REVIEW

Inequality in the long run

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This Review presents basic facts regarding the long-run evolution of income and wealth inequality in Europe and the United States. Income and wealth inequality was very high a century ago, particularly in Europe, but dropped dramatically in the first half of the 20th century. Income inequality has surged back in the United States since the 1970s so that the United States is much more unequal than Europe today. We discuss possible interpretations and lessons for the future.

The distribution of income and wealth is a widely discussed and controversial topic. Do the dynamics of private capital accumulation inevitably lead to the concentration of income and wealth in ever fewer hands, as Karl Marx believed in the 19th century? Or do the balancing forces of growth, competition, and technological progress lead in later stages of development to reduced inequality and greater harmony among the classes, as Simon Kuznets thought in the 20th century? What do we know about how income and wealth have evolved since the 18th century, and what lessons can we derive from that knowledge for the century now under way? For a long time, social science research on the distribution of income and wealth was based on a relatively limited set of firmly established facts together with a wide variety of purely theoretical speculations. In this Review, we take stock of recent progress that has been made in this area. We present a number of basic facts regarding the long-run evolution of income and wealth inequality in advanced countries. We then discuss possible interpretations and lessons for the future.

Data and Methods

Modern data collection on the distribution of income begins in the 1950s with the work of Kuznets (*1*). Shortly after having established the first national income time series for the United States, Kuznets set himself to construct time series of income distribution. He used tabulated income data coming from income tax returns—available since the creation of the U.S. federal income tax in 1913—and statistical interpolation techniques based upon Pareto laws (power laws) to estimate incomes for the top decile and percentile of the U.S. population. By dividing by national income, Kuznets obtained series of U.S. top income shares for 1913 to 1948.

In the 1960s and 1970s, similar methods using inheritance tax records were developed to construct top wealth shares (*2*, *3*). Inheritance declarations and probate records dating back to the 18th and 19th centuries were also exploited by a growing number of scholars in France, the United States, and the United Kingdom (*4*–*7*).

Such data collection efforts on income and wealth dynamics have started to become more systematic and broader in scope and time only since the 2000s. This is due first to the advent of information technologies, which allow much larger volumes of data to be collected and processed than were accessible to previous generations of scholars. The second reason for this time gap in using tax data is that most modern research on inequality has focused on micro-survey data that became available in the 1960s and 1970s in many countries. Survey data, however, cannot measure top percentile incomes accurately because of the small sample size and top coding. The top percentile plays a very large role in the evolution of inequality that we will discuss. Survey data also have a much shorter time span—typically a few decades—than tax data that often cover a century or more.

Kuznets-type methods to construct top income shares were first extended and updated to the cases of France (*8*, *9*), the United Kingdom (*10*), and the United States (*11*). By combining the efforts of an international team of over 30 scholars, similar series covering most of the 20th century were constructed for more than 25 countries (*12*–*15*). The resulting "World Top Incomes Database" (WTID) is the most extensive data set available on the historical evolution of income inequality. The series is constantly being extended and updated and is available online (http://topincomes.parisschoolofeconomics.eu/) as a research resource for further analysis.

Historical top wealth shares series have also been constructed with similar methods, albeit for a smaller number of countries so far, but with a longer time frame (*16*–*21*). Drawing on previous attempts to collect historical national balance sheets (*22*), long-run series on the evolution of aggregate wealth-income ratios in the eighth largest developed economies were established, some of them going back to the 18th century (*23*).

This Review draws extensively on this body of historical research on income and wealth, as well as on a recently published interpretive synthesis (*24*). We start by presenting three basic facts that emerge from this research program (Figs. 1 to 3), and then turn to interpretations.

