TECHNOLOGY, INSTITUTIONS, AND WEALTH INEQUALITY OVER ELEVEN MILLENNIA

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Summary:

To better understand the determinants of economic disparities among households and their long term evolution we study wealth inequalities over the past 11 millennia, measured so as to be comparable across differing asset types and demographic structures. The unparalleled temporal scope of these new data allows us to assess inequality under widely varying technologies and politico-economic institutions.

We find that (with few exceptions) wealth disparities vary remarkably little among these differing economies. They are no less in modern democratic and capitalist economies than in the autocratic societies of the past, excepting slave economies; the only populations with notably less inequality are those without a state organization exercising a monopoly on the use of force.

We conjecture that where material wealth is less important as a factor of production (as in many of the non state populations) it will be less unequally distributed.

Predictions of future economic inequality include both substantial declines and the opposite, exemplified by the prominent works of Kuznets and Piketty, respectively.[1,2] These and other conjectures about trends in economic inequality are generally based on historical studies of past trends, along with models allowing predictions using expected movements in the influences on inequality.

Technology, institutions and inequality. Stressing technology and environment as determinants of inequality, some economists derive hypotheses about inequality from the characteristics of a production function.[3,4] Similarly, the predictions concerning inequality among non-human animals by behavioral ecologists derive from the nature of the goods constituting the livelihood of a population, for example clumped or dispersed resources.[5-7] Economists and behavioral ecologists alike would anticipate changes in inequality to be associated with major developments in methods of production such as the increased capital intensity of production brought about by machine-based production during the industrial revolution or changes in the source of one's livelihood such as the prehistoric shift from wild to cultivated and tended plant and animal species.[8-10]

By contrast, many historians,[11-13] sociologists of the "conflict" school[14,15] and others[16-18] focus on institutions and politics. For these scholars, the key to understanding the evolution of economic inequality is change in the distribution of political power, such as that which occurred due to the increasing domain of private property and the emergence of states by the Bronze Age, or the demise of slavery and feudalism and the rise of liberal democracy with universal suffrage as a form of rule.

Empirical investigations of the ways in which these two sets of influences affect the degree of economic inequality are hampered by the limited span of the available data. Even the best data sets from Kuznets in the 1950s to Atkinson, Piketty and their co-authors recently cover at most a few centuries in economies that, seen from the perspective of world history and prehistory, are quite similar in both institutions and technologies.[1,2,19]

Here we broaden the range of variation of the determinants of inequality by studying inequalities in material wealth in economies with vastly different technologies and institutions. The technologies on which the economies we study are based range from hunting and gathering, horticulture (low technology land abundant farming), agriculture, and manufacturing as well as modern service-based economies. The institutions governing these economies include common ownership of land, ancient slavery, early modern centralized authoritarian systems and urban economies, and capitalist economies governed by democratic states.

Comparing measures of wealth inequality. We measure between-family wealth disparities by the Gini coefficient, a measure based on the entire distribution of wealth that ranges from zero (all households have identical wealth) to 1 (all wealth is held by a single household). Our data set complements that of Milanovic, Lindert, and Williamson on ancient income inequality[20] in that we measure a different dimension of inequality – wealth (a stock of assets) rather than income (a flow of services making up a household's living standards). Our data are on individual households, while Milanovic and his co authors construct inequality measures indirectly, using estimates of the size and average incomes of population sub-groups.

Our measures of material wealth include the extent of land owned, taxable urban property, size of homes and extent of stored food, and wealth included in burials, as well as conventional modern measures of net worth. To compare wealth inequality across our time period or among differing economic and political institutions we would ideally have estimates based on the same type of asset, unit of observation, and population size.

Lacking a common measure of material wealth over our long temporal domain, we adjust our estimates so that they measure inequality in the same hypothetical benchmark with a common population size (1000 households), unit of observation (household) and asset type (household wealth). Statistical methods and sources are described in full in our online supplementary information.[21]

First, we need to convert individual level data to household equivalents when we do not know which individuals were paired in households, as is often the case with burial wealth. To do this we simulate a large number of hypothetical couples by matching males and females under a range of assumptions concerning the degree of wealth assortment in marriage. Household wealth is the sum of the wealth of the paired individuals.

Second, some measures of wealth – house size, for example – are more equally distributed than others – burial wealth for example. To develop comparable measures for the different asset types we exploit cases in which we have measures of multiple forms of wealth in a single population to convert measures based on different wealth types to a common form of wealth.

Third, because larger populations may include greater geographical and social heterogeneity, and as a reason may exhibit greater wealth inequality, we adjust all observations to a hypothetical common benchmark population size. We address this problem using a quasi-experimental technique, exploiting three nested data sets – for medieval Finland, 19th century U.S. and a group of hunter-gatherers in pre-European contact North America -- in which we can estimate wealth inequality at the level of both a larger entity (a district, e.g.) and the lower level entities (the villages that constitute the district).

The thought experiment motivating our method is to imagine that we had data on wealth inequality in just one of the villages constituting a district and that we wanted an estimate of inequality in the district or some other larger population unit. The difference between the village and district inequality measures and populations is then the basis for our estimate of the scale effect at that level of population.

Wealth inequality over 11 millennia. Our comparability-adjusted data appear in Figure 1. Given the extraordinary differences in both technologies and economic and political institutions over this long period the generally high levels of inequality is something of a surprise. The mean Gini coefficient for the entire period is 0.68 which is to say that the mean difference between all pairs of households in the population is 1.36 times the average wealth level. A Gini coefficient of this magnitude describes an economy of 10 individuals one of whom owns three quarters of the land, the rest owning a quarter of the total acreage in total.

As surprising as the magnitude of these estimates is the similarity (with few exceptions) of wealth inequality across quite different social structures. Analysis using crude categories to capture differences in political and economic institutions, as can be seen in Figure 2, yields small differences in the level of material wealth inequality.

Societies without states are the major exception to the lack of distinctiveness of the institutional categories that we have used. We have identified 17 societies in which on the basis of the historical and archaeological evidence available it seems likely that there was no specialized cadre of individuals with a monopoly on the legitimate use of violence. Average wealth inequality in these non-state societies is less than two thirds the level of the state societies (*p* = .0001)

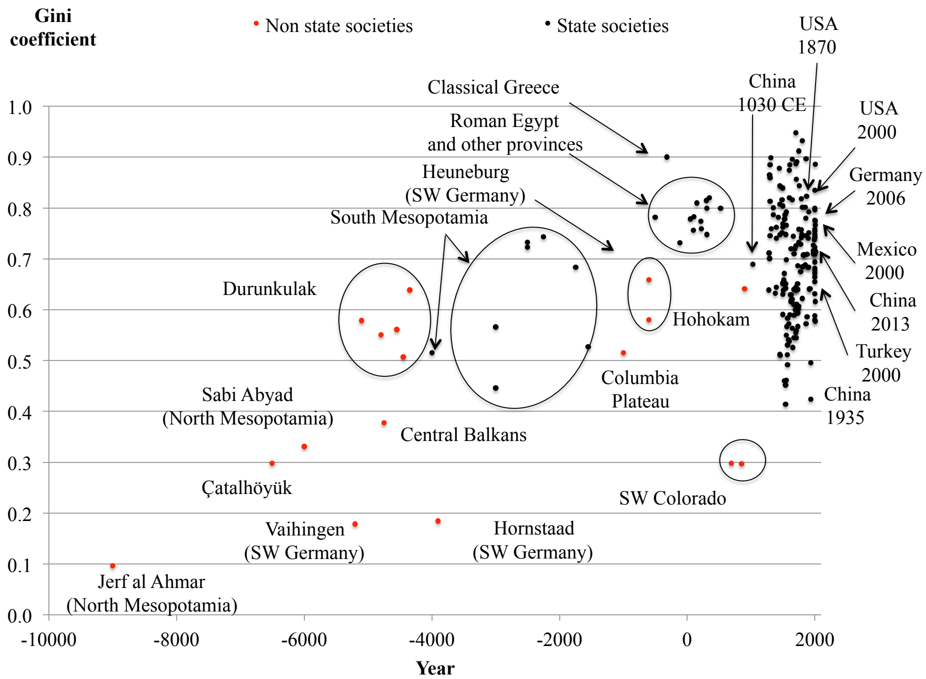

Figure 1. **Gini coefficients for material wealth**. Corrected for comparability with respect to household composition, asset type and population size.[21]

A less striking exception is the greater wealth disparity in the slave economies (including Roman Egypt, 18th century South Africa, 18th century Brazil, and the Confederate states of the U.S. prior to the Civil War.) The greater inequality in these economies, on average 0.092 Gini points more than the other state societies ($p < 0.001$), is consistent with our estimates of the effect of the abolition of slavery based on a comparison of slave and non-slave states before and after the Civil War.[22]

What we term "democratic and capitalist" societies are characterized by civil liberties, political competition and the absence of substantial restrictions of the right to vote and a market economy based on the employment of labor by privately owned profit making firms. In our data set they are a bit more unequal (0.023 Gini points; $p=0.07$) than the other state (non slave) economies The Gini coefficient for wealth in Sweden, for example, is substantially greater in recent years than was four centuries ago and also just prior to the advent of democratic rule early in the 20th century. The same is true of Finland in recent years compared to two centuries ago.

European wealth inequality over 7 centuries. Our data set allows us to explore long term trends in wealth inequality in a region that has a rich tradition of historical analysis of institutions, technology and other influences on wealth disparities. Our data are not sufficient to make inferences about trends within most localities or nations, but they suggest three distinct periods for the region as a whole.

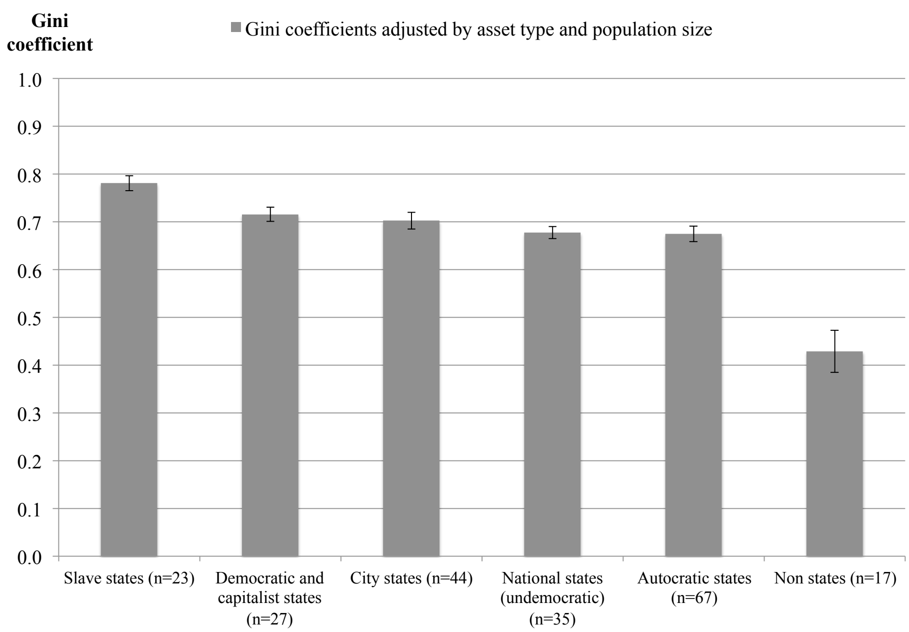

Figure 2. **Gini coefficients across different political institutions.** Error bars are the standard errors of the average Gini coefficients in each institutional category.[21]

Population declines, in some cases predating the bubonic plague in 1348 and recurring with subsequent plagues in the next two a half centuries, affected the entire region, lowering the supply of labor relative to land and other forms of material wealth.[23,24] The effect broadly was to increase the bargaining power of labor – both employees and landless or land poor farmers -- vis a vis the owners of material wealth.

Throughout the region, the prices of agricultural goods relative to the manufacturing goods fell and real wages rose.[25,26]

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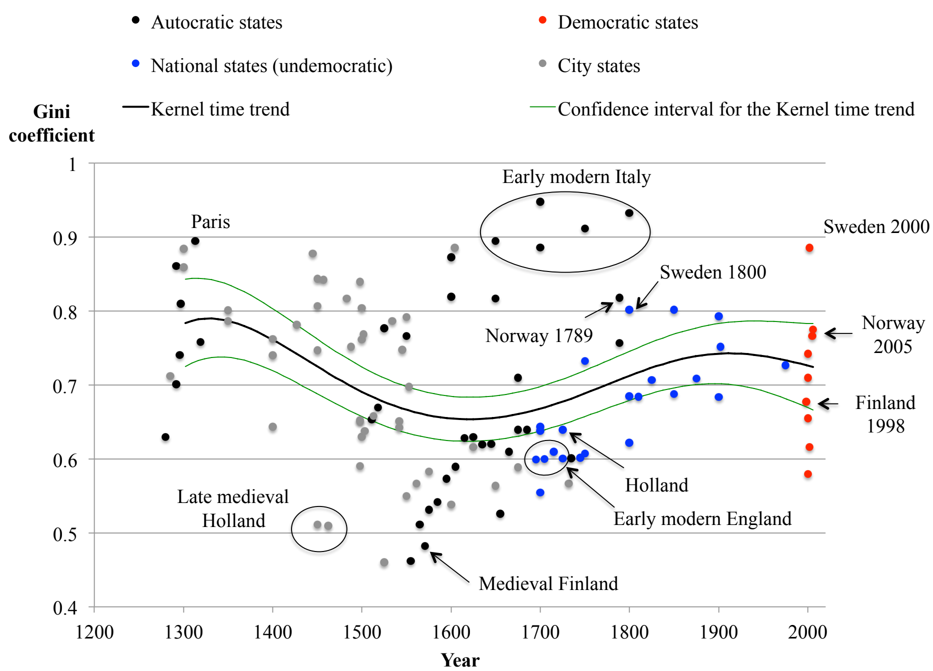

Figure 3. **Wealth inequality in Europe since 1250.** The data points are comparability adjusted Gini coefficients. The black line is a kernel trend estimate; the green lines are confidence intervals.

Labor scarcity persisted as a result of extensive mortality in warfare and increased trade and urbanization, which increased the reach and severity of epidemics.[27] The diffusion in northern Europe of norms of increased labor force participation by women and delayed marriage, termed the European Marriage Pattern,[28,29] also delayed the demographic recovery, keeping labor scarce and real wages high. In addition, where the bargaining power of those with less wealth was considerable, as in 1380s England,[30] increased wages and peasant incomes were stabilized by the emergence of new social norms and less unequal relationships between the landed and the land-poor, allowing for a prolonged phase of reduced wealth inequality in Europe.[11]

This trend reversed around the beginning of the 17^{th} century, consistent with recent studies on early modern European regional inequality.[2,31,32] A key development was the recovery of population and labor supply,[33,34] but unlike the regionally uniform positive impact of labor shortages on wages following the plagues, the impact of greater labor supply was uneven.

In southern, central and eastern Europe, wages fell as population recovered. But in the northwestern areas wages had come to be substantially delinked from demographic movements. The fact that in London, Amsterdam and other parts of northwestern Europe wages responded little to the increase in labor supply may reflect the institutionalization of the gains in bargaining power that the less well off had achieved under the preceding period of labor shortage.[35]

While incomes of the non-wealthy were sustained in the northwestern regions, wealth disparities increased even in those areas, most likely in response to two developments stressed by historians of the period. The Atlantic trade in sugar and other commodities allowed the accumulation of extraordinary wealth in some countries.[36,37] It also reduced the cost of calories, dampening upward pressures on the wage, as some of the economies in the northwest expanded rapidly under the joint effects of the commercial and then industrial revolutions.[38] Also contributing to the dis-equalizing trend, the accelerating introduction of labor-saving technologies raised output per worker while avoiding labor shortages that might have allowed workers to raise their real wages.[39]

Central, eastern and southern European regions experienced an even more drastic drop of the wage share of the national income. The recovery of labor supply in an institutional setting characterized by substantial bargaining power by wealth owners resulted in a generalized redistribution of social and economic power in favor of the historical elites.[11] Labor contracts returned to feudal- like relationships, as with the return of serfdom in eastern Europe, or to the reassertion of the economic and political interests of rural elites, as in Italy.[40]

The twentieth-century reversal of rising wealth inequality evident in the kernel estimated trends in Figure 3 may have been the result a set of difficult-to-reverse policies adopted during the world wars including greatly increased levels of taxation and the spread universal suffrage during and in the aftermath of World War I. However, our data indicate that even in the presence of effective policies of income redistribution though taxes, transfers and other policies, extraordinary levels of wealth inequality persisted even in the Nordic social democratic countries.[41]

Our European data suggest that changes in the broad categories of effects – technology (including the ratio of labor to land and other forms of material wealth) and institutions – thus may provide a contribution to the explanation of changes in wealth disparities over the long run.

Egalitarian labor-limited economies. But in view of the major differences in technology and institutions among the economies in our data set, the similarity in the degree of wealth inequality is puzzling. The substantial inequality among the hunting and gathering populations on the Columbia River Plateau, for example, is not what one would expect if it had been the shift in technology from a reliance on wild species to cultivated plants and tended animals that brought about the considerable increase in inequality observed during the Neolithic period.

