). 'Rich and poor before the industrial revolution: a comparison between Java and the Netherlands at the beginning of the 19th Century', *Explorations in Economic History*, vol. 40(1), pp. 1–23.

Yun Casalilla, B. (1987). 'Sobre la transición al capitalismo en Castilla: economía y sociedad en Tierra de Campos 1500–1830', doctoral thesis at the University of Salamanca.

Zimmerman, C.C. (1999). *Siam Rural Economic Survey 1930–31*, Bangkok: White Lotus Press; originally published in 1931, New York: Putnam's.