Income inequality in Europe and the United States, 1900–2010

Share of top income decile in total pretax income

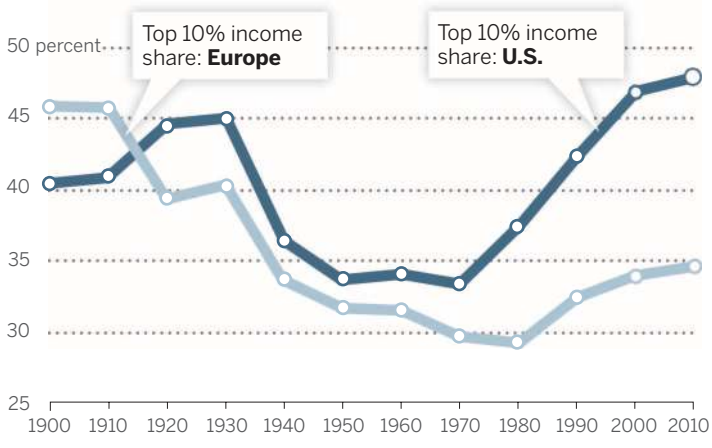

Fig. 1. Income inequality in Europe and the United States, 1900 to 2010. The share of total income accruing to top decile income holders was higher in Europe than in the United States from 1900 to 1910; it was substantially higher in the United States than in Europe from 2000 to 2010. The series report decennial averages (1900 = 1900 to 1909, etc.) constructed using income tax returns and national accounts. See (*24*), chapter 9, Fig. 9.8. Series available online at piketty.pse.ens.fr/capital21c.

Three Facts About Inequality in the Long Run

We find large changes in the levels of inequality, both over time and across countries. This reflects the fact that economic trends are not acts of God, and that country-specific institutions and historical circumstances can lead to very different inequality outcomes.

Income Inequality

First, we find that whereas income inequality was larger in Europe than in the United States a

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century ago, it is currently much larger in the United States. This is true for every inequality metric. The simplest and most powerful measure, on which we focus in this article, is the share of total income going to the top decile (Fig. 1).

On the eve of World War I (WWI), in the early 1910s, the top decile income share was between 45 and 50% of total income in most European countries. This applies in particular to the United Kingdom, France, Germany, and Sweden, which are the four countries that we use to compute the European average series reported in this article. At the same time, the top decile income share was slightly above 40% in the United States.

One century later, in the early 2010s, the inequality ordering between Europe and the United States is reversed. In Europe, the top decile income share fell sharply, from 45 to 50% to about 30%, between 1914 and the 1950s–1960s. It has been rising somewhat since the 1970s–1980s, and it is now close to 35% (somewhat less in continental Europe and somewhat more in the United Kingdom, which has experienced an evolution closer to that of the United States). That is, the top decile share in Europe is currently almost one-third smaller than what it used to be one century ago. The secular decline in inequality would be even larger if we took into account the rise of taxes and transfers, and measure instead income after taxes and transfers. Total tax revenues and public spending were less than 10% of national income in every country before WWI, and they are now on the order of 30 to 50% of national income in every developed country. Properly attributing taxes, transfers, and public spending to each income decile raises important measurement issues, however, particularly regarding in-kind transfers (such as health, education, or public good spending). In this Review, we therefore focus on the long-run evolution of the inequality of primary income (pretax, pretransfer).

In the United States, the top decile income share in 1910 was lower than in Europe, then rose in the 1920s, fell in the 1930s–1940s, and stabilized around 30 to 35% in the 1950s–1960s, slightly above European levels of the time. It then rose at an unprecedented pace since the 1970s–1980s, and is now close to 50%. According to this measure, primary income concentration is currently higher than it has ever been in U.S. history. It is also slightly higher than in pre-WWI Europe.

Wealth Inequality

Second, we observe the same "great inequality reversal" between Europe and the United States when we look at wealth inequality rather than income inequality. That is, the share of total net private wealth owned by the top 10% of wealth holders was notably larger in Europe than in the United States one century ago, while the opposite is true today (Fig. 2).

There are important differences between income and wealth inequality dynamics, however. First, we stress that wealth concentration is always much higher than income concentration. The top decile wealth share typically falls in the 60 to 90% range, whereas the top decile income share is in the 30 to 50% range. Even more striking, the bottom 50% wealth share is always less than 5%, whereas the bottom 50% income share generally falls in the 20 to 30% range. The bottom half of the population hardly owns any wealth, but it does earn appreciable income: On average, members of the bottom half of the population (wealth-wise) own less than one-tenth of the average wealth, while members of the bottom half of the population (income-wise) earn about half the average income.

In sum, the concentration of capital ownership is always extreme, so that the very notion of capital is fairly abstract for large segments—if not the majority—of the population. The inequality of labor income can be high, but it is usually much less extreme. It is also less controversial, partly because it is viewed as more merit-based. Whether this is justified is a highly complex and debated issue to which we later return.