Also inconsistent with this view are the early food producing economies in Northern Mesopotamia (Jerf al Ahmar), Anatolia (Çatalhöyük) and Germany (Vaihingen and Hornstaad) respectively 11, 9 and 7 to 6 and millennia ago which are the least unequal economies in our entire data set.[21] A recent ethnographic study also shows that the degree of material wealth inequality in horticultural economies is not significantly greater than that in hunting and gathering economies; but it is only a third of the levels of wealth disparity evident in pastoral and agricultural economies.[42]

The fact that food production is sometimes not associated with the extraordinary wealth inequalities that are common in our data set could be explained by the persistence in these populations of the egalitarian social norms and political practices that in mobile hunter gatherers limited the accumulation of wealth.[43] It could as well be explained by the limits to the degree inequality that is biologically feasible given the modest energetic output of an hour of labor under conditions likely to have obtained in the early Holocene.[44,45] The data do not allow us readily to distinguish between these two accounts, one stressing politics and institutions the other focusing on technology.

But the substantial wealth inequality levels among the Columbia River sedentary hunter gatherers and the absence of pronounced inequalities among some food producing people are both consistent with the “clumped resources” explanation of inequality mentioned at the outset. We know that the wealth differences among the Columbia River fishers was based on the heritable use of highly productive fishing sites.[46] Where these and other defensible “clumped resources” were absent or unimportant to the livelihood of a people, we conjecture, wealth inequality may have been limited. By this reasoning the limited inequality of some food producing populations would be the result of the lack of such high value and defensible resources.

These examples suggest a generalization of the clumped resources explanation. On the basis of archaeological evidence it seems likely that the primary limiting factor of production in the more egalitarian populations’ livelihoods was human capabilities – skills, strength, social networks -- rather than land, livestock or other capital goods, at least by comparison to the other economies in our data set. The labor-limited character of horticultural and mobile hunting and gathering economies may help to explain the just- mentioned modest wealth inequality in these economies by comparison to the more material-wealth-limited pastoral and agricultural economies.

Our conjecture is that where the production of goods and services is limited primarily by the amount of labor devoted to production, economic disparities, including inequalities in material wealth will be relatively modest. Reasons include the intrinsic biological and other limits to the degree of inequality in human capacities for labor and the fact that human capabilities are (excepting slave societies) not capable of being accumulated under a single owner.

Consistent with this view, the significantly greater inequality in slave economies may be traceable to the fact that in these societies, the ownership of people converted labor itself into a type of wealth that could be accumulated and transmitted across generations. We also know from previous work[42] that human capabilities are transmitted from parents to offspring to a considerably lesser extent than is the case for material wealth, thereby limiting the extent to which differences in wealth accumulate from one generation to the next.

The labor-limited versus material wealth limited distinction is well illustrated by some of the earliest observations in our set: Çatalhöyük in Anatolia, and the Durunkulak - Hamangia site in what is now Bulgaria. Both engaged in land abundant farming (of similar crops), but the latter also produced salt ingots (which also served as currency) using highly capital intensive methods. The former was a labor-limited economy; the latter was material wealth limited. The Durunkulak – Hamangia economy is associated with the extraordinarily opulent burials at Varna, suggestive of extreme and inherited wealth differences.[47] Our estimate of wealth inequality at Çatalhöyük –described by one of its leading archaeologists as “aggressively egalitarian”[48] – is about half of that at Durunkulak – Hamangia. Evidence on the farming methods at the three other egalitarian populations mentioned above also suggests that they are labor limited.

Figure 4 explores the labor-limited hypothesis. We present the frequency distribution of our data, excepting the four labor-limited cases just mentioned, the mean of which is shown separately. We also provide two measures of inequality in human wealth. First is the mean Gini coefficient from a series of 18 measures of human capacities such as strength, hunting ability, knowledge in various productive areas, and farming skill based on an ethnographic study of wealth in its many forms.[42] The second is the mean Gini coefficient for years of schooling within five age cohorts across 42 contemporary nations.[49] Consistent with the logic of the limiting factor hypothesis, the data suggest that human capacities are far less unequally distributed than is material wealth, and that material wealth is less unequally held in labor-limited economies (though this last observation is based on such very limited data).

If our conjecture on the sources of inequality is borne out by further study it would provide a possible explanation of the apparent increase in the levels of wealth inequality over the first 10 thousand years evident in Figure 1. Earlier populations may have been predominantly labor-limited – with exceptions such as Durunkulak – until the introduction of the oxen-drawn plough (an important labor-saving and land-using innovation) tipped the balance of scarcity among the factors of production in the direction of a material wealth limited economy.

Because the labor-limited cases that we have just described are also populations without states, in the absence of more adequate measures of the labor-limited status of our cases we have not been able to explore how these two possible influences on inequality might have interacted. A labor-limited economy may well have posed impediments to the emergences of states; but we leave these proposals as conjectures.

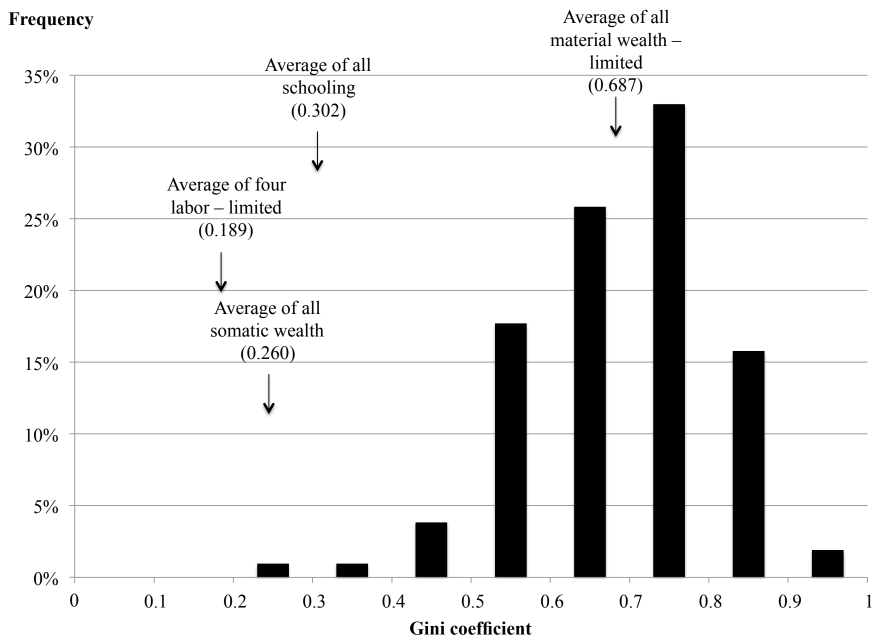

Figure 4. **Frequency distribution of Gini coefficients for material wealth over 11,000 years.** The four labor limited economies are excluded from the black bars.[21]

Discussion. Inequalities in material wealth contribute to inequalities in living standards as measured by disposable income, that is income net of transfers to (taxes, e.g.) and from (income support e.g.) the government. But across the contemporary 37 countries for which comparable data are available (mostly but not exclusively OECD) less than a third of between-country differences in disposable income inequality is attributable to between- country differences in market income inequality (that is, before taxes and transfers.) The rest is attributable to the fact that countries differ substantially in the extent of redistribution, as measured by the difference between the Gini coefficient for market and for disposable incomes.[21]

Ethnographic evidence suggests an even greater role for consumption smoothing institutions among mobile hunter gatherers. In three Latin American and one African forager group a mean of almost two-thirds (by calories) of the food acquired by an individual is consumed by those beyond his or her immediate family.[41]

Our data motivate two questions about the future trajectory of inequality in living standards under the influence of rapidly changing technology in the production and distribution of information and the changes in social structure and institutions likely to accompany this technological revolution. The first is: will the knowledge- and service-based economy now emerging in the high income economies represent a shift towards a system of production that is limited more by scarce human capabilities than by capital goods and other forms of material wealth? And, second, will the politics of this new technological and institutional environment sustain a substantial degree of egalitarian redistribution, as has been the case in many democratic and capitalist nations over the past half century? Positive answers to both questions would lend support to Kuznets conjecture of a possible future with reduced disparities in living standards (although on different grounds); while negative replies would support Piketty's contrary scenario.

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Author Contribution: The authors contributed equally to this work.

SUPPLEMENTARY INFORMATION

Technology, institutions and wealth inequality over eleven millennia

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1 Introduction

We present the methods of estimation for 213 measures of between-household material wealth inequality from archaeological and historical sources, dating from human prehistory to the present. The estimates are inevitably subject to considerable imprecision and bias given the limitations of the data available. We have sought to identify and to minimize bias and imprecision in our estimates so as to provide the basis for comparative studies of inequality of wealth measured across the vast differences in technology, institutions and other possible influences on inequality over this 11 millennium time period.

By material wealth we mean such alienable as tools, livestock, household assets (including dwellings) and land associated with a flow of valued services (income or other) contributing to the living standard of the owner. We measure inequality using Gini coefficients adjusted so as to be comparable across differing asset types, population and units of observation (individuals or households).

To provide a preview of our methods, Figure 1 illustrates our comparability adjustment using a group of Gini coefficients estimated from 498 observations on grave wealth among a pre-European-contact population of fishers at 22 burial sites on the Columbia Plateau in Washington, Oregon and California, presented in Schulting (1995). The unadjusted Gini ratio for the aggregate value of grave goods of the entire population is 0.622. This is the first number in the lower left of the figure. Then (the methods are described in detail in section 2 below) we create fictitious 'couples' under a range of degrees of wealth assortment in marriage and compute the Gini ratio for this population of 'husband-wife' households as 0.541, a reduction reflecting a lack of perfect wealth assortment in our "marital" matching algorithm.

Then, because grave goods are a distinctive indicator of a household's wealth that is typically more unequal than our benchmark asset type, household wealth (as we will show in sections 3 and 4) we adjust this estimate to our benchmark asset type (total household wealth), and we get a Gini coefficient adjusted by asset type equal to 0.510. Finally because the relevant population is smaller than our benchmark population, and because larger populations tend to be more unequal due to a pure scale effect (section 5) we estimate the level of the Gini that would correspond to a hypothetical population size equal to our benchmark level of a thousand households, arriving at our comparability adjusted estimate for the Columbia Plateau, namely

0.515.

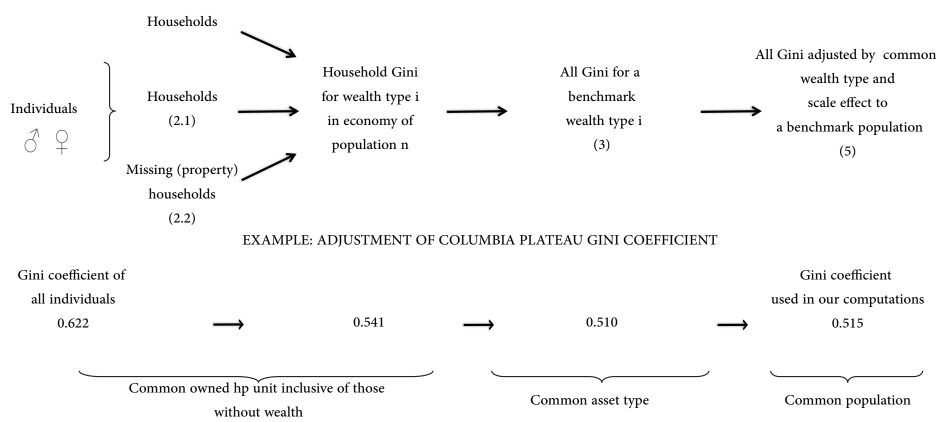

Figure 1**: Overview of comparability adjustment methods**. Numbers in parentheses refer to sections of this document where the relevant adjustment is made. At the bottom of the figure is an example of adjustment of the Gini coefficient for the Columbia Plateau. Source: see text.

2 Demographic adjustments

2.1 From individual to household inequality in grave wealth

In addition to the Columbia Plateau data we estimate Gini coefficients from grave wealth of 254 individuals at 5 burial sites in, Hohokam, Arizona, from McGuire (1992). The unadjusted Gini ratio for that entire population is 0.772.

Because household membership cannot be identified from the burial remains, we calculate a between-household inequality measure as follows. We identify, both from the Columbia Plateau and the Hohokam archaeological excavations, the burial sites with the greatest number of gender-identified observations. In Columbia Plateau they are Wildcat Canyon, Berrian's Island and Sheep Creek. In Hohokam only the Belleview site has a sufficient number of gender-identified graves. On the selected four sites we implemented the following method. First, we computed the Gini coefficient of individuals' wealth (only among the individuals whose gender is identified.) Second, we estimated the Gini of hypothetical couples' wealth where males and females were matched into “couples” assuming maximal wealth assortment, i.e. richest females are matched with richest males and poorest females with poorest males.[1] Couples' wealth is the sum of the wealth of the individuals matched. Third, we computed the Gini coefficients on couples' wealth with couples generated assuming random assortment, i.e. males and females were randomly matched irrespective of wealth.[2] Table 1 presents the results of the method implemented. (The !Kung provide a robustness test that we explain below.)

Society (1)	**Site** (2)	**Gini on individuals** (3)	**Gini wealth assortment** (4)	**Gini random assortment (average across 10 rounds)** (5)	**Average Gini of couples' wealth** (6)	**μ** (7)
Hohokam	Belleview	0.668	0.704	0.502	0.603	0.87
Columbia Plateau	Wildcat Canyon	0.593	0.621	0.471	0.546	0.92
	Berrelan's Island	0.489	0.495	0.341	0.418	0.85
	Sheep Creek	0.712	0.682	0.529	0.605	0.85
!Kung	-	0.219	0.196	0.136	0.166	0.77

Table 1**: Gini coefficients of grave wealth for individual and couples.** Shown in column (3) are the Gini computed only across the gender-identified individuals in each site and in column (4) those computed on couples' wealth when individuals are matched through wealth assortment. Column (5) reports the average Gini coefficient across the ten rounds of random assortment. Column (6) is the mean of the Gini in columns (4) and (5). Shown in column (7) are the ratios μ in each archaeological site and in the !Kung data set and obtained as the fraction between the average Gini of couples' wealth, column (6), and the Gini of individuals' wealth, column (3).

We let μ be the ratio of the average Gini coefficients estimated from couples to the one estimated from individual data. Remarkably, it is equal to 0.87 both in the Columbia Plateau data (the value is obtained averaging the three μ for Columbia Plateau shown in column (7) of Table 1) and for Hohokam. For both cases, we use μ=0.87 to obtain the couples' corrected Gini estimates for whole population.

In the Columbia Plateau dataset, we then take the Gini coefficient computed on

[1] In the perfect assortment algorithm when females outnumber males (or vice versa), in order to not lose information, the poorest female is matched with a fictitious male with a wealth equal to the wealth of the poorest man.

[2] We first created a vector made of females observations randomly ordered and then assigned each element of the vector (first to last) to an element of the males vector ordered per increasing wealth. When females outnumbered males (or vice versa) some males were randomly drawn twice to couple any female. The random draw was repeated ten times to check sensitivity of random choice on estimated coefficients.

all the individual graves (0.622) and multiply it by the μ=0.87 ratio, to obtain the estimated Gini on couples' wealth equal to 0.541 (these numbers are also the first two shown at the bottom left of Figure 1.) Applying the same procedure to the Hohokam dataset, we multiply the Gini of individuals' wealth (0.772) by the μ ratio found in the Hohokam Belleview site (*0.87*) and we obtain the estimated Gini coefficient of couples' wealth (0.671.)

We have also used the μ ratio equal to 0.87 to adjust all the other Gini coefficients in our dataset that were originally estimated on individuals rather than households. These are estimates from the Varna archeological site, Windler, Thiele et al. (2013), the ancient Balkans, Porčić (2012), grave goods inequality in ancient Mesopotamia, Stone (2016), probate inventories in the Ottoman Empire**,** Establet and Pascual (2009), Coşgel and Ergene (2011) and Cosgel (2013), probate inventories in 18th-20th century Sweden, Bengtsson (2016) probate inventories in the 19th -20th century Canadian regions, Di Matteo (2016)[3] and 17th-20th century England, Di Matteo (2016).

The fact that our algorithm applied to the Hohokam and Columbia Plateau sites yields identical results (μ = 0.87 in both cases) is encouraging. But we also have a dataset with information on individual's wealth and actual couples' composition. So we can check if the Gini for couples obtained through our method is close to the Gini computed on the wealth of true couples. We do this using the information on individuals' wealth in the !Kung population described in Wiessner (1982)**.** To replicate our methods used on the Columbia and Hohokam data sets, we estimate couple's wealth as the simple sum of all the items owned by the male and the female member and we compute the Gini coefficient based on this sum for all couples, which is equal to 0.168. We then replicate for the !Kung the couples' matching procedures described above for the archaeological datasets. In other words, we use the individual observations as if we knew nothing about who was paired with whom in reality, which is the problem we confront with the burial data. We then we create hypothetical couples by wealth assortment as well as through ten random assortments. Averaging the Gini coefficients obtained through the two assortment methods, we get a Gini coefficient equal to 0.166.

[3] The two Gini coefficients are the average value across the available estimates of the regions of Thunder Bay Ontario, Toronto, Manitoba and Wentworth county, in two 50- years intervals: 1850-1899 and 1900-49. See Di Matteo (2016) for more details on the sources.