Next, in contrast to income inequality, U.S. wealth inequality levels have still not regained the record levels observed in Europe before World War I. The U.S. top decile wealth share was about 70 to 80% in from 1870 to 1910, fell to 60 to 70% from 1950 to 1980, and has been rising above 70% in recent decades. Naturally, this means that wealth concentration has been high throughout U.S. history. But this also implies that there has always been a large fraction of U.S. aggregate wealth—about 20 to 30% —that did not belong to the top 10%. As the bottom 50% wealth share has always been negligible, this remaining 20 to 30% fraction corresponds to the share owned by the "middle 40%" (i.e., the intermediate group between the bottom 50% and the top 10%), a social group that one might want to call the "wealth middle class." The important point is that, to a large extent, there has always been a wealth middle class in the United States.

In contrast, wealth concentration was so extreme in pre-WWI Europe that there was basically no wealth middle class. That is, the top decile wealth share was close to 90% (or even somewhat higher than 90%, as in the UK), so that the middle 40% wealth holders were almost as poor as the bottom 50% wealth holders (the wealth share of both groups was close to or less than 5%). Between 1914 and the 1950s–1960s, the top decile wealth share fell dramatically in Europe, from about 90% to less than 60%. It has been rising since the 1970s–80s, and is now close to 65% (somewhat more in the United Kingdom, and somewhat less in Continental Europe). In other words, the wealth middle class now commands a larger share of total wealth in Europe than in the United States—although this share has been shrinking lately on both sides of the Atlantic.

Wealth inequality in Europe and the United States, 1870–2010

Share of top wealth decile in total net wealth

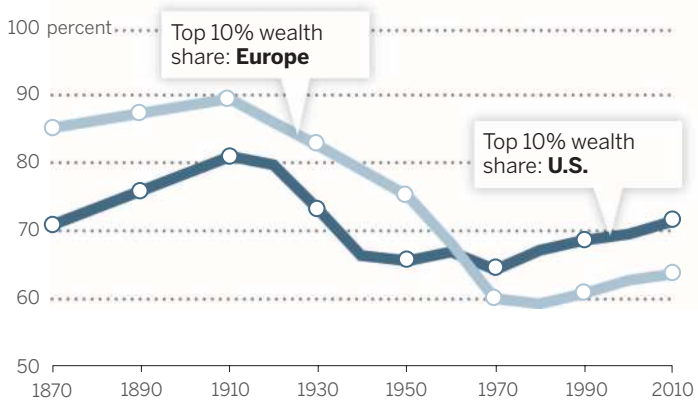

Fig. 2. Wealth inequality in Europe and the United States, 1870 to 2010. The share of total net wealth belonging to top decile wealth holders became higher in the United States than in Europe over the course of the 20th century. But it is still smaller than what it was in Europe before World War I. The series report decennial averages constructed using inheritance tax returns and national accounts. See (*24*), chapter 10, Fig. 10.6. Series available online at piketty.pse.ens.fr/capital21c.

Given that wealth inequality is lower in the United States today than in 1913 Europe, why is U.S. income inequality now as large as (or even slightly larger than) that in 1913 Europe? The reason is that modern U.S. inequality is based more on a very large rise of top labor incomes than upon the extreme levels of wealth concentration that characterized the "patrimonial" (wealth-based) societies of the past. In 1913 Europe, top incomes were predominantly top capital incomes (rent, interest, and dividends) coming from the very large concentration of capital ownership. Top U.S. incomes today are composed about equally of labor income and capital income. This generates approximately the same level of total income inequality, but it is not the same form of inequality.

Wealth-to-Income Ratios

Before further discussing the different possible interpretations for these important transformations, we introduce a third basic fact: If we look at the evolution of the aggregate value of wealth relative to income, we also find large historical

variations, again with striking differences between Europe and the United States (Fig. 3). This ratio is of critical importance for the analysis of inequality, as it measures the overall importance of wealth in a given society, as well as the capital intensity of production.

In every European country for which we have data, and in particular France, the United Kingdom, and Germany, the aggregate wealth-income ratio has followed a pronounced U-shaped pattern over the past century. On the eve of WWI, net private wealth was about equal to 6 to 7 years of national income in Europe. It then fell to about 2 to 3 years of national income in the 1950s. It has risen regularly since then, and it is now back to about 5 to 6 years of national income. Interestingly, we also find a similar pattern for Japan (*23*).

In contrast, the U.S. pattern is flatter: Net private wealth has generally equalled about 4 to 5 years of national income in the United States, with much less variation than in Europe or Japan. The U.S. pattern is also slightly U-shaped—with aggregate wealth-income ratios standing at a relatively lower level in the mid-20th century than at both ends of the century. But it is clearly much less marked than in Europe.

The comparison between Figs. 1 and 3 is particularly striking. Both figures have two U-shaped curves, but these are clearly different. The United States displays a U-shaped pattern for income inequality (mostly driven by the large rise of top labor incomes in recent decades). Europe (and Japan) shows a U-shaped pattern for aggregate wealth-income ratios. The United States is the land of booming top labor incomes; Europe is the land of booming wealth (albeit with a lower wealth concentration than in the United States). These are two distinct phenomena, involving different economic mechanisms and different parts of the developed world.

Interpreting the Long-Run Evidence

We now turn to the discussion of possible interpretations and lessons for the future. We stress at the outset that what we have to offer is little more than an informed discussion. Although we have at our disposal much more extensive historical and comparative data than were available to previous researchers, existing evidence is still far too incomplete and imperfect for a rigorous quantitative assessment of the various causes at play. Several different mechanisms have clearly played an important role in the evolution of income and wealth depicted in Figs. 1 to 3, but it is extremely difficult to disentangle the individual processes. We are not in the domain of controlled experiments: We cannot replay the 20th-century income and wealth dynamics as if the world wars, the rise of progressive taxation, or the Bolshevik revolution did not happen. Still, we can try to make some progress.

Wealth-to-Income Ratios

The relatively easier part of the story is the long-run evolution of aggregate wealth-to-income ratios (Fig. 3). The fall of European wealth-income ratios following the 1914–1945 capital shocks can be well accounted for by three main factors: direct war-related physical destruction of domestic capital assets (real estate, factories, machinery, equipment); lack of investment (a large fraction of 1914–1945 private-saving flows was absorbed by the enormous public deficits induced by war financing; there was also massive dissaving in some cases, e.g., foreign assets were sold to purchase government bonds; the resulting public debt was eventually wiped away by inflation); and a fall in relative asset prices (real estate and stock market prices were both historically very low in the immediate postwar period, partly due to rent control, nationalization, capital controls, and various forms of financial repression policies). In France and Germany, each of these three factors seems to account for about one-third of the total decrease in wealth-income ratios. In the United Kingdom, where domestic capital destruction was of limited importance (less than 10% of the total), the other two factors each account for about half of the decline in the aggregate wealth-income ratio (*23*, *24*).

Why did the postwar recovery of European wealth-income ratios take so much time? The simplest way to understand why capital accumulation is a slow process is to consider the following elementary arithmetic: With a saving rate of 10% per year, it takes 50 years to accumulate the equivalent of 5 years of income.

How is the long-run equilibrium wealth-income ratio determined, and why does it seem to vary across countries and over time? A simple yet powerful way to think about this issue is the so-called Harrod-Domar-Solow formula (*23*). In the long-run, assuming no systematic divergence between the relative price of capital assets and consumption goods, one can show that the wealth-to-income (or capital-to-income) ratio $\beta_t = K_t/Y_t$ converges toward $\beta = s/g$, where s is the long-run annual saving rate and g is the long-run annual total growth rate. The growth rate g is the sum of the population growth rate (including immigration) and the productivity growth rate (real income growth rate per person). This formula holds whether savings are invested in domestic or foreign assets (it also holds at the global level).

That is, with a saving rate $s = 10\%$ and a growth rate $g = 3\%$, then $\beta \approx 300\%$. But if the growth rate drops to $g = 1.5\%$, then $\beta \approx 600\%$. In short: Capital is back because low growth is back.

Intuitively, in a low-growth society, the total stock of capital accumulated in the past can become very important. In the extreme case of a society with zero population and productivity growth, income Y is fixed. As long as there is a positive net saving rate $s > 0$, the quantity of accumulated capital K will go to infinity. Therefore, the wealth-income ratio $\beta = K/Y$ would rise indefinitely (at some point, people in such a society would probably stop saving, as additional capital units become almost useless). With positive but small growth, the process is not as extreme: The rise of β stops at some finite level. But this finite level can be very high.