2.2 Accounting for those without wealth

Gini coefficients computed on data from historical documents such as tax registers or probate inventories often report the wealth owned only by those paying taxes or having a sufficient amount of wealth to write wills. Where the number of excluded non owners is substantial, which is common, this results in a substantial underestimate of the degree of inequality in the whole population. Where we do not have the raw data, but only a reported Gini coefficient, to include the non owners (who we will call the 'missing zeros') we need two pieces of information. The first is how numerous the missing zeros are, which we estimate from historical sources about the population in question. The second is an estimate of the effect of excluding zeros on the Gini coefficient, which we obtain by studying populations on which we have both owners and zeros and can artificially remove the zeros.

To estimate the effect of missing zeros we use 23 complete distributions of different forms of wealth: grave wealth of 22 burial sites from the Columbia Plateau three millennia ago, and land ownership in Krummohorn, Germany three centuries ago (Borgerhoff -Mulder, Bowles et al. (2009).) We estimate eq. (1) predicting the Gini coefficient computed on the whole sample ($Gini_{inc}$) as a function of the Gini computed on the population without individuals with zero wealth ($Gini_{exc}$) and the fraction of non-owners in the population (*Zeros*).

$$(Gini_{inc})_i = b_0 + b_1(Gini_{exc})_i + b_2 Zeros_i + b_3(Gini_{exc})_i^2 + b_4(Gini_{exc})_i * Zeros_i + b_5 Zeros_i^2 + e_i \qquad (1)$$

Table 2 shows data used for the adjustment (for the moment ignore column 6). The results of the estimation in Table 3 show that the equation provides a reasonably precise estimate of the effects, and it provides the basis for our upwards adjustment of the Gini coefficients with missing zeros. Figure 2 shows the relationship between the true Gini coefficients of the 23 wealth distributions used in the adjustment and the Gini's estimated with the above method. We label the Krummhorn observation in the figure as it confirms that the very different asset type, institutional setting and historical period that it represents does not result in its being in any way atypical. In the next three subsections we explain how the correction has been used for the following cases: ancient Mesopotamia, Classical Greece and the Roman Empire as well as tax rolls in late medieval Paris; and probate inventories in cities of the Ottoman Empire.

Society **(1)**	**Sample size** **(2)**	**Fraction of zeros** **(3)**	**Gini$_{exc}$** **(4)**	**Gini$_{inc}$** **(5)**	**Gini$_{without}$** **(6)**
Dalles- Deschutes	34	0.41	0.461	0.683	0.373
Congdon	30	0.10	0.285	0.356	0.179
Beek's pasture	18	0.44	0.494	0.719	0.270
Sundale	19	0.47	0.494	0.734	0.270
Juniper	22	0.18	0.445	0.546	0.299
Wildcat Canyon	32	0.31	0.486	0.647	0.402
Berrelan's Island	33	0.12	0.466	0.531	0.314
Yakima Valley	22	0.45	0.392	0.668	0.322
Selah	12	0.16	0.192	0.326	0.107
Sheep Island	22	0.31	0.428	0.610	0.301
Okonogan	18	0.38	0.35	0.603	0.247
Keller Ferry	12	0.58	0.235	0.681	0.121
Whitestone Creek	38	0.34	0.338	0.564	0.215
45-FE-7	24	0.58	0.44	0.767	0.386
45-ST-8	15	0.26	0.246	0.447	0.229
Sheep Creek	38	0.44	0.513	0.730	0.397
45-ST-47	11	0.09	0.527	0.570	0.317
Nicoamen	15	0.13	0.448	0.521	0.369
Nicola Valley	10	0.20	0.259	0.407	0.106
Koomloops/Chase	24	0.04	0.272	0.302	0.198
Rabbit Island	26	0.03	0.349	0.418	0.326
Fish Hooks Island	23	0.21	0.577	0.669	0.515
Krummhorn	1602	0.54	0.554	0.708	0.452

Table 2: **Gini coefficients in 23 populations.** The first 22 rows show the computations for the Columbia Plateau dataset, while the last row shows the computation for the non archaeological dataset. Column (4) reports coefficients computed on the population without individuals owning no wealth. Column (5) shows Gini computed on the whole population. The last column provides the Gini coefficients computed on the non-zero population without the richest 10% and poorest 15% of population. (Used for adjustment in late medieval Paris. (section 2.2.2.) Note that the Gini coefficients of the whole population, column (5), in Berrelan's Island, Wildcat Canyon and Sheep Creek are different than those reported for the same three sites in column (3) of Table 1. The reason is that while in Table 1, the Gini coefficients were computed only on the gender identified individuals, here the Gini are estimated on all the individuals at the site.

(1)	Estimated coefficients (2)
Intercept	-0.009 (0.025)
$Gini_{exc}$	1.153*** (0.133)
Zeros	0.885*** (0.059)
$Gini_{exc}^2$	-0.211 (0.170)
$Gini_{exc}$*Zeros*	-0.962*** (0.098)
Zeros	0.133* (0.073)
n R^2	23 0.997

Table 3: **Results of the relationship between missing zeros and the Gini coefficient.** Shown are, for each independent variable in eq. (1) the coefficients estimated through OLS, column (2). Standard errors in parentheses. ***Significant at 99%. **Significant at 95%. * Significant at 90%.

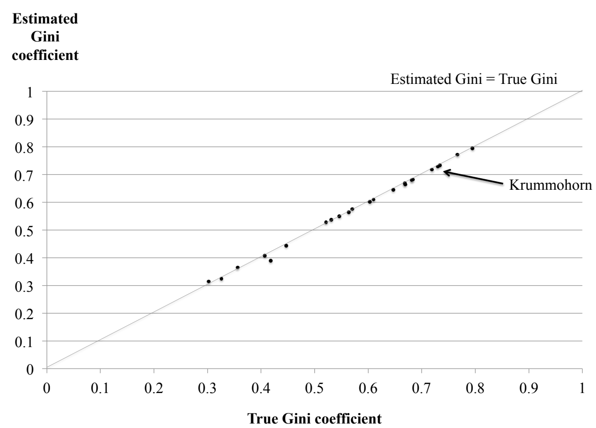

Figure 2: **Estimated and true coefficients for 23 populations**. Shown is the relationship between the Gini coefficients estimated with equation (1) from data in Table 2 columns (4-5). The arrow shows the predicted Gini coefficients of the largest dataset used in the estimation.

2.2.1 Mesopotamia, Classical Greece, and Roman Towns and Villages

The estimates of inequality of grave goods in the ancient southern Mesopotamia, Stone (2016), include the missing zeros among the free population, but exclude the slaves, who lived and worked in the urban centers. We describe below how we approximate the proportion of slaves in the ancient Mesopotamia urban population, reconstructing the number of slaves living in the city of Uruk in 3000 BCE. We then apply the resulting slave ratio to the different periods (4th to 2nd millennium BCE) covered by the inequality estimates (house space and grave goods) in southern Mesopotamia.

According to Westenholz (2002), the total population of Uruk in 3000 BCE numbered 40-45,000 individuals (including free and slave households.) Taking as total population number the midpoint 42,500 and considering that about 9,000 of them were slave workers employed in the textile sector, Jacobsen (1953) and McC. Adams (1978), the first estimate of the slave percentage of the total population is equal to 21%. In addition, we add to this estimate also the slaves employed as household workers in private, public and temple households. To estimate how many of the extant 33,500 individuals were household slaves, we use the estimated proportion between free individuals and household slaves provided by Diakonoff (1969) from which we find that of every 100 free individuals about 16 were privately owned slaves (our computation from Diakonoff (1969) p. 175) employed as household workers. If we apply this ratio to the 33,500 individuals, we find that about 28,100 were free individuals, while 5,400 were the slaves privately owned by households. Summarizing, we count 14,400 slaves (textile workers and household workers), who accounted for 34 percent of the Uruk population. This is the ratio of missing zeros we use in our adjustment of the Gini estimates in southern Mesopotamia, 4th-2nd millennia BCE.

Household wealth inequality in the 321 BCE Athens in the available data is estimated across the free population. It, therefore, takes into account of the households who owned nothing, but it does not include in the estimation the slaves, who according to Finley (1959) represented 2/3 of the total urban population. We add this proportion of missing zeros (67%) for the adjustment of the Athens Gini coefficient in 321 BCE.

To assess the fraction of landless in the Roman towns and villages, we first approximate the proportions of free and slave households in Roman provinces. According to the information provided in Scheidel (2011), we estimate that the total population in Roman Egypt was composed by 6% slave households and 94% free households. In Italy and the other Roman provinces in our dataset (North Africa and Asia Minor), the proportion was slightly different, with slaves representing 9% of total population. Then, we have determined the fraction of the landless among the free households using evidence from an Egyptian Nome, the administrative district. There the approximate proportions for inhabitants status were: 35% of free population landowners, and the 65% of free population non-landowners (Bagnall (1992).) Lacking similar studies for the other regions of the Empire, we assume that in the provinces in Italy, Asia Minor and Northern Africa the fraction of landowners was the same

The resulting fractions of missing zeros (including both free landless and slaves) in the different regions of the Roman Empire are the following: 0.67 in Egypt and 0.68 in Italy, North Africa and Asia Minor. The new Gini coefficients are in Table 4. It is evident that taking account of those without wealth implies a quite substantial increase in measured inequality, as expected.

2.2.2 Late Medieval Paris

The Gini coefficients for Paris in 1292, 1296, 1297 and 1313 are computed on wealth assessment from tax rolls. They are estimated in Sussman (2006) from tax registers reported in Géraud (1837) and in Michælsson (1951, 1958, 1962). Late medieval Paris is a more complicated adjustment because of exclusions at both ends of the wealth distribution. These documents include only individuals subjected to taxation. The excluded were members of the royal court, nobles, members of the clergy, indigents and the university community (professors and students.)

To assess the effect of the exclusion of these members of the society we first took the total number of population for the end of 13th century Paris from Dollinger (1956), where an attempt is made to assess the relationship between the whole population and citizens included in the 1292 tax register. From the 15200 individuals registered in the document, the relatives of family heads are subtracted and a number of 13460 taxable hearths (i.e. households) is obtained. This number is multiplied by 3.5 reflecting an estimate of the average size of the nuclear family living in the city.[4] The taxable population of Paris is then estimated as 47110 inhabitants.

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[4] The 3.5 multiplier is chosen by Dollinger (1956) as the average value between the two multipliers most commonly used in European population (3 and 4). See also Bairoch, Batou et al. (1988).

Region (1)	Period	Source (2)	Type of wealth (3)	Gini w/o missing zeros (4)	Fraction of missing zeros (5)	(6)	(7)	Est. Gini (8)
South Mesopotamia	2500 BCE	Stone (2016)	House size	0.374	-	0.34	0.34	0.587
South Mesopotamia	1750 BCE	Stone (2016)	House size	0.400	-	0.34	0.34	0.604
South Mesopotamia	1750 BCE	Stone (2016)	House size	0.456	-	0.34	0.34	0.640
South Mesopotamia	500 BCE	Stone (2016)	House size	0.399	-	0.34	0.34	0.603
South Mesopotamia	3000 BCE	Stone (2016)	Grave goods	0.378	-	0.34	0.34	0.589
South Mesopotamia	2500 BCE	Stone (2016)	Grave goods	0.670	-	0.34	0.34	0.766
South Mesopotamia	2500 BCE	Stone (2016)	Grave goods	0.699	-	0.34	0.34	0.781
South Mesopotamia	2250 BCE	Stone (2016)	Grave goods	0.697	-	0.34	0.34	0.780
South Mesopotamia	1750 BCE	Stone (2016)	Grave goods	0.769	-	0.34	0.34	0.818
South Mesopotamia	500 BCE	Stone (2016)	Grave goods	0.765	-	0.34	0.34	0.816
Greece - Athens	321 BCE	Kron (2011)	Household wealth	0.708	-	0.67	0.67	0.898
Egypt – Kerkeosiris	116 BCE	Bowman and Wilson (2009)	Land	0.374	0.61	0.06	0.67	0.804
Egypt – Krokodilopolis	50CE	Bowman and Wilson (2009)	Land	0.553	0.61	0.06	0.67	0.860
Egypt – Panopolis	150 CE	Bowman and Wilson (2009)	Land	0.702	0.61	0.06	0.67	0.897
Italy - Ligures Baebiani	101 CE	Duncan-Jones (1990)	Land	0.435	0.59	0.09	0.68	0.831
Italy – Veleia –	102 CE	Duncan-Jones (1990)	Land	0.526	0.59	0.09	0.68	0.858
Egypt - Philadelphia	216 CE	Bagnall (1992)	Land	0.532	0.61	0.06	0.67	0.854
Africa - Lamasba	220 CE	Duncan-Jones (1990)	Land	0.447	0.59	0.09	0.68	0.835
Asia –Magnesia	300 CE	Duncan-Jones (1990)	Land	0.679	0.59	0.09	0.68	0.896
Italy - Volcei-	307 CE	Duncan-Jones (1990)	Land	0.394	0.59	0.09	0.68	0.818
Egypt – Karanis	308 CE	Bowman and Wilson (2009)	Land	0.638	0.61	0.06	0.67	0.882
Egypt – Hermopolis	350 CE	Bowman and Wilson (2009)	Land	0.758	0.61	0.06	0.67	0.908
Egypt – Aphrodito	525 CE	Bagnall (1992)	Land	0.623	0.61	0.06	0.67	0.879

Table 4: **Adjusted Gini coefficients for Mesopotamia, Ancient Greece and Roman Empire**. For each ancient society whose Gini has been adjusted, the table shows the fraction of free individuals owning nothing missing from the original sources, column (5), the fraction of slaves, column (7), and the total fraction of missing zeros used for the adjustment of the Gini coefficient, column (7). Shown in column (4) is the Gini coefficient before the adjustment, and the measures of inequality in Ancient Greece and the Roman Empire (the last 12 rows of the table.) The Gini of grave goods in Mesopotamia reported in column (4) are those corrected by couples' adjustment (section 2.1.) Column (8) shows the adjusted Gini accounting by the fraction of zeros not included in the original estimate.

We have added to this figure the following approximate number of excluded groups: the members of the royal court (around 5000 individuals), the nobles, the clergy, the indigents (around 10000 individuals) and the students and professors (around 10000 individuals), Dollinger (1956). Among the 10000 individuals including nobles, clergy and indigents we were able to separate the richest from the very poor. Indigents and beggars represented about 10% of the total Paris population in the early 14th century, Geremek (1987) and Farmer (2002), and hence, we have estimated them to have been around 7200 individuals while 2800 where the members of the aristocracy and the Church.

The resulting total population of Paris is estimated around 72000 inhabitants. It is here assumed that the proportions estimated for the 1292 population held constant also in the following two decades. We are aware that this estimation contrasts with results from other studies in which the total population is estimated around 150000 - 200000 inhabitants from different sources, Cazelles (1966), Bairoch, Batou et al. (1988). However, we judge the lower estimate to be more likely to be correct because if the higher number is accepted, then the portion of taxable individuals would have represented about 1/3 of the total population, a small fraction that would have had very little information value for the administrators of the city, not justifying the effort in compiling it, Dollinger (1956).

As a second step of the method, we took the 23 wealth distributions used for the general method (section 2.2) and, after having dropped from them the missing zeros, the top 10% and the bottom 15%, we computed the Gini coefficient, $Gini_{without}$ (last column of Table 2.) Then, as we do not know the distribution of wealth inside the top 10% and the bottom 15% of the Paris distribution, we estimate in our 23 observations the Gini of the total population ($Gini_{inc}$) as a linear function of the fraction of missing zeros, *Zeros* and the Gini computed on the population without the three groups previously excluded, $Gini_{without}$. To reduce prediction error we also add an interaction term. The estimated function is shown in eq. (2).

$$(Gini_{inc})_i = b_0 + b_1(Gini_{without})_i + b_2Zeros_i + b_3(Gini_{without})_i * Zeros_i + e_i \qquad (2)$$

The results of the estimation are shown in Table 5.

(1)	Estimated coefficients (2)
Intercept	0.101** (0.047)
$Gini_{without}$	1.014*** (0.163)
Zeros	0.973*** (0.141)
$Gini_{without}$*Zeros*	-1.224** (0.462)
n R^2	23 0.935

Table 5: **Results of the relationship between excluded groups and the Gini coefficient.** Shown are, for each independent variable in eq. (2) the coefficients estimated through OLS, column (2). Standard errors in parentheses. ***Significant at 99%. **Significant at 95%. * Significant at 90%.

Figure 3 shows the relationship between the original Gini in the 23 wealth distributions (True Gini, horizontal axis) and the Gini estimated with the above new method (Estimated Gini, vertical axis.) In Table 6 we present the new Gini coefficients for Late Medieval Paris as well as the fractions used in the computation.