One can show that this simple logic can account relatively well for why the United States accumulates structurally less capital relative to its annual income than Europe and Japan. U.S. population growth rates exceed 1% per year, thanks to large immigration flows, so total U.S. growth rates—including productivity growth of around 1 to 1.5%—are at least 2 to 2.5% per year, if not 2.5 to 3%. By contrast, population growth in Europe and Japan is now close to zero, so that total growth is close to productivity growth, i.e., about 1 to 1.5% per year. This is further reinforced by the fact that U.S. saving rates tend to be lower than in Europe and Japan. To the extent that population growth will eventually decline almost everywhere, and that saving rates will stabilize, this also implies that the return of high

Wealth-to-income ratios in Europe and the United States, 1900–2010

Market value of net private wealth (% national income)

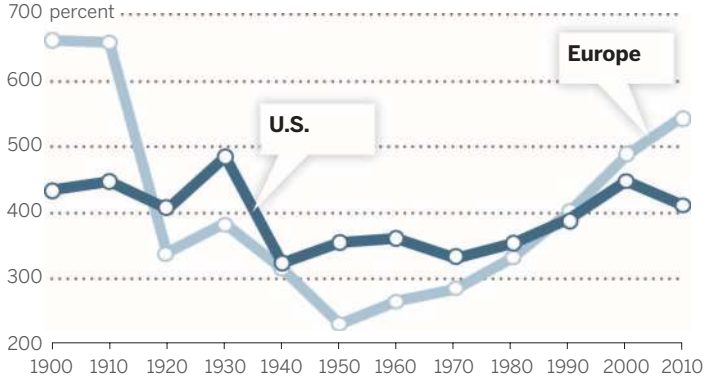

Fig. 3. Wealth-to-income ratios in Europe and the United States, 1900 to 2010. Total net private wealth was worth about 6 to 7 years of national income in Europe before World War I, fell to 2 to 3 years in 1950–1960, and increased back to 5 to 6 years in 2000–2010. In the United States, the U-shape pattern was much less marked. The series report decennial averages (1900 = 1900 to 1909, etc.) constructed using national accounts. See (*24*), chapter 5, Fig. 5.1. Series available online at piketty.pse.ens.fr/capital21c.

capital-to-income ratios will apply at the global level in the very long run (*23*, *24*).

The share of capital income in national income is defined as $\alpha = rK/Y = r\beta$, where r is the average annual real rate of return on wealth. For instance, if $r = 5\%$ and $\beta = K/Y = 600\%$, then $\alpha = 30\%$. Whether the rise in the capital income ratio β will also lead to a rise in α is a complicated issue.

In the standard economic model with perfectly competitive markets, r is equal to the marginal product of capital (that is, the additional output produced by one additional capital unit, all other things being equal). As the volume of capital β rises, the marginal product r tends to decline. The important question is whether r falls more or less rapidly than the rise in β. This depends on what economists define as the elasticity of substitution σ between capital and labor in the production function $Y = F(K, L)$.

A standard hypothesis in economics has been to assume a unitary elasticity, in which case the fall in r exactly offsets the rise in β, so that the capital share $\alpha = r\beta$ is a technological constant. However, historical variations in capital shares are far from negligible: α typically varies in the 20 to 40% range (and the labor share $1 - \alpha$ in the 60 to 80% range). In recent decades, rich countries have experienced both a rise in β and a rise in α, which suggests that σ is somewhat larger than 1. Intuitively, it makes sense to assume that σ tends to rise over the development process, as there are more diverse uses and forms for capital and more possibilities to substitute capital for labor (e.g., replacing delivery workers by drones or self-driving trucks).

Whether the capital share α will keep rising in future decades is an open question. It depends both on technological forces and on the bargaining power of capital and labor and the collective institutions regulating the capital-labor relationship (the simple economic model with perfectly competitive markets is likely excessively naïve). But from a logical standpoint, this is a plausible possibility, especially if the population and productivity growth slowdown pushes the global capital income ratio β toward higher levels.

Wealth Inequality: r > g

We now move to an even more complicated—and arguably more important—issue: the long-run dynamics of wealth inequality (Fig. 2). High capital intensity, as measured by high β and α, is not bad in itself. After all, it would be good to have an infinite quantity of robots producing most of the output, so that we can devote more time to leisure activities. The problem is twofold: Can we all find jobs as a robot designer (or in leisure-related activities), and who owns the robots? In practice, the concentration of capital ownership always seems to be very high—much more than the concentration of labor income (Figs. 1 and 2). The "patrimonial" (wealth-based) societies of Europe one century ago were characterized not only by very high β and α, but also by extreme capital concentration, with a top decile wealth share of around 90%.