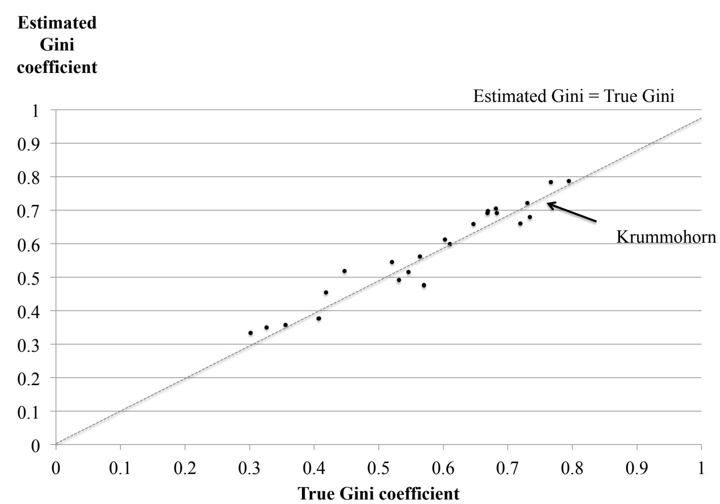

Figure 3: **Estimated and true Gini coefficients for 23 populations.** Shown is the relationship between the Gini coefficients estimated with the results from the OLS estimation of equation (2), using data in table 2 columns (5-6). The arrow shows the predicted Gini coefficients of the largest dataset used in the estimation.

City (1)	Date (2)	Reported Gini (3)	Fraction of missing zeros (4)	Estimated Gini (5)
Paris	1292	0.750	0.132	0.869
Paris	1296	0.610	0.132	0.749
Paris	1297	0.690	0.132	0.818
Paris	1313	0.790	0.132	0.903

Table 6: **Corrected Gini coefficients in medieval Paris.** Column (3) shows the Gini reported in the sources, column (4) shows the fraction of missing and columns (5) shows the corrected Gini.

2.2.3 Late medieval and early modern Italian regions

We include in our dataset the average Gini estimates for inequality of taxable wealth (real estate) across the 14th-18th century communities of Piedmont, northwestern Italy, given in Alfani (2015). As stated by the author, a small number of zeros, estimated to be 9.2% of total population, was excluded from the tax registers. We correct the average Gini coefficients using that fraction of zeros and we present the results in Table 7.

We have also averaged and included the Gini coefficients of taxable wealth (real estate) across urban and rural communities in 14th-18th century Tuscany, central Italy, provided in Alfani (2017). As the author warns, a substantial fraction of zeros -- on average across time and places, 30% of total population --was likely to be excluded from the registers. We correct the average Gini coefficients using that fraction of missing zeros and we show the results in Table 7.

2.2.4 Ottoman urban areas

Inequality in Ottoman cities is estimated from data from probate inventories. A limitation of these sources is that they represent a very small part of the society, as probate inventories were compulsory only for those having heirs of minor age. They exclude the wealth of all the individuals not compelled to register their inheritances, Canbakal (2007). The main limitation is the exclusion of those owning nothing. The approximate number of zero wealth owners for the city of Cairo in the 18th century was 70000, including serfs, wageworkers, beggars and street sellers, Raymond

(1973), while the total population has been estimated around 263,000-270,000 inhabitants, Raymond (2002). Non-owners, therefore, represented about the 25% of the population in the city of Cairo. We have assumed that the fraction of poor in the 17th century was the same. Due to missing information in the literature about the proportion of missing zeros in the other Ottoman cities, we have assumed that their fraction of poor was equal to the one in the city of Cairo. Table 8 presents the new Gini coefficients. These are obtained by adjusting the Gini coefficients corrected by couples' adjustment, as shown in section 2.1.

Region **(1)**	**Date** **(2)**	**Gini (average across communities)** **(3)**	**Fraction of missing zeros** **(4)**	**Estimated Gini** **(5)**
Italy - Piedmont	1300	0.715	0.092	0.833
Italy - Piedmont	1350	0.660	0.092	0.774
Italy - Piedmont	1400	0.605	0.092	0.715
Italy - Piedmont	1450	0.610	0.092	0.721
Italy - Piedmont	1500	0.624	0.092	0.736
Italy - Piedmont	1550	0.627	0.092	0.739
Italy - Piedmont	1600	0.671	0.092	0.792
Italy - Piedmont	1650	0.673	0.092	0.788
Italy - Piedmont	1700	0.738	0.092	0.857
Italy - Piedmont	1750	0.761	0.092	0.881
Italy - Piedmont	1800	0.779	0.092	0.901
Italy - Tuscany	1300	0.703	0.300	0.857
Italy - Tuscany	1350	0.593	0.300	0.762
Italy - Tuscany	1400	0.565	0.300	0.738
Italy - Tuscany	1450	0.615	0.300	0.781
Italy - Tuscany	1500	0.611	0.300	0.778
Italy - Tuscany	1550	0.598	0.300	0.767
Italy - Tuscany	1600	0.691	0.300	0.846
Italy - Tuscany	1650	0.715	0.300	0.867
Italy - Tuscany	1700	0.774	0.300	0.918

Table 7: **Corrected Gini coefficients in late medieval and early modern Italy.** Column (3) shows the Gini reported in the sources, column (4) shows the fraction of missing zeros and columns (5) shows the Gini computed using the method described in section 2.2.

3 Comparability across sites: Adjustment for asset type

The thought experiment motivating our asset type comparability estimates is to imagine that in the same population wealth of type *x* were instead household wealth (our benchmark) and ask how unequally distributed would that be given how unequally distributed is x-wealth? We think, for example, that house size is more equally distributed than land ownership (or land farmed) because inequalities in family size (which would contribute to house size) are limited in ways that land ownership is not, due diminishing returns to house size after some point being more pronounced than for land, and for other reasons. We address this problem empirically using data from populations for which we have inequality measures for multiple forms of wealth.

City (1)	Date (2)	Gini corrected by couples' adjustment (3)	Fraction of missing zeros (4)	Estimated Gini (5)
Cairo	1630	0.643	0.25	0.721
Cairo	1690	0.643	0.25	0.721
Damascus	1700	0.643	0.25	0.721
Kastamonu	1731	0.539	0.25	0.651
Anatolia	1737	0.591	0.25	0.687
Cairo	1751	0.704	0.25	0.759
Kastamonu	1776	0.574	0.25	0.675
Cairo	1787	0.678	0.25	0.743

Table 8: **Adjusted Gini coefficients for Ottoman cities.** Column (3) the Gini corrected for the couples' adjustment (see section 2.1.) Columns (4) and (5) show respectively the estimated fraction of propertyless and the Gini computed through the correction estimated in section 2.2.

3.1 Aggregating wealth types

3.1.1 In archaeological data

Material wealth inequality in the Neolithic settlement of Çatalhöyük, Central Anatolia (7100-6000 cal. BCE), has been estimated using measures of house floor size obtained from archaeological excavations, as described and reported in Demirergi, Twiss et al. (2000). There the area of main and side (storage) rooms in 19 house buildings of the settlement is given. According to the authors, the main room was intended as the space for the most frequent daily functions (living, dining and socialization), while the side area was likely to be used as a space for food storage and processing. A first estimation of wealth inequality consists in the computation of the Gini coefficient of the main room area, the side room area and the sum of the two spaces in each building. Using this method the Gini coefficients are respectively 0.186, 0.343 and 0.213.

However, as the two spaces were devoted to two distinct uses, summing up main and side room is not the best way to aggregate the two measures of wealth: they had different functions and were indicative of different kinds of wealth and, hence, they were not substitutable in the determination of the household's overall well being. Instead, we think about the main room as the wealth which generates housing services and the side room (or the storage area) as a measure that varies positively with access to land.

As we assumed the main and side room to be two different kinds of wealth, we aggregated them as complements, meaning the marginal utility of each area is increasing in the other. We then measure total household wealth (our benchmark) as proportional to the flow of well being made possible by these two forms of wealth. So to measure the inequality of household wealth we simply compute the inequality of the well being. To implement this we aggregate the two kinds of wealth using a Cobb-Douglas function of the following form

$$w_i = AH_i^{\alpha}F_i^{1-\alpha} \quad (3)$$

where w_i (our measure of total household wealth) is the well being generated by housing wealth (H_i) and farming wealth (F_i, the side room area), with A a positive constant and α the elasticity of well being with respect to housing wealth (with $0 \leq \alpha \leq 1$.) The coefficient α would (if one were purchasing housing and food at given prices so as to maximize well being) be the share of one's budget devoted to housing. This measure of the importance of housing is thus critical in the process of aggregation of the two kinds of wealth in a single measure for well-being. Lacking sufficient information to properly evaluate it for Çatalhöyük, we make a reasonable conjecture. Something like a fourth of the annual income might be spent on housing (or, alternatively, one might think that over a lifetime of work about a fourth of one's time might be spent in creating and maintaining the value of the house.) On this basis we conjecture that in an ancient society housing would have the same importance. Hence, we set $\alpha = 0.25$. The coefficient of the storage area is simply $1- \alpha$ reflecting the fact that the exponents in equation (3) sum to one, so that increasing both living area and storage by a factor of q increases wellbeing by the same factor. Because our choice of $\alpha = 0.25$ is at best an informed conjecture, w also study estimates with $\alpha = 0.5$. We have used the same procedure for the aggregation of main and side room area for the buildings excavated in pre historic Mesopotamia (Sabi Abyad[5], Tell Brak and Tepe Gawra), pre historic South West Germany (Vaihingen, Hornstaad and Heuneburg) and the Dolores Archaeological Project (DAP) in Southwestern Colorado.[6] Table 9 shows the Gini coefficients of living and side room and of their aggregation according to the method explained above. The table also shows that choosing a higher α, e.g. $\alpha = 0.5$, does not relevantly affect the Gini of aggregated wealth.

Society **(1)**	**N** **(2)**	**Gini (living room)** **(3)**	**Gini (storage area)** **(4)**	**Gini of aggregated wealth (α=0.25)** **(5)**	**Gini of aggregated wealth (α=0.5)** **(6)**
Çatalhöyük (7100-6000BCE)	19	0.186 (0.017)	0.343 (0.036)	0.284 (0.029)	0.267 (0.027)
Sabi Abyad (6000 BCE)	4	0.356 (0.037)	0.276 (0.072)	0.300 (0.061)	0.321 (0.055)
Vaihingen (late 6th millennium BCE)	11	0.153 (0.019)	0.172 (0.018)	0.165 (0.018)	0.160 (0.018)
Tell Brak Mesopotamia (3850 -3700 BCE)	4	0.300 (0.029)	0.523 (0.030)	0.464 (0.033)	0.405 (0.034)
Hornstaad (3918 -3902 BCE)	30	0.171 (0.008)	0.171 (0.009)	0.171 (0.009)	0.171 (0.009)
Heuneburg ivb2 (800-450 BCE)	11	0.274 (0.033)	0.605 (0.059)	0.566 (0.057)	0.536 (0.058)
Heuneburg iva2 (800 -450 BCE)	8	0.371 (0.040)	0.665 (0.074)	0.645 (0.083)	0.673 (0.070)
DAP (600-770 CE)	14	0.240 (0.022)	0.360 (0.033)	0.331 (0.035)	0.304 (0.035)
DAP (780-925 CE)	25	0.292 (0.015)	0.325 (0.027)	0.305 (0.024)	0.285 (0.021)

Table 9: **Aggregating different types of wealth in an ancient society.** Gini coefficients are computed for mid-Neolithic Çatalhöyük and the excavations from the Dolores Archaeological Project (DAP) Column (2) reports the number of observations in each society. Columns (3)-(6) show the Gini coefficients of, respectively, the living and side area taken singularly and the two areas aggregated according to the method shown in section 3.1.1 and using two different values of α in eq. (3). Standard errors from bootstrapping the sample 1000 times are shown in parentheses.

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[5] Discussion of the model chosen for the imputation of storage and living space in Sabi Abyad is in Bogaard, Styring et al. (2017).

[6] The data of the archaeological sites in pre historic Mesopotamia and South West Germany are shown in Bogaard, Styring et al. (2017). Data for the Dolores Archaeological Project and its periodization have been kindly provided to us by Tim Kolher and are analyzed in Kohler and Higgins (2016).

The Gini coefficients of house area provided in Smith, Dennehy et al. (2014), for Aztec Mexico, do not distinguish between storage and living space and, thus, they cannot be compared with our Cobb Douglas aggregated measure of household wealth. As we are not able to retrieve the individual observations used to compute those Gini coefficients, we adjust them in the following way. We compute the ratio between the Gini computed on the Cobb Douglas aggregation of the two measures and the Gini computed on their simple sum for each case in which we have individual data of living and storage space. We average the ratio and multiply by it the Aztec Gini on the simple sum of house spaces for the town of Cuexcomate (the one provided in the original sources and with a sufficiently high mean house space to guarantee a large social group representation.) The resulting Gini is considered as an approximation of the Gini on the Cobb Douglas aggregation of house spaces.

3.1.2 Jerf al Ahmar

We have included in our dataset the well documented ancient site of Jerf Al Ahmar, Northern Mesopotamia (9500-8700 BCE). The house plans are taken from Stordeur (2015) and studied in Bogaard, Styring et al. (2017).

However, a problem arises when we aggregate living and storage spaces for this case. As the 6 storage spaces were located in a central and public area of the village their allocation to the 5 households excavated in the village is uncertain.

Our method to estimate a measure of aggregated wealth is based on two steps. We first assign the storage areas to dwelling areas much as we assigned male and female grave wealth. We assume that the house with the larger living area would have had the larger storage bin, the house with the second larger living area the second larger storage bin and so on. Excluding from the matching procedure the smallest storage bin, we compute the Gini coefficient of the Cobb Douglas aggregations on the basis of this 'wealth matching' procedure and we get a Gini coefficient equal to 0.097.

We then consider the alternative zero assortment case and randomly assign the 5 bins (still excluding the smallest storage bin) to the 5 houses and compute the Gini coefficient on the Cobb Douglas aggregation of the two measures. We repeat the random assignment 10 times and get an average Gini across the 10 random pairings equal to 0.069. Finally, the average Gini between the perfect 'wealth' assortment and

and random matching is 0.083 and it is the measure we use in our dataset. We also check what would be the Gini coefficient if each household would had had equal access to each of the bins, and hence the same storage space (as could have been the case for a communal storage facility). We find that the Gini of the Cobb Douglas aggregation of the two measures after equal assignment of storage across households is 0.043.

3.1.3 Knossos

A problem arising with the house size dataset in Neo Palatial Knossos is that the current excavation provides information on total house space and partially identifies the storage space for only 14 houses in the Acropolis, including the Palace and Little Palace. Thus it excludes a large fraction of the relevant population living in the surrounding areas. The Gini coefficient computed on the Cobb Douglas aggregation of living and storage space of these 14 houses, is substantial, 0.756. (The storage area in the cases in which it was not identified was assumed as the 10% of the total area, a fraction obtained as the average ratio between the two spaces in the cases in which storage was identified.)

Therefore, in order to include the missing population, we create a random log normal distribution of total house space for the population non excavated with the following parameters. Following Whitelaw (2004), we take as the estimate of Knossos population the midpoint between his range 14,000 and 18,000 individuals, which corresponds to 4570 households (assuming that the households had a size of 3.5 adults equivalent.) Since this population fraction was likely representing the middle and lower social strata Whitelaw (2004), we reproduce their possible house space as a truncated random log normal distribution with the mean and standard deviation computed from the three available observations more likely to be similar to non elite houses (SEX North, SEX south and Acropolis house.) We finally set as minimum and maximum house size, respectively, 10 and 511 square meters. (The maximum number is obtained as the midpoint between the two largest non palace houses among the 14 known observations.) After having estimated the storage space as 10 percent of the total space, we aggregate living and storage space through the Cobb Douglas method and obtain a Gini coefficient for the entire population – observed and imputed -- equal to 0.530.

Adding a large portion of non elite population with a somewhat homogenous wealth distribution decreases the Gini coefficient. We observe that the estimation of the Gini coefficient is sensitive to three key parameters in the random log normal distribution: the number of missing households, how unequally distributed these house sizes are, and the mean size of total space they have. Knossos, iconic of social hierarchy and economic disparity in the archaeological literature, may not have been as unequal as the estimates based solely on the available measurements would suggest. But a Gini coefficient of 0.528 is nonetheless substantial as the note below on the interpretation of the Gini coefficient shows.

3.2 Correcting for wealth inequality computed on different asset types

Within a given economy a given type of asset may be typically more equally distributed than some other type. Reliance on one or the other may lead to biased estimates. Empirically, house area (a measure available in some archaeological data) is typically more equally distributed than land area. In the Southern Mesopotamia, during the Neo Babylonian period, coefficients for house area and grave goods were respectively 0.603, and 0.816 (after the adjustments by couples and missing zeros shown in the previous sections.) Household wealth (our benchmark concept) is some aggregate of the two, so reliance on one or the other exclusively will bias our results. To address this problem we adjust our estimates for the type of asset they represent to approximate what that measure would have been, if we had know the other kinds of wealth making up household wealth for that community.

We identify the following 5 categories of assets on which material wealth inequality has been estimated: land, house area (the floor area of the main household dwelling), household wealth (including all measures of household assets, e.g. probate inventories, net worth, etc.), real estate (including buildings and land other than the main dwelling of a household) and grave wealth (goods buried with the individuals) and we adopt an empirical method to infer, in those cases in which the Gini coefficients was estimated on grave goods, land, house area, or real estate what could have been the corresponding distribution of household wealth inequality in the same society.