How can we account for the very high level of wealth concentration that we observe in historical series, and what does this tell us about the future? The most powerful model to analyze structural changes in wealth inequality is a dynamic model with multiplicative random shocks. That is, assume that the individual-level wealth process has the following general form: $z_{it+1} = \omega_{it} z_{it} + \varepsilon_{it}$, where z_{it} is the position of individual i in the wealth distribution prevailing at time t (i.e., $z_{it} = k_{it}/k_t$ where k_{it} is net wealth owned by individual i at time t, and k_t = average net wealth of the entire population at time t), ω_{it} is a multiplicative random shock, and ε_{it} is an additive random shock.

The shocks ω_{it} and ε_{it} can be interpreted as reflecting different types of events that often occur in individual wealth histories, including shocks to rates of return (some individuals may get returns that are far above average returns; investment strategies may fail and lead to family bankruptcy); shocks to demographic parameters (some families have many children; some individuals die young); shocks to preferences parameters (some individuals like to save, some prefer to consume their wealth); shocks to productivity parameters (capital income is sometimes supplemented by high labor income); and so on.

Importantly, for a given structure of shocks, the variance of the multiplicative term ω_{it} is an increasing function of $r - g$, where r is the (net-of-tax) rate of return and g is the economy's growth rate. Intuitively, a higher $r - g$ tends to amplify initial wealth inequalities: It implies that past wealth is capitalized at a faster pace, and that it is less likely to be overtaken by the general growth of the economy. Under fairly general conditions, one can show that the top tail of the distribution of wealth converges toward a Pareto distribution, and that the inverted Pareto coefficient (measuring the thickness of the upper tail and hence the inequality of the distribution) increases with $r - g$ (*3*, *14*, *24*–*26*).

The dynamic wealth accumulation model with multiplicative shocks can explain the extreme levels of wealth concentration that we observe in the data much better than alternative models. In particular, if wealth accumulation were predominantly driven by lifecycle or precautionary motives, then wealth inequality would not be as large as what we observe (it would be comparable in magnitude to income inequality, or even lower).

The dynamic multiplicative model can also help to explain some of the important historical variations that we observe in wealth concentration series.

Rate of return vs. growth rate at the world level, Antiquity–2100

Annual rate of return or rate of growth

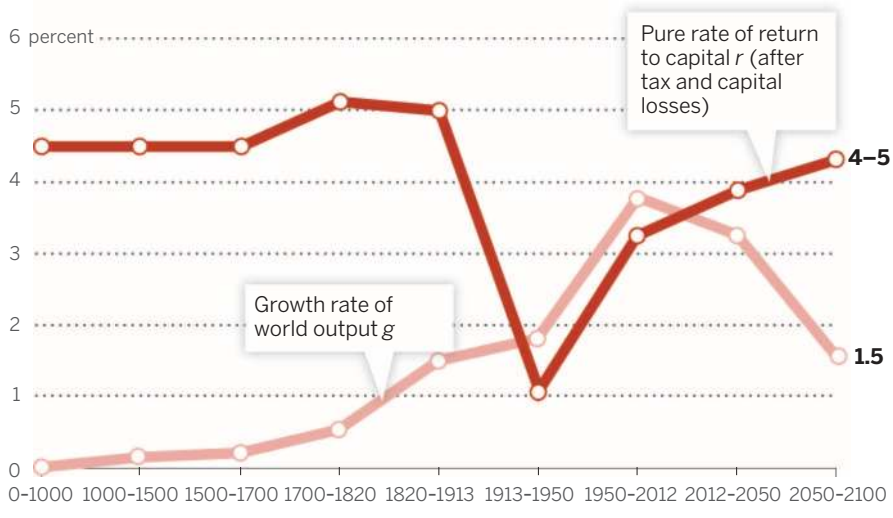

Fig. 4. Rate of return versus growth rate at the global level, from Antiquity until 2100. The average rate of return to capital (after tax and capital losses) fell below the growth rate in the 20th century. It may again surpass it in the 21st century, as it did throughout human history except in the 20th century. The series was constructed using national accounts for 1700 and after and historical sources on growth and rent to land values for the period before 1700. See (*24*), chapter 10, Fig. 10.10. Series available online at piketty.pse.ens.fr/capital21c. The future values for g are based upon UN demographic projections (median scenario) for population growth and on the assumption that between-country convergence in productivity growth rates will continue at its current pace. The future values for r are simply based upon the continuation of current pretax values and the assumption that tax competition will continue. See (*24*), chapter 10, Fig. 10.10. Series available online at piketty.pse.ens.fr/capital21c.