We first describe how we reconcile three wealth types – land, housing, and grave archaeological datasets for which inequality is measured, in the same society and in the same time period, for at least 2 among the previously listed asset types. Concerning land (indicated by storage area) and housing, we use the data from the archeological sites of Çatalhöyük, Demirergi, Twiss et al. (2000), Tell Brak and Tepe Gawra in ancient northern Mesopotamia Vaihingen and Heuneburg in late Neolithic and early Iron age south-west Germany, Bogaard, Styring et al. (2017) and Dolores archeological excavations in south-west Colorado, Kohler and Higgins (2016) to estimate the average relative difference between inequality of household wealth and inequality of house size and the average relative difference between the inequality of household wealth and the inequality of land. Household wealth inequality is itself estimated from land and housing inequality using the methods in section 3.1.1. [7]

The two mean relative differences are shown in the bottom line of Table 10. These are used to adjust the Gini coefficients in our dataset estimated either only on house size or only on land. For example, to approximate household wealth, a Gini coefficient estimated on housing will be adjusted upwards by 31.6 percent of its value, because where we are able to make direct comparisons, the difference between the household wealth and the housing Gini coefficients are, on average, 31.6 percent of the housing Gini. By similar reasoning, a Gini measured on land inequality will be reduced by 9.7 per cent of its value.

Using a similar method, we estimate the average difference between grave goods inequality and household wealth inequality. Lacking pre historical or historical observations, in which both the two measures of inequality are observed, we combine the results from adjusting land and housing wealth with the information provided in the archeological sites of Balkans, Porčić (2012), and those from South Mesopotamia, Stone (2016), where Gini coefficients are measured on burial sites and house space. From the Southern Mesopotamian dataset we use the data reported in table 5 of Stone (2016). There are shown 6 Gini coefficients of grave good inequality, dating from the Ubaid period (3000 BCE) to the Neo Babylonian one (500 BCE), and 4 house size measures of inequality corresponding to the Early Dynastic period (2500 BCE), and the Old and Neo Babylonian ones (1750 BCE and 500 BCE.)[8] Using these data, we can compare the inequality between grave goods and house size in 5 cases: 2 in Early

[7] We do not include in this estimation those cases in which the uncertainty of storage (Sabi Abyad, Jerf al Ahmar and Knossos) has involved some imputation or conjectural choice regarding the original data.

[8] For the Old Babylonian period, we use both the Gini computed from the archaeological excavations and the one from the written sources, see Stone (2016).

Dynastic (the single observation for house size is used twice), 2 in Old Babylonian (the single observation for grave goods is used twice) and 1 in Neo Babylonian. We use in the comparison the Gini coefficients after the correction to represent couples (section 2.1) and by zero adjustments. (Section 2.2.1)

We first estimate household wealth inequality in the Balkans and Mesopotamia increasing their Gini coefficients of house size by the adjustment to household wealth estimated from step 1, the 31.6 per cent upwards adjustment. Then, we estimate the average relative difference between the estimated inequality of household wealth (already adjusted to represent couples rather than individuals) and the inequality of grave goods.

This value, 5.7 percent, is the downward adjustment of inequality measured on grave goods to the estimated inequality of household wealth in the same society at the same time. The fact that grave wealth is more unequally distributed than household wealth is consistent with our signaling model of grave the grave wealth phenomenon, developed in section 4 below.

In Table 10 we show the Gini coefficients from archeological data used to estimate the asset adjustments. We use this adjustment to correct the Gini coefficients in our dataset computed on land, house area and grave goods. (We show in Table 18 the asset type of each estimate in our database)

We have used the ratio of correction of Gini coefficients of house area also to adjust the estimates of inequality of house rental values. The raw data, which are the average Gini coefficients across some 15th-19th cities in the Low Countries, Ryckbosch (2015), measure the inequality of house rental values, and mainly estimate the inequality among the main dwellings of the households. For this reason, even if we are aware that the rental values might have been not proportional to the house area, we use the house area adjustment ratio as a best approximation of their relationship with the total household wealth.

We implement a similar method to adjust the Gini coefficients estimated on taxable real estate in late medieval and early modern Italy. This asset category cannot be considered either as house area, as it usually excluded the main dwelling of a household, or as land, as this was not the only asset censed, Alfani (2015), Alfani (2017). We adjust it, implementing a method similar to the one used for the other asset categories and use the 1427 Florentine tax registers, Herlihy and Klapisch-Zuber (1985), in which both the real estate and other movables assets of households were censed. We estimate the relative difference between the Gini of household wealth (0.786) and the Gini of real estate (0.759), a measure, also in this case, including building and land and excluding the first house. The difference of the two measures of inequality relative to the Gini of household wealth is equal to 3.4 percent of the inequality of household wealth. We use this ratio to adjust upward the Gini coefficients of real estate in late medieval and early modern Tuscany and Piedmont.

Summarizing, we use the following measures to adjust our set of raw data:

- From house area to household wealth: we increase the original Gini by 31.6 percent of its value.
- From land to household wealth: we reduce the original Gini by 9.7 percent of its value
- From grave goods to household wealth: we reduce the original Gini by 5.7 percent of its value
- From real estate to household wealth: we increase the original Gini by 3.4 percent of its value.

Since the Southern Mesopotamia cases provided in Stone (2016) show, in some cases (Early Dynastic period and Old Babylonian), two Gini coefficients in the same period computed on two different assets from the same population, we add them in our dataset in the following way. We adjust both the two measure by the asset adjustment coefficient as explained in this section and then, because they are from the same location and time period, we average the two measures.

Region (1)	Period (2)	Gini (house size) (3)	Gini (hh wealth) (4)	Gini (land) (5)	Gini (grave) (6)	Relative difference between the Gini of household wealth and the Gini of house size (7)	Relative difference between the Gini of household wealth and the Gini of land (8)	Relative difference between the Gini of household wealth and the Gini of grave goods (9)
Central Anatolia - Çatalhöyük	6500 BCE	0.186	0.284	0.343	-	0.527	-0.148	-
SW Germany Vaihingen	5200 BCE	0.153	0.165	0.172	-	0.287	-0.125	-
North Mesopotamia - Tepe Gawra	4000 BCE	0.357	0.501	0.564	-	0.072	-0.042	-
North Mesopotamia - Tell Brak	3000 BCE	0.204	0.432	0.496	-	0.515	-0.068	-
SW Germany - Heuneburg Ivb2	600 BCE	0.274	0.566	0.605	-	0.424	-0.031	-
SW Germany - Heuneburg Iva1	600 BCE	0.371	0.645	0.665	-	0.345	-0.207	-
SW Colorado - Dolores	690 CE	0.240	0.330	0.360	-	0.272	-0.090	-
SW Colorado - Dolores	850 CE	0.280	0.305	0.325	-	0.081	-0.065	-
Balkans	4750 BCE	0.200	0.263	-	0.385	-	-	-0.31706479
South Mesopotamia	2500 BCE	0.587	0.772	-	0.766	-	-	0.008513739
South Mesopotamia	2500 BCE	0.587	0.772	-	0.781	-	-	-0.010855923
South Mesopotamia	1750 BCE	0.604	0.794	-	0.818	-	-	-0.028246481
South Mesopotamia	1750 BCE	0.640	0.842	-	0.818	-	-	0.029672603
South Mesopotamia	500 BCE	0.603	0.793	-	0.816	-	-	-0.027477538
Average difference of inequality measures						0.316 (0.071)	-0.097 (0.024)	-0.057 (0.129)

Table 10: **Gini coefficients in archaeological sites and the adjustment across different asset type.** Shown for each archeological dataset for which more than one measure of inequality is available, column (1), are the Gini computed on available asset types, columns (3)-(6), and the differences between the measures of inequality relative to inequality of household wealth, column (7)-(9), when wealth inequality had been assessed from at least 2 different assets. The Gini estimates of household wealth with white background, column (4), are from the Cobb Douglas aggregation of living and storage space (section 3.1.1.) The Gini in column (4) with green background color are obtained by adjusting upwards the Gini of housing, column (3), by the average relative difference between the Gini of household wealth and the Gini of housing wealth, estimated in those cases in which both the two observations are available. Shown in the last row are the relative mean differences between the Gini estimated on different asset types. (Standard errors in parentheses.)

4 Signaling and grave goods

If burying wealth with the deceased is a form of social signaling, we will see that it is likely that grave wealth will be more unequally distributed than the total wealth of the living population. Because it is the latter that is of interest (the grave wealth is just an indicator of total wealth) we would overestimate the degree of total wealth inequality by using unadjusted measures of grave wealth.

Here is a very simple model showing why this may occur. There is assumed to be one kind of wealth, and the amount held by an individual is w. When he dies his son (a clone of his dad, the population is asexual) inherits all of his wealth and places some amount of it g in the grave, retaining the remainder w-g. The son gains a social esteem value v for every unit of wealth that he buries with his late father. In additional to the social signaling value of the grave wealth, an individual's utility u is an increasing concave function of his wealth remaining after assigning some to the grave (marginal utility is positive but diminishing with increasing remaining wealth). So, with ln(w-g) as a suitable increasing concave utility function, we have for the son the following maximization problem. Choose g to maximize

$$u = \ln(w - g) + vg \tag{5}$$

Differentiating this with respect to g and setting the result equal to zero, we have the son's first order condition that determines the amount of grave wealth he should deposit as a function of the wealth he inherited from his father:

$$g = w - 1/v \text{ for } w > 1/v \text{ and } = 0 \text{ otherwise} \tag{6}$$

In the entire wealth distribution there will be two classes of sons: those with wealth equal to or less than $1/v$ who will deposit nothing in their father's grave and then those with greater wealth who will deposit an amount in the grave that increases proportionally as wealth increases. In this model those with wealth equal to or less than $1/v$ do not signal, and those with greater wealth deposit all wealth in excess of $1/v$ in the grave.

The fraction of wealth placed in the grave (dividing the above equation by w) is

$$g/w = 1 - 1/vw \tag{7}$$

which increases as wealth rises. The result is that for any non-degenerate distribution (e.g. perfect equality or its opposite, one person has the entire wealth) grave wealth (g) will be more unequally distributed than will wealth itself (w).

5 Population size and inequality

Due to the large variability in population size of estimates in our dataset, we check for any effect of scale on Gini estimates. The thought experiment motivating our scale adjustment is to suppose that we have data on a single village but would like to estimate the degree of inequality in the district of which that village is a part, along with other villages on which we do not have data. It is technically possible that the average inequality in the 'villages' would be greater than the inequality in the district; but this does not appear to be the typical case.

We expect that as larger populations will be more heterogeneous geographically, demographically, and even institutionally and culturally they will exhibit greater levels of wealth inequality. We have already seen that this is the case in our measures of inequality of grave wealth on the Columbia Plateau: the Gini for the entire population is 0.622 while the average of the Gini for the 22 burial sites is 0.568. (The source is the average value of the 22 Columbia Plateau Gini coefficients in column (5) of Table 2.)

Here and in the rest of our analysis, we have used the household as the measurement unit for population size. The main reason for this choice is that almost all of our sources report inequality estimates computed on household-level data. We know that the concept of household and its numerical dimension had not been constant over time. But if we consider households as consumption units its average size (adult equivalent) apparently did not radically change over time. Its composition was equivalent to 2-5 adults equivalent in mostly of the sedentary prehistoric societies (Gregg (1988), Cessford (2005)) and remained a relatively fixed small consumption unit in ancient and pre modern and modern societies, Goody (1996). For comparability we would like an estimate of the population size effect so that our estimates of the Gini coefficient refer to populations that are hypothetically the same benchmark size, which is 1000 households.

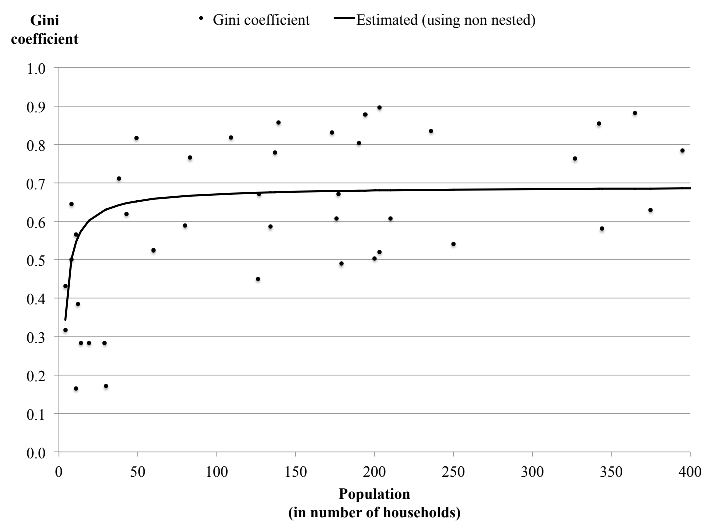
5.1 Methods: Naïve and nested.

A naïve approach to this problem would use an estimate of the statistical relationship between the Gini coefficient and population size to assign a predicted level of the Gini coefficient to each population size, and on this basis to adjust the observed Gini coefficient from its true population size to a hypothetical Gini coefficient at our benchmark size. We refer to this method as the 'non nested method'. Using our dataset of collected Gini coefficients, we estimate the following equation, through non linear least squares estimation,

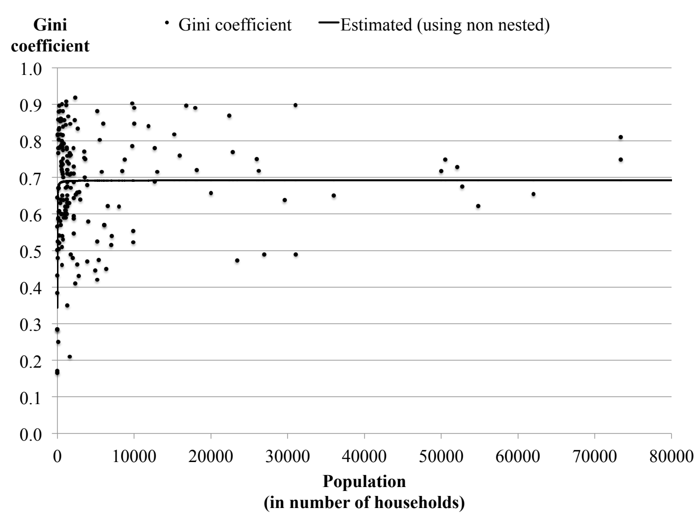
$$Gini_i = b_0 + \frac{1}{1-b_1}\left(Population_i^{1-b_1} - 1\right) + \varepsilon \qquad (8)$$

where $Gini_i$ and $Population_i$ are, respectively, the Gini coefficient and population size of each observations i from our dataset, while b_0 and b_1 are the coefficients to be estimated and ε is the error term. The estimated b_0 and b_1 coefficients are respectively equal to -0.464 (0.093) and 1.865 (0.072), with standard errors in parentheses. (Both the estimated coefficients are significant at 99% level.)

Figure 4 shows the Gini coefficients by the size of the population, in number of households, from which they are drawn and the values estimated with the non nested method. Small populations tend to have lower Gini coefficients but the positive association of scale and inequality is greatly mitigated or possibly even absent for larger population, where the non-nested estimation becomes almost flat. This suggests the need to undertake substantial upwards adjustments for populations significantly lower than our benchmark, with only modest adjustments for larger populations.



(a)



(b)

Figure 4: **Gini coefficient and population size.** Shown in panels (a) and (b) are the Gini coefficients (black dots) from our dataset and the value predicted by the estimated non nested function when population maximum is respectively 400 and 80,000 households. Source: text.

A more adequate method is based on the comparisons of the Gini coefficients for lower level population entities and the larger entities that they make up. This number along with the difference in population of the lower units and the upper unit gives us an estimate of the effect of population size on measured inequality. The advantage of this method is that we are able to estimate the size effect for population groups that are on average necessarily similar between the higher and lower level entities other than size, because the larger unit is composed of the smaller units. We call this method as the 'nested method', and as it corresponds exactly to our thought experiment it is the one that we use.

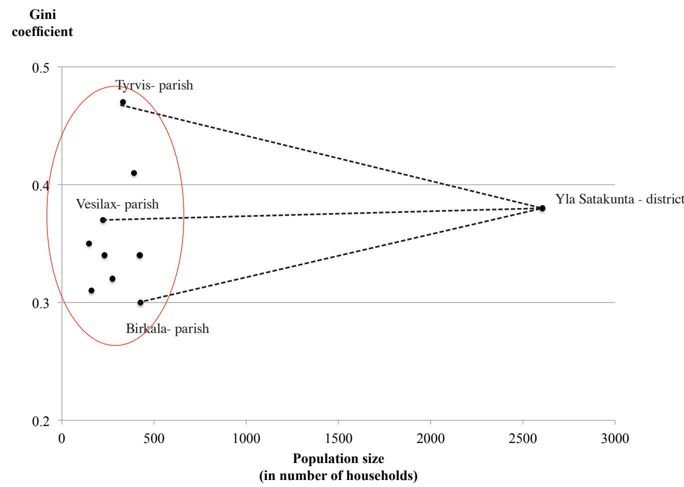
Three of our datasets allow us to estimate the difference between the Gini for the constituent lower level units and the Gini for the higher level unit of which these lower level units are a part: the Columbia Plateau dataset, Schulting (1995), the dataset for 1571 Finland,[9] and the data from the 1860 US census.[10] Using the 1571 Finland dataset we illustrate here how the scale effect is computed and how it compares to the non nested method in predicting the Gini coefficient of a higher level unit when the lower level unit is known.

The scale effect, γ, is computed as the difference between the Gini coefficient for the higher level entity, g_i, and the Gini coefficient for the lower level entity, g_j, divided by the difference between the population of the higher level entities, n_i, and the population of the lower one, n_j:

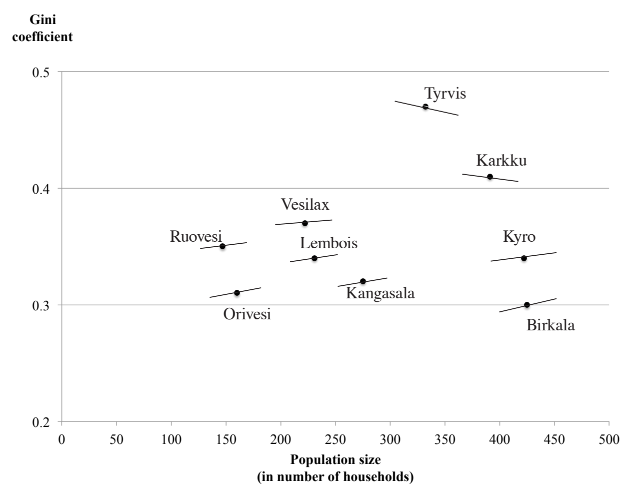
$$\gamma = \frac{g_i - g_j}{n_i - n_j} \tag{9}$$

In Figure 5 we show that the scale effect is, for each parish of one of the 1571 Finland district, the slope of the line connecting the Gini coefficient with the Gini at the district level of which the parishes were part.

[9] Data have been provided by Ilka Nummela, Nummela (2011).
[10] Raw data have been provided by Peter Lindert from the Lindert-Williamson data base underlying their 2016 book, Lindert and Williamson (2016).



(a)



(b)

Figure 5: **Examples of scale effect for one district in 1571 Finland.** Shown in panel (a) are the Gini coefficient and population size for each parish in the Yla Satakunta district in 1571 Finland (dots inside the red ellipse) and the Gini coefficient and population size at the district level. The three examples in panel (a) show when the scale effect is negative (Tyrvis), when it is positive but close to zero (Vesilax) and when it is positive and large (Birkala). Panel (b) shows, in more detail, the scale effects for each parish of the district.

We estimate a total of 127 scale effects in this way. Then, in Figure 6 we plot, for each administrative unit the relationship between its scale effect (multiplied by 10,000) and the population of the lower administrative units that constitute it. We observe that, as expected from results of the naïve estimation method, scale effects are large for small populations, but as the population increases a very sharp decline in the scale effect occurs with virtually no effect for large populations.

We develop a statistical summary of these data that will allow us to scale adjust the Gini coefficient for any population size in our Gini data set. To do this we fit a non parametric estimation of the relationship between scale and population: we first estimate a moving average of the scale effect with a varying size window containing at least 5 observations and then smooth it through a Kernel regression. We show the moving average and the kernel regression in Figure 6.

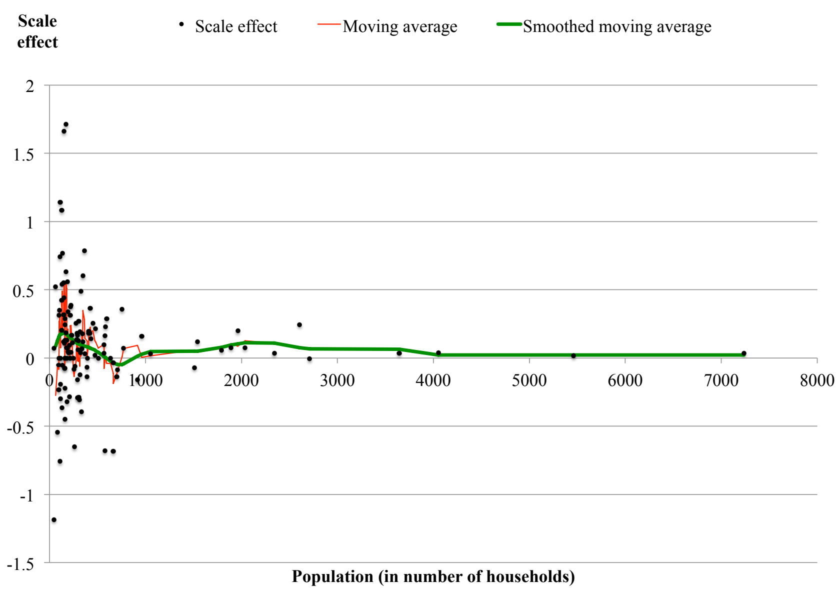


Figure 6: **Scale effect and population size in late medieval Finland.** Shown in the figure are the scale effects computed in 1571 Finland, (black dots) the moving average, (red line) and the kernel smooth of the moving average (green line.) Source: see text. The vertical axis is the scale effect times 10,000.

Interestingly the non parametric regression shows that the relationship between the scale effect and population size is, as expected, declining, but not necessarily monotonically. This feature captures the fact that the scale effect might also be negative, as also shown in the example in Figure 5, meaning that unequal lower administrative units might aggregate into a more equal higher administrative unit. As this adjustment method is an entirely data driven (not theory motivated) exercise, we do not seek to interpret the shape of the function that we have estimated.

We then check how the nested method compares with the non nested in predicting the Gini coefficient at a higher level entity when the Gini at a lower administrative level is known. We do this by estimating for 1571 Finland the Gini at the higher level using the scale predicted using the nested and the non nested (naïve) method. For the latter we use coefficients of the non nested function estimated across the Finland dataset (the coefficients of eq. (8) estimated with the Finland dataset are b_0=-0.957 (0.131) and b_1=1.733 (0.077) with standard errors in parentheses.) We find that the mean square error using the nested method (0.0025) is lower than the one when using the non nested, (0.0033). While demonstrating the superiority of the nested method, the associated mean absolute errors using the nested method is not small, namely 0.050 (the mean Gini coefficient in this data set, counting only the higher level entities is 0.403.)

5.2 The nested method and the adjustment of the Gini coefficients

Since the Finland observations start at a lower population level of 46 households and ends at 7237 households and many of our Gini coefficient estimates are either for quite small populations (particularly those based on archaeological data) or for larger ones, we design the nested adjustment estimating the scale effect from a combined dataset of the three historical nested databases that allow for the estimation of the scale effect across different levels of population. In particular, for the archaeological dataset of Columbia Plateau, Schulting (1995) using the methods just described for Finland, we estimate the scale effect between Gini of each site and at the whole population, while for the US 1860 dataset, we estimate the scale effect between counties and states, states and regions and regions and country.

The estimated scale effects at each population level are then used to derive the function of the Gini coefficient as a function of population size predicted through the nested method, which we call 'estimated pure scale effect function'. Because this function is derived from its estimated slopes it is arbitrary in its height, for illustrative purposes we anchor it to the value of the Gini predicted by the non nested function, estimated on our raw dataset, at 1000 households. We then reconstruct its value at each integer population level as the value of the Gini at the previous integer level plus the slope for that population level, estimated through the scale effect.

We show in Figure 7 one example of how the 'estimated pure scale effect' function is used to correct the Gini coefficient originally estimated at a population level smaller than the benchmark value of 1000 households used in our analysis (the method works in the same way for Gini coefficients estimated at population levels larger than 1000 households.) The figure shows the adjustment of the Gini estimated for the whole excavation at the Columbia Plateau (after the demographic and asset adjustments described in the previous sections.) The Gini g_i and g(249) are, respectively, the observed Gini in Columbia Plateau at the population level equal to 249 households (the Gini is the one adjusted by couples' adjustment and the number of household is estimated as half of the total number of burials, 498) and the expected Gini at that population level according to the estimated pure scale effect function. The residual r_i is obtained as the difference between g_i and g(249) and is added to the expected Gini at 1000 households, g(1000) to get the corrected Gini coefficient, $g^i(1000)$. The figure also shows that the resulting actual correction, equal to the difference between $g^i(1000)$ and g(1000), is 0.005.

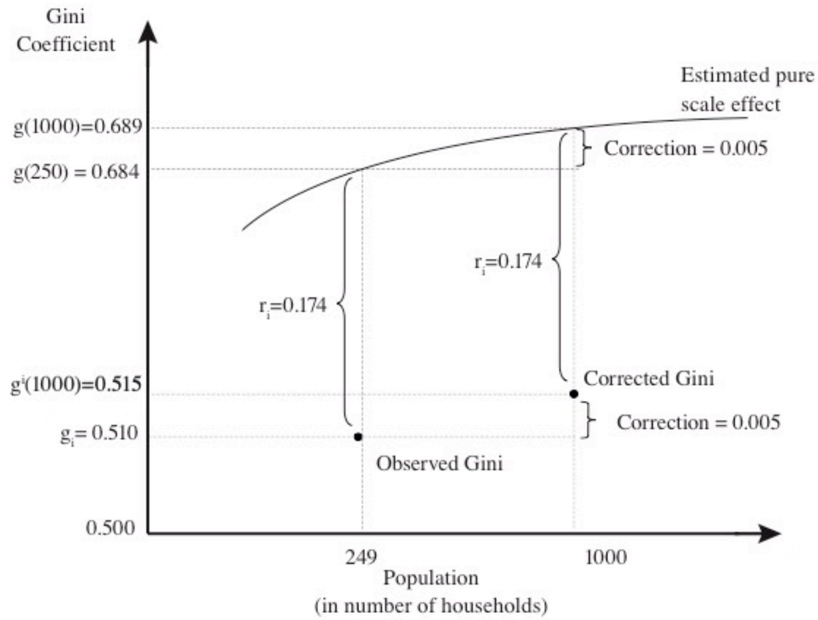


Figure 7: **The pure scale effect adjustment.** Shown in the figure is the scale effect adjustment when the population size on which the Gini coefficient was originally computed is smaller than the 1000 households benchmark population. The estimated pure scale effect function is reconstructed using the non parametric regression of the relationship between the scale effect and population size in the three datasets (see the procedure description in the text.)

6 A note on the interpretation of the Gini coefficient.

The illustrations of the meaning of a Gini coefficient of 0.68 are based on the following reasoning. Let Δ be the sum of the absolute differences between the all of the pairs of *n* wealth holders in a population and $\underline{y}$, the mean wealth. Then we have using Bowles and Carlin (2016) the following measure of the Gini coefficient

$$G = \frac{\Delta}{(n^2 - n)/2}\frac{1}{\underline{y}}\frac{1}{2} = \frac{\Delta}{n(n-1)}\frac{1}{\underline{y}} \qquad (10)$$

So the Gini is the mean difference among all pairs (the first term) relative to (divided by) the mean value of y (the "relative mean difference") times one half. (This expression for the Gini coefficient is a correction of the commonly used expression to provide unbiased estimates for small population sizes.) So the relative mean difference quoted in the text is simply 2G, a Gini coefficient of 0.68 indicating that the average difference between all pairs in the population is 1.36 times the mean wealth.

To interpret the Gini coefficient for wealth in a class based economy, consider a large two-class population whose size is normalized to 1, and suppose that the share of wealth owned by *m* poor wealth holders is *s*; the 1-*m* wealthy individuals own 1-*s* of the wealth. Then using again Bowles and Carlin (2016) we know that $G = m - s$, so if ninety-nine of a hundred identical wealth holders own 0.31 of the wealth and the remaining holder owns the rest, we have G = 0.99 – 0.31. = 0.68

7 Inequality and institutions in historical perspective

We classify in Table 11 our populations under the following necessarily somewhat arbitrary headings. The names given to these categories are less informative than a perusal of the actual populations included in each.

We then check for the statistical significance of the difference in inequality across those institutional categories. We do this by regressing the Gini coefficients on dummy variables for institutions: non state (*NonState*), autocratic states (*Autocratic*), slave states (*Slavery*), city states (*CityState*), national states (undemocratic) (*National*) and democratic and capitalist states (*Democratic*.) The null variable is the national states (undemocratic). The regression estimated is summarized in eq. (11)

$$Gini_i = b_0\text{-}b_1(NonState)_i + b_2(Slavery)_i + b_3(Autocratice)_i + b_4(CityState)_i + b_5(Democratic)_i + e_i \qquad (11)$$

with $b_0,..,b_5$ being the parameters to be estimated and e_i the error term.

As a robustness check, we estimate the eq.(11) using three sets of Gini coefficients: those adjusted only by couples and zero correction, those adjusted by couples and zero correction, and by asset types, and those adjusted also by population size. We show the results of the estimations in Table 12. In addition, we report in Table 13 the F-test for the significance of the difference between each pair of coefficients in the regression.

Institutional system (1)	Definition (2)	Data included (3)
Non -state	Lacking in any entity with an effective monopoly on the use of violence in a given territory including acephalous populations and big man systems. Here we also distinguish:	
	Labor - limited economies	Çatalhöyük, Jerf Al Ahmar, Vaihingen (SW Germany), Hornstaad (SW Germany).
	Material wealth - limited economies	Heuneburg (SW Germany), (10th-7th millennia BC), Durunkulak (Hamangia and Varna phases), Columbia Plateau, Dolores, Tell Sabi Abyad, Balkans, Hohokam.
Slave society	A significant fraction of the work force is made up of owned persons (irrespective of other aspects of its political structure)	Southern Mesopotamia (4th-2nd millennia BCE) Greece (4th century BCE), Roman Egypt and other colonies (2nd century BCE-6th century CE), South Africa (18th century), Brazil (18th century), US Southern states (1860).
Autocratic state	A national state (with taxation powers and standing army) lacking in effective limits on executive powers and representative institutions.	Tepe Gawra and Tell Brak (Northern Mesopotamia)[11], Aztec state (14th-15th century), Kingdom of France (13th-16th century), Kingdom of England (13th-17th century, up to the Glorious Revolution, 1688), 17th-18th century central and NW Italy, Denmark and Norway (18th century), Chinese Empire (11th-19th century), Republic of China (1935), Ottoman Empire (17th-18th century), contemporary Russia, Vietnam and China.
City state	A polis containing a single urban area and its hinterland.	Northern Italian cities (13th-16th century), German cities (15th-16th century), Low Countries cities (15th - 17th century).
National state (undemocratic)	Those with liberal and representative institutions both limited in scope (for example, a parliamentary system but substantial disenfranchisement of property less individuals.)	England (late 17th and 18th century), Low Countries (18th-19th century), Sweden and Finland (19th century), USA - Northern states (18th century, 1860), USA - All states (1870,1890).
Democracy & capitalism	Democracy: Modern national states with civil liberties, competitive elections and virtually universal (at least) male suffrage. Capitalism: work for wages and salaries in profit making firms the dominant form of private employment	Contemporary Japan, India, Canada, USA, Mexico, Turkey, Finland, Sweden, Norway, Germany, Italy, Bangladesh, Pakistan, Nigeria, Indonesia.

Table 11: **Institutional systems in our inequality database.** In column (1) the names of the main categories used in our classification are given. Definition of the categories and observations included are, respectively, in columns (2) and (3). Source: text and Table 18.

[11] According to Stein (2012), Northern Mesopotamia societies showed no political hierarchy and centralized bureaucracy until the 5th millennium BC, while they experienced those political features from the 4th millennium BCE, when they also had warfare systems. For this reason Jerf al Ahmar (10th millennium BC) and Tell Sabi Abyad (6th millennium BC) are considered as non states, while Tepe Gawra and Tell Brak (4th millennium BC) are considered as states.

Independent variables (1)	Whole dataset Gini coefficients before adjustments (2)	Gini adjusted per asset type (3)	Gini adjusted per asset type and population (4)
Intercept	0.653*** (0.021)	0.677*** (0.019)	0.677*** (0.019)
Non State	-0.220*** (0.036)	-0.259*** (0.034)	-0.248*** (0.033)
Slavery	0.174*** (0.033)	0.098*** (0.031)	0.103*** (0.030)
Autocratic	0.028 (0.026)	-0.004 (0.024)	-0.002 (0.023)
City state	0.015 (0.028)	0.026 (0.026)	0.025 (0.026)
Democratic	0.056* (0.031)	0.033 (0.029)	0.038 (0.029)
R^2	0.330	0.339	0.332
n	213	213	213

Table 12: **The effect of institutions on wealth inequality**. Shown are the OLS estimated coefficients of eq. (11). The null variable are the national states (undemocratic). For each dataset, the regression is estimated using the Gini coefficients prior to asset and population adjustments, (column 2), those adjusted by asset type, (column 3), and those adjusted by asset type and population size, (column 4). Standard errors in parentheses. ***Significant at 99%. **Significant at 95%. * Significant at 90%.

	Non state	**Slavery**	**Autocratic states**	**City states**	**National states (undemocratic)**
Slavery	F=91.61 (p<0.001)	-	-	-	-
Autocratic states	F= 61.94 (p<0.001)	F=14.61 (p=95e-5)	-	-	-
City states	F=69.47 (p<0.001)	F=7.01 (p=0.008)	F=1.56 (p=0.210)	-	-
National states (undemocratic)	F=53.46 (p<0.001)	F=11.23 (p<0.001)	F=0.13 (p=0.907)	F=0.93 (p=0.335)	-
Democratic and capitalist states	F=64.88 (p<0.001)	F=3.99 (p=0.004)	F=2.44 (p=0.119)	F=0.21 (p=0.642)	F=1.68 (p=05.19)

Table 13: **F-test on the coefficients of the institutional regression.** Each cell of the triangular matrix shows the F-statistics and the p-values for the null hypothesis that the corresponding pair of coefficients is equal.

8 A note on wealth inequality in contemporary Scandinavian countries

The literature provides different estimates of wealth inequality in contemporary economies. These differences do indeed suggest circumspection in interpreting the results. But as the Table 14 indicates, when one studies all of the estimates country by country one does not get the impression that the estimates that we have used (in bold in the table) diverge greatly from the alternatives, or that the use of the alternatives would radically change our conclusions. For example, we illustrate here the implication of such variety for the assessment of the, to some, surprisingly elevated levels of wealth inequality in the Nordic countries. The average absolute difference between the estimates we used and all of other estimates (for the countries in question) is 0.069 excluding our LWS non-home estimation and 0.07 including it. There is one major discrepancy in the data: the Gini coefficient for Sweden in 1985 (0.590) reported in Davies and Shorrocks (2000) is very different than the 17 other Gini estimates reported in the table just mentioned including the one computed by us from the LWS database. There is a clear upward trend from the late 70s to the late 90s (in the Sweden Statistics data set, which gives a value of 0.808 for the year 1985, in contrast to Davies and Shorrocks' 0.590.) But this trend is insufficient to explain the unusual Davies and Shorrocks estimate. Extensive email correspondence with the authors concerned failed to resolve the discrepancy in any definitive way. We used the Gini estimated from the LWS dataset (0.890) on grounds that it is more comparable with coefficients from other countries from the same dataset. However, even were we to the average of all of the Swedish estimates (0.840), or even the seemingly anomalous Davies and Shorrocks estimate alone it would not alter our conclusion, namely that the average wealth inequality in the Nordic nations is not substantially less then the rest of the data set.

Source		Wolff (2010)		Sierminska, Brandolini et al. (2006)	Davies and Shorrocks (2000)	Davies, Sandström et al. (2008)	Davies, Shorrocks et al. (2012)	Sweden (2000)	Klevmarken (2006)	(Flood and Klevmarken, 2010)	Epland and Kirkeberg (2012)	LWS (2012)(our computation)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Country	**Year**												
USA	1983	0.799	0.893		0.790								
	1989	0.832	0.926										
	1992	0.823	0.903										
	1995	0.828	0.914										
	1998	0.822	0.893										
	2000					0.800						**0.840 (0.05)**	0.940
	2001	0.826	0.888	0.810									
	2004	0.829	0.902										
	2007	0.834	0.908										
Canada	1984				0.690								
	1999			0.750								**0.760 (0.08)**	0.950
	2000					0.688							
Finland	1998			**0.680**									
Germany	1988				0.690								
	2000					0.660							
	2001											0.780	0.820
	2002			0.780									
	2006											**0.800 (0.05)**	0.810
Italy	1987				0.600								

Source		**Wolff (2010)**		**Sierminska, Brandolini et al. (2006)**	**Davies and Shorrocks (2000)**	**Davies, Sandström et al. (2008)**	**Davies, Shorrocks et al. (2012)**	**Sweden (2000)**	**Klevmarken (2006)**	**(Flood and Klevmarken, 2010)**	**Epland and Kirkeberg (2012)**	**LWS (2012)(our computation)**	
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Country	**Year**												
	2000					0.600							
	2002			0.610								**0.62 (0.03)**	0.7*
Sweden	1978							0.783					
	1983							0.798					
	1985				0.590			0.808					
	1988							0.831					
	1990							0.838					
	1992							0.865					
	1997							0.855					
	1999								0.860	0.930			
	2000									0.960			
	2001								0.840				
	2002			0.890					0.850			**0.890 (0.07)**	0.970*
	2003								0.850				
	2012						0.800						
UK	2000			0.660		0.697							
Norway	2009										**0.770**		
France	1986				0.710								
	2000					0.730							
Korea	1988				0.580								

Source		Wolff (2010)		Sierminska, Brandolini et al. (2006)	Davies and Shorrocks (2000)	Davies, Sandström et al. (2008)	Davies, Shorrocks et al. (2012)	Sweden (2000)	Klevmarken (2006)	(Flood and Klevmarken, 2010)	Epland and Kirkeberg (2012)	LWS (2012)(our computation)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Country	**Year**												
Japan	1984				0.520								
	2000					0.547							
	2003											**0.580 (0.05)**	0.660*

Table 14: **Wealth inequality from different sources in selected contemporary countries.** Gini coefficients are computed on net worth (total household assets minus liabilities). Gini coefficients in columns (3) andd (4) come from Wolff (2010) and are computed respectively on net worth and net worth excluding housing assets. In our computation from the LWS dataset we have also computed the Gini coefficients on total net worth, column (13), and net worth excluding housing, column (14). In bold are the coefficients we have included in our dataset and in parentheses are shown the averages of the absolute differences between the estimates we used and the all others (including our LWS non home estimations). Source: Wolff (2010), Sierminska, Brandolini et al. (2006), Davies and Shorrocks (2000), Davies, Sandström et al. (2008), Davies, Shorrocks et al. (2012), Sweden (2000), Klevmarken (2006), Flood (2008), Epland and Kirkeberg (2012) and LWS (2012).

9 Redistribution and market income

How much of between country differences in the degree of disposable income inequality can be explained (in an accounting sense) by inequalities in market income and redistribution respectively? Let the superscripts 1 and 0 refer to disposable and market income respectively. The definition of the redistribution ratio ϱ is

$$\rho = 1 - \frac{G^1}{G^0} \quad (12)$$

or

$$G^1 = G^0(1-\rho) \quad (13)$$

so

$$lnG^1 = lnG^0 + \ln(1-\rho) \quad (14)$$

and

$$var(lnG^1) = var(lnG^0) + var(\ln(1-\rho)) + 2cov(lnG^0, \ln(1-\rho)) \quad (15)$$

The last expression decomposes country differences in inequality in living standards into a part that is arguably due to the market value of endowments, a part that is due to redistribution of the income flows associated with these endowments, and the covariation of these two influences. Using the data in Wang and Caminada (2011)**,** we have the following decomposition.

Decomposition component	**Values**	**%**
Variance of *lnGini(marketincome)*	0.0194	0.284
Variance of *ln(1- ϱ)*	0.0465	0.681
Covariance of *[lnGini(marketincome),ln(1- ϱ)]*	0.0024	0.035
Variance of *lnGini(disposableincome)*	0.0683	1.000

Table 15: **Market income inequality and redistribution.** Decomposition of between-country differences in inequality in disposable income.

Among contemporary societies with a long tradition of democratic government, differences in the degree of income inequalities and associated disparities in living standards are not primarily due to differences in the degree of material wealth inequality but instead are almost entirely attributable to differences in the extent to which the incomes arising from differing assets and capacities are redistributed.

10 Labor limited farming economies: ethnographic and econometric evidence.

Our conjecture on the greater equality of labor-limited economies is based on the idea that food producing economies may differ considerably in whether the essential inputs to farming production can be owned, stored, accumulated, and transmitted across generations. Here we provide evidence on the differing importance of material wealth – which has these characteristics -- across production systems.

Ethnographic evidence. A group of economists and ethnographers wanted to know how important material wealth was to a population's livelihood compared to other forms of wealth, and how this varied across four production systems: hunter-gatherer, horticulture, pastoral, and farming (the latter distinguished from horticulture by its commercial nature, use of animal traction, and land scarcity). Two other forms of wealth considered were dimensions of individual capacities (or broadly, labor), which they termed 'embodied' (referring to an individual's health, strength and other individual capacities) and "network" (or relational) wealth referring to the individual's social ties, (Borgerhoff -Mulder, Bowles et al. 2009).

For each wealth class they solicited ethnographers' judgments of the percentage difference in household well-being that would be associated with a hypothetical one percent difference in amount of a given wealth class, holding other wealth classes constant at the average for that population, and requiring these percentage effects to sum to one. This is a subjective estimate of the exponent of each class of wealth in a Cobb-Douglas function.

The average values of the estimates by wealth class and economic system appear in Figure 8, in which the distance from the edge opposite the named vertex is a measure of how important the wealth type at the named vertex is. Consistent with descriptive ethnographies of these and other populations, embodied and relational wealth are relatively important for hunter-gatherers and horticultural peoples while material wealth is more important in pastoral and agricultural populations.

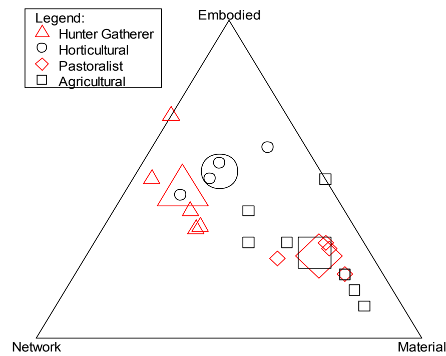


Figure 8: **Labor and material wealth as limits on livelihoods.** Coordinates sum to one; the small triangle on the left edge means, for example, that according to the ethnographer of that hunting and gathering society material wealth was unimportant while among the two other components, relational wealth was about 3 times as important as embodied wealth. Source: Table S1 in Borgerhoff -Mulder, Bowles et al. (2009).

Statistical estimates. In the same study, econometrically estimated measures of the importance of material wealth are also available, from diverse populations including two horticultural, two pastoral and seven small-scale agricultural economies, Borgerhoff - Mulder, Bowles et al. (2009) These are the exponent on material wealth in a Cobb-Douglas production function, corresponding exactly to the ethnographers' estimated quantities just mentioned. These estimates are remarkably close to the ethnographers' estimates. Table 16 summarizes these results.

Population (1)	Date (2)	Mode of production (3)	Material wealth (4)	Est. exponent β (Ethnographic est.) (5)	Source of econometric estimate (6)
Nyaturu Tz	1950s	Agro pastoralist	Cattle and land	0.76 (0.60)	Massell (1963)
India	1950s	Agriculture (all cereal)	Land	0.68 (0.59)	Bardhan (1973)
India	1950s	Agriculture (rice)	Land	0.33 (0.41)	Bardhan (1973)
Borara Ethiopia	2000s	Pastoral	Livestock	0.84 (0.61)	Berhanu, Coleman et al. (2007)
Borara Ethiopia	2000s	Horticultural	Land and livestock	0.23 (0.21)	Berhanu, Coleman et al. (2007)
Gambia	1940s	Horticultural	Land	0.11 (0.21)	Haswell (1953); Bowles (2011)

Table 16: **The importance of material wealth in horticultural, pastoral, and agricultural economies.** Source (Borgerhoff -Mulder, Bowles et al. 2009) based on Massell (1963); Bardhan (1973); Berhanu, Coleman et al. (2007); Haswell (1953)

Data from the same study, shown in Figure 9, indicate that the estimated importance of material wealth is positively associated with the estimated wealth inequality.

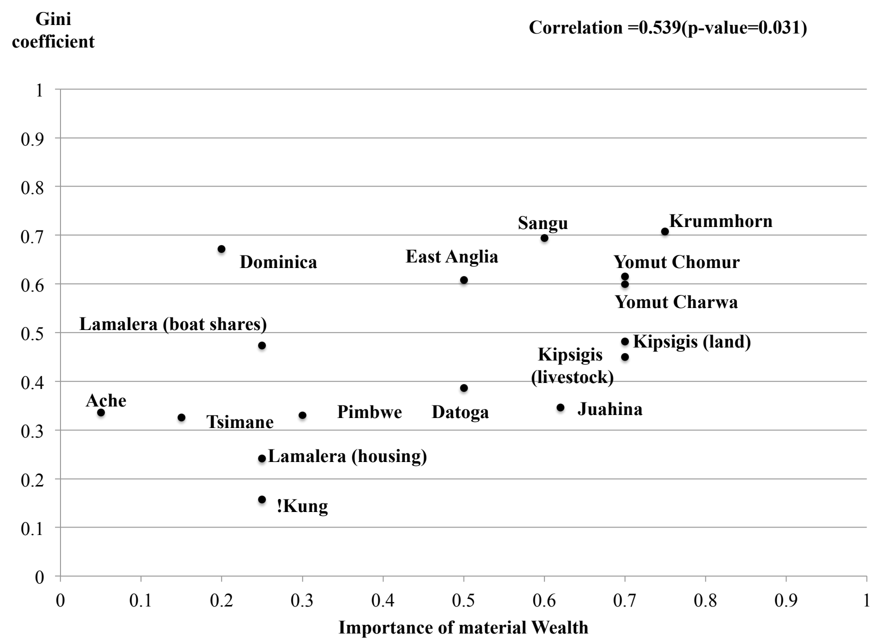


Figure 9: **The importance of material wealth and material wealth inequality in small scale societies** The simple correlation among the two variables is 0.539 (p = 0.031) Source: Bergerhoff Mulder, Bowles et al. (2009) except Pimbwe (subsequent data correction by ethnographer), !Kung (from (Fochesato and Bowles 2015), with the material wealth exponent for Jo'hansi (a !Kung community) reported in the source, and Ache (data supplied by Kim Hill, with the anthropologists' employees removed from the sample).

11 Sources used for somatic wealth and schooling inequality

In Table 17 we show the main information used for figure 4 in Fochesato and Bowles (2017). We measure schooling inequality using the average Gini coefficients in years of schooling across the 5-years birth cohorts spanning from 1960 through 1999 in the Hertz, Jayasundera et al. (2008) dataset. We are aware of the existence of an alternative series of Gini coefficients of schooling years presented in Castello and Domenech (2002) and based on the dataset firstly compiled by Barro and Lee (1996). The choice of the Gini computed from Hertz, Jayasundera et al. (2008) dataset allows us to have a more geographically representative dataset than the one available from Castello and Domenech

(2002). We also observe that for the 32 countries reported in both datasets the average Gini coefficients is similar: 0.312 using Hertz, Jayasundera et al. (2008) and 0.375 using Castello and Domenech (2002). The difference in means of the 32 observations across the two groups is not significantly different than zero (p=0.248.) Data used for material wealth frequency are explained in detail in this document and summarized in Table 18.

Type of wealth (1)	**Source (2)**	**n (3)**	**Societies/ countries included (4)**
Somatic wealth	Borgerhoff - Mulder, Bowles et al. (2009)	18	Hadza (grip strength), Tsimane (grip strength), Lamalera (reproductive success), Meriam (reproductive success), Gambians (reproductive success), Pimbwe (reproductive success), Tsimane (reproductive success), Datoga (reproductive success), Bengali (reproductive success), East Anglia (reproductive success), Khasi (reproductive success), Kipsigis (reproductive success), Skelleftea (reproductive success), Pimbwe (Farming Skills), Ache (Hunting and gathering returns), Tsimane (Hunting and gathering returns), Hadza (Hunting and gathering returns), Tsimane (Knowledge of skills)
Schooling	Hertz, Jayasundera et al. (2008)	42	Sweden, Denmark, Norway, Finland, United Kingdom, Ireland, Northern Ireland, Netherlands, Belgium, Italy, Switzerland, Poland, Czech Republic, Hungary, Slovakia, Ukraine, Estonia, Slovenia, USA, New Zealand, Rural China, South Africa, Colombia, Kyrgyzstan, Philippines, Chile, Malaysia, Sri Lanka, Vietnam, Panama, Ecuador, Indonesia, Peru, Brazil, Nicaragua, Bangladesh, Egypt, Ghana, East Timor, Ethiopia, Pakistan, Nepal

Table 17: **Data source and information on somatic and schooling inequality**. For each of the two types of wealth, column (1), shown are the sources used, column (2), the number of observations, column (3), and societies (or countries) used for the estimation of the average Gini coefficients reported in figure 4 in Fochesato and Bowles (2017).

12 Dataset description

Our data is restricted in a number of respects.

First, we have excluded estimates that are not based on individual or household data (for example estimates of wealth inequality based on group averages wealth and group population shares).

Second, where we have a great number of alternative estimates for similar dates and locations, so as not to overweight regions and time periods we have averaged them (as in the case of contemporary Sweden, or the Colombia Plateau fishing populations) or eliminated estimates that in our judgment were less reliable.

Third, we have preferred estimates computed on observations on wealth among all members of an economically connected communities. We do this so as to avoid the underestimation that would result if we treated separately the inequality in a village of land poor farmers and the adjacent hamlet of their landlords (or if we measured one but not the other of these). The estimates by Stephan (2013) of house size inequality in the Roman Empire are likewise excluded as they are based on a sample of houses throughout the Italian peninsula rather than an as exhaustive as possible survey of house sizes among members of an economically interacting community.

There are undoubtedly sources of data of which we are unaware – both archaeological and historical – that could provide the basis of further estimates. We hope that our essay will stimulate researchers to use their data to estimate measures of wealth inequality in comparable ways so as to advance the comparative study of economic disparity.

Table 18: **The dataset.** The table shows for any society included in the dataset, location, column (1);the year of the observation, column (2) (we use midpoint when the Gini is computed on a time interval); the asset type, column (3),;the political institution we have attributed to the observation, column (4); and the source for either the raw data or the Gini itself, column (5). Notes: (a) The year is the midpoint of the period interval provided in the original source. (b) The Gini is the average across the period given in the original source. (c) The Gini is the average value across the observations in a 50-years interval.

Society (1)	**Year (2)**	**Asset type (3)**	**Institution (4)**	**Source (5)**	**Notes (6)**
Jerf al Ahmar	9100 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Çatalhöyük	6500 BCE	Household wealth	Non state	Demirergi, Twiss et al. (2000)	(a)
Tell Sabi Abyad	6000 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Germany - Vaihingen	5000 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Durunkulak - Hamangia I and II	5100 BCE	Grave goods	Non state	Windler, Thiele et al. (2013)	(a)
Durunkulak - Hamangia III	4800 BCE	Grave goods	Non state	Windler, Thiele et al. (2013)	(a)
Central Balkans	4750 BCE	Grave goods	Non state	Porčić (2012)	(a)
Durunkulak - Hamangia IV	4550 BCE	Grave goods	Non state	Windler, Thiele et al. (2013)	(a)
Durunkulak - Varna I	4450 BCE	Grave goods	Non state	Windler, Thiele et al. (2013)	(a)
Durunkulak - Varna	4350 BCE	Grave goods	Non state	Windler, Thiele et al. (2013)	(a)
Mesopotamia –	4000	Grave goods	Autocratic state	Bogaard, Styring et al. (2017)	(a)

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
Tepe Gawra	BCE				
Mesopotamia - Ubaid	3000 BCE	Grave goods	Slavery	Stone (2016)	(a)
Mesopotamia – Tell Brak	3000 BCE	Grave goods	Autocratic state	Bogaard, Styring et al. (2017)	(a)
Mesopotamia - Khafajah	2500 BCE	Grave goods	Slavery	Stone (2016)	(a)
Mesopotamia – Ur	2500 BCE	Grave goods	Slavery	Stone (2016)	(a)
Mesopotamia – Ur	2250 BCE	Grave goods	Slavery	Stone (2016)	(a)
Germany - Hornstaad	3910 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Mesopotamia – Ur	1750 BCE	Grave goods	Slavery	Stone (2016)	(a)
Knossos	1500 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Columbia Plateau - All	1000 BCE	Grave goods	Non state	Schulting (1995)	(a)
Germany - Heuneburg	600 BCE	Household wealth	Non state	Bogaard, Styring et al. (2017)	(a)
Germany Heuneburg	600 BCE	Grave goods	Non state	Bogaard, Styring et al. (2017)	(a)
Mesopotamia – Ur	500 BCE	Grave goods	Slavery	Stone (2016)	(a)
Greece	321 BCE	Household wealth	Slavery	Kron (2011)	
Egypt	116 BCE	Land	Slavery	Bagnall (1992)	
Egypt	50	Land	Slavery	Bowman and Wilson (2009)	
Roman Empire	101	Land	Slavery	Duncan-Jones (1990)	
Roman Empire	102	Land	Slavery	Duncan-Jones (1990)	
Egypt	150	Land	Slavery	Bowman and Wilson (2009)	
Egypt	216	Land	Slavery	Bowman and Wilson (2009)	

Society **(1)**	**Year** **(2)**	**Asset type** **(3)**	**Institution** **(4)**	**Source** **(5)**	**Notes** **(6)**
Roman Empire	220	Land	Slavery	Duncan-Jones (1990)	
Roman Empire	300	Land	Slavery	Duncan-Jones (1990)	
Roman Empire	307	Land	Slavery	Duncan-Jones (1990)	
Egypt	308	Land	Slavery	Bowman and Wilson (2009)	
Egypt	350	Land	Slavery	Bagnall (1992)	
Egypt	525	Land	Slavery	Bagnall (1992)	
SW Colorado	690	Household wealth	Non state	Kohler and Higgins (2016)	(a)
SW Colorado	850	Household wealth	Non state	Kohler and Higgins (2016)	(a)
Hohokam - All	900	Grave goods	Non state	McGuire (1992)	(a)
China	1030	Land	Autocratic state	Zhao (1986)	
England	1280	Household wealth	Autocratic state	Bekar and Reed (2013)	
Italy - Perugia	1285	Household wealth	City state	Blanshei (1979)	
France - Paris	1292	Household wealth	Autocratic state	Sussman (2006)	
England - London	1292	Household wealth	Autocratic state	Sussman (2006)	
France - Paris	1296	Household wealth	Autocratic state	Sussman (2006)	
France - Paris	1297	Household wealth	Autocratic state	Sussman (2006)	
Italy - Piedmont	1300	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1300	Real estate	City state	Alfani (2015)	(b)
France - Paris	1313	Household wealth	Autocratic state	Sussman (2006)	
England - London	1319	Household wealth	Autocratic state	Sussman (2006)	
Italy - Piedmont	1350	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1350	Real estate	City state	Alfani (2015)	(b)
Aztec - Cuexcomate	1375	House area	Autocratic state	Smith, Dennehy et al. (2014)	
Italy - Piedmont	1400	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1400	Real estate	City state	Alfani (2015)	(b)

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
Low Countries	1400	House rental value		Ryckbosch (2015)	(b)
Italy - Florence	1427	Household wealth	City state	Herlihy and Klapisch-Zuber (1985)	
Germany - Freiburg	1445	Household wealth	City state	Fügedi (1980)	
Germany - Konstanz	1450	Household wealth	City state	Fügedi (1980)	
Italy - Piedmont	1450	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1450	Real estate	City state	Alfani (2015)	(b)
Holland - Hildesheim	1450	Real estate	City state	Fügedi (1980)	
Italy - Florence	1457	Household wealth	City state	Zanden (1995)	
Holland - Edam	1462	Household wealth	City state	Zanden (1993)	
Aztec - Cuexcomate	1475	House area	Autocratic state	Smith, Dennehy et al. (2014)	
Aztec - Yautepec	1475	House area	Autocratic state	Smith, Dennehy et al. (2014)	
Holland - Haarlem	1483	Household wealth	City state	Zanden (1993)	
Germany - Dresden	1488	Household wealth	City state	Fügedi (1980)	
Italy - Perugia	1498	Household wealth	City state	Blanshei (1979)	
Holland - Leiden	1498	Household wealth	City state	Zanden (1993)	
Holland - Zutphen	1498	Household wealth	City state	Zanden (1995)	
Germany - Augsburg	1498	Household wealth	City state	Zanden (1995)	
Italy - Piedmont	1500	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1500	Real estate	City state	Alfani (2015)	(b)
Low Countries	1500	House rental value	City state	Ryckbosch (2015)	(b)
Germany - Dresden	1502	Household wealth	City state	Fügedi (1980)	
Holland - s-Hertogenbosch	1503	Household wealth	City state	Hanus (2013)	
Italy - Perugia	1511	Household wealth	City state	Blanshei (1979)	
Holland – s-Hertogenbosch	1513	Household wealth	City state	Hanus (2013)	

Society **(1)**	**Year** **(2)**	**Asset type** **(3)**	**Institution** **(4)**	**Source** **(5)**	**Notes** **(6)**
Italy - Perugia	1518	Household wealth	City state	Blanshei (1979)	
England - Norwich	1525	Household wealth	Autocratic state	Our computation from Pound (1966)	
Low Countries	1525	House rental value	City state	Ryckbosch (2015)	(b)
Holland - Alkmaar	1534	Household wealth	City state	Zanden (1993)	
Germany - Weimar	1542	Household wealth	City state	Zanden (1993)	
Germany - Eisenach	1542	Household wealth	City state	Zanden (1993)	
France - Lyons	1545	Household wealth	Autocratic state	Our computation from Gascon (1971)	
Italy - Piedmont	1550	Real estate	City state	Alfani (2015)	(b)
Italy - Tuscany	1550	Real estate	City state	Alfani (2015)	(b)
Low Countries	1550	House rental value	City state	Ryckbosch (2015)	(b)
Low Countries	1553	Household wealth	City state	Hanus (2013)	
England	1555	Household wealth	Autocratic state	Overton (2006)	(a)
Holland - Amsterdam	1561	Household wealth	City state	Soltow and Zanden (1998)	
England	1565	Household wealth	Autocratic state	Overton (2006)	(a)
Finland	1571	Household wealth	Autocratic state	Nummela (2011)	
England	1575	Household wealth	Autocratic state	Overton (2006)	(a)
Low Countries	1575	House rental value	City state	Ryckbosch (2015)	(b)
England	1585	Household wealth	Autocratic state	Overton (2006)	(a)
England	1595	Household wealth	Autocratic state	Overton (2006)	(a)
Italy - Piedmont	1600	Real estate	Autocratic state	Alfani (2015)	(b)
Italy - Tuscany	1600	Real estate	Autocratic state	Alfani (2015)	(b)
Low Countries	1600	House rental value	City state	Ryckbosch (2015)	(b)
Germany - Augsburg	1604	Household wealth	City state	Zanden (1995)	
England	1605	Household wealth	Autocratic state	Overton (2006)	(a)
England	1615	Household wealth	Autocratic state	Overton (2006)	(a)

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
England	1625	Household wealth	Autocratic state	Overton (2006)	(a)
Low Countries	1625	House rental value	City state	Ryckbosch (2015)	(b)
Ottoman Empire - Cairo	1630	Household wealth	Autocratic state	Establet and Pascual (2009)	
England	1635	Household wealth	Autocratic state	Overton (2006)	(a)
England	1645	Household wealth	Autocratic state	Overton (2006)	(a)
Italy - Piedmont	1650	Real estate	Autocratic state	Alfani (2015)	(b)
Italy - Tuscany	1650	Real estate	Autocratic state	Alfani (2015)	(b)
Low Countries	1650	House rental value	City state	Ryckbosch (2015)	(b)
England	1655	Household wealth	Autocratic state	Overton (2006)	(a)
Cape Colony	1663	Household wealth	Slavery	Fourie and von Fintel (2010)	
England	1665	Household wealth	Autocratic state	Overton (2006)	(a)
England	1675	Household wealth	Autocratic state	Overton (2006)	(a)
Low Countries	1675	House rental value	City state	Ryckbosch (2015)	(b)
England	1675	Household wealth	Autocratic state	Di Matteo (2016)	(c)
USA	1675	Household wealth	Autocratic state	Soltow (1989)	(c)
England	1685	Household wealth	Autocratic state	Overton (2006)	(a)
Ottoman Empire	1690	Household wealth	Autocratic state	Establet and Pascual (2009)	
England	1695	Household wealth	National state (undemocratic)	Overton (2006)	(a)
Italy - Piedmont	1700	Real estate	Autocratic state	Alfani (2015)	(b)
Italy - Tuscany	1700	Real estate	Autocratic state	Alfani (2015)	(b)
Ottoman Empire - Damascus	1700	Household wealth	Autocratic state	Establet and Pascual (2009)	
East Anglia	1700	Household wealth	National state (undemocratic)	Borgerhoff -Mulder, Bowles et al. (2009)	
Krummhorn	1700	Land	National state (undemocratic)	Borgerhoff -Mulder, Bowles et al. (2009)	

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
Low Countries	1700	House rental value	National state (undemocratic)	Ryckbosch (2015)	(b)
England	1705	Household wealth	National state (undemocratic)	Overton (2006)	(a)
China	1706	Land	Autocratic state	Zhao (1986)	
China	1706	Land	Autocratic state	Zhao (1986)	
Cape Colony	1709	Household wealth	Slavery	Fourie and von Fintel (2010)	
England	1715	Household wealth	National state (undemocratic)	Overton (2006)	(a)
Brasil	1718	Household wealth	Slavery	Luna (1982)	
England	1725	Household wealth	National state (undemocratic)	Di Matteo (2016)	(c)
USA	1725	Household wealth	National state (undemocratic)	Soltow (1989)	
Ottoman Empire - Kastamonu	1731	Household wealth	Autocratic state	Cosgel (2013)	
Low Countries	1732	Land	City state	Soltow and Zanden (1998)	
England	1735	Household wealth	National state (undemocratic)	Overton (2006)	(a)
Ottoman Empire - Kastamonu	1736	Household wealth	Autocratic state	Cosgel (2013)	
China	1736	Land	Autocratic state	Zhao (1986)	
England	1745	Household wealth	National state (undemocratic)	Overton (2006)	(a)
Sweden	1750	Household wealth	National state (undemocratic)	Bengtsson (2016)	
Italy - Piedmont	1750	Real estate	Autocratic state	Alfani (2015)	(b)
Low Countries	1750	House rental value	National state (undemocratic)	Ryckbosch (2015)	(b)
Ottoman Empire - Cairo	1751	Household wealth	Autocratic state	Establet and Pascual (2009)	
Cape Colony	1757	Household wealth	Slavery	Fourie and von Fintel (2010)	

Society (1)	**Year (2)**	**Asset type (3)**	**Institution (4)**	**Source (5)**	**Notes (6)**
USA – Thirteen colonies	1774	Household wealth	National state (undemocratic)	Lindert (2000)	
Ottoman Empire – Kastamonu	1776	Household wealth	Autocratic state	Cosgel (2013)	
Ottoman Empire - Cairo	1787	Household wealth	Autocratic state	Establet and Pascual (2009)	
Denmark	1789	Household wealth	Autocratic state	Soltow (1979, 1981, 1985)	
Norway	1789	Household wealth	Autocratic state	Soltow (1979, 1981, 1985)	
USA	1798	Household wealth	National state (undemocratic)	Soltow (1989)	
Italy - Piedmont	1800	Real estate	Autocratic state	Alfani (2015)	(b)
Finland	1800	Household wealth	National state (undemocratic)	Soltow (1979, 1981, 1985)	
Sweden	1800	Household wealth	National state (undemocratic)	Bengtsson (2016)	
Low Countries	1800	House rental value	National state (undemocratic)	Ryckbosch (2015)	(b)
England	1810	Household wealth	National state (undemocratic)	Di Matteo (2016)	
Low Countries	1825	House value	National state (undemocratic)	Ryckbosch (2015)	(b)
USA	1825	Household wealth	National state (undemocratic)	Soltow (1989)	(c)
China	1832	Household wealth	Autocratic state	Myers (2008)	
Sweden	1850	Household wealth	National state (undemocratic)	Bengtsson (2016)	
Low Countries	1850	House rental value	National state (undemocratic)	Ryckbosch (2015)	(b)
China	1857	Land	Autocratic state	Myers (2008)	
USA - North	1860	Household wealth	National state (undemocratic)	Lindert (2000)	
USA - South	1860	Household wealth	Slavery	Lindert (2000)	

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
China	1862	Land	Autocratic state	Zhao (1986)	
USA	1870	Household wealth	National state (undemocratic)	Lindert (2000)	
Canada	1875	Household wealth	National state (undemocratic)	Di Matteo (2016)	(c)
England	1875	Household wealth	National state (undemocratic)	Di Matteo (2016)	(c)
USA	1890	Household wealth	National state (undemocratic)	Williamson and Lindert (1980)	
China	1895	Land	Autocratic state	Myers (2008)	
Sweden	1900	Household wealth	National state (undemocratic)	Bengtsson (2016)	
Low Countries	1900	House rental value	National state (undemocratic)	Ryckbosch (2015)	(b)
England	1902	Household wealth	National state (undemocratic)	Di Matteo (2016)	
China	1909	Land	Autocratic state	Zhao (1986)	
Canada	1925	Household wealth	National state (undemocratic)	Di Matteo (2016)	
China	1935	Land	Autocratic state	Zhao (1986)	(b)
China	1935	Land	Autocratic state	Zhao (1986)	(b)
Canada	1975	Household wealth	Democracy & capitalism	Di Matteo (2016)	(c)
England	1975	Household wealth	Democracy & capitalism	Di Matteo (2016)	(c)
USA	1975	Household wealth	Democracy & capitalism	Soltow (1989)	
India	1991	Household wealth	Democracy & capitalism	Subramanian (2006)	
Finland	1998	Household wealth	Democracy & capitalism	Sierminska, Brandolini et al. (2006)	
Canada	1999	Household wealth	Democracy & capitalism	LWS (2012)	
Sweden	2000	Household wealth	Democracy & capitalism	LWS (2012)	
Italy	2002	Household wealth	Democracy & capitalism	LWS (2012)	

Society (1)	Year (2)	Asset type (3)	Institution (4)	Source (5)	Notes (6)
USA	2000	Household wealth	Democracy & capitalism	LWS (2012)	
Mexico	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Turkey	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
UK	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
France	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Spain	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Taiwan	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Australia	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Netherlands	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
South Korea	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Brazil	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Argentina	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Switzerland	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
India	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Russia	2000	Household wealth	Autocratic state	Davies, Sandström et al. (2008)	
Indonesia	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Thailand	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Pakistan	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Vietnam	2000	Household wealth	Autocratic state	Davies, Sandström et al. (2008)	
Bangladesh	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Nigeria	2000	Household wealth	Democracy & capitalism	Davies, Sandström et al. (2008)	
Germany	2001	Household wealth	Democracy & capitalism	LWS (2012)	
Japan	2003	Household wealth	Democracy & capitalism	LWS (2012)	
Norway	2005	Household wealth	Democracy & capitalism	LWS (2012)	
China	2013	Household wealth	Autocratic state	Tang (2014)	

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