In particular, it is critical to realize that $r - g$ was very large during most of human history (Fig. 4). Growth was very low until the industrial revolution (much less than 1% per year), whereas average rates of return were typically on the order of 4 to 5% per year (historically, in preindustrial agrarian societies, annual rent on land, the main capital asset, was about 4 to 5% of the land value) and taxes were minimal. Growth rates rose substantially during the 18th and 19th centuries, but they remained relatively small (1 to 1.5%) compared to rates of return. This large gap between r and g explains why wealth concentration was so large until World War I and why wealth concentration was smaller in the United States, where population growth was faster.

During the 20th century, growth rates were exceptionally high (in particular due to very high population growth, which even today represents about half of global gross domestic product growth), and rates of return were severely reduced by capital shocks (destructions) and the rise of taxation. Simple simulations show that this effect is quantitatively sufficiently important to explain why wealth concentration did not return to pre-WWI levels in the postwar period.

Other factors might also have played a role. For instance, the rise of the wealth middle class might partly come from the fact that the growth of incomes and living standards eventually induced the rise of middle class saving. However, this process does not seem to have taken place in pre-WWI Europe, because of the powerful unequalizing impact of the $r - g$ factor (*17*, *21*, *24*, *27*).

To the extent that population growth (and possibly productivity growth) will slow down in the 21st century, and that after-tax rates of return to capital will rise (due to rising international tax competition to attract capital, and maybe also to changing technology), it is likely that $r - g$ will increase again in the 21st century, which could lead to a structural rise in wealth concentration.

This model seems to capture relatively well some of the evolutions that we are currently observing at the global level. For instance, if we use the global billionaires rankings published by *Forbes* magazine since 1987, we find that the very top fractiles of the global wealth distribution have been rising on average at about 6 to 7% per year in real terms over the 1987–2013 period, i.e., more than three times as fast as average global wealth (about 2% per year over the same period) (*24*).

We stress, however, that our ability to properly measure and monitor the dynamics of the global distribution of wealth is far from being satisfactory. National statistical institutes as well as international organizations are facing major difficulties in tracking down cross-border wealth, and magazines are ill-equipped to produce rigorous statistics. Despite some recent progress in this area (*28*), our ability to measure global wealth is also severely limited by the rise of tax havens (*29*).

The Dynamics of Income Inequality

We finally return to the most difficult and uncertain part: the long-run dynamics of income inequality (Fig. 1). This is the most difficult part because income inequality combines forces arising from the inequality of capital ownership and capital income (which, as we have just seen, are relatively complex) and forces related to the inequality of labor income (which involve a different set of economic and social processes).

Kuznets posited that income inequality first rises with economic development when new, higher-productivity sectors emerge (e.g., manufacturing industry during the industrial revolution) but then decreases as more and more workers join the high-paying sectors of the economy. Our data show that this is not the reason that income inequality declined in developed countries during the first half of the 20th century. The compression of incomes occurred primarily because of the fall of top capital incomes induced by the world wars, the Great Depression, and the regulatory and fiscal policies developed in response to these shocks. In particular, there was no structural decline in the inequality of labor income (*8–13*, *24*). Kuznets' overly optimistic theory of a natural decline in income inequality in market economies largely owed its popularity to the Cold War context of the 1950s as a weapon in the ideological fight between the market economy and socialism (*24*).

What are the main forces that determine the level of labor income inequality in the long-run? The most widely used economic model is based on the idea of a race between education and technology (*30*). That is, the expansion of education leads to a rise in the supply of skills, while technological change leads to a rise in the demand for skills. Depending on which process occurs faster, the inequality of labor income will either fall or rise.

One proposed explanation for the increase of inequality in recent decades has been the rise in the global competition for skills, itself driven by globalization, skill-biased technical change and the rise of information technologies. Such skill-biased technological progress is not sufficient to explain important variations between countries: The rise of labor income inequality was relatively limited in Europe (and Japan) compared to the United States, despite similar technological changes. In the very long run, European labor income inequality appears to be relatively stable (there is no major downward or upward trend in the wage shares received by the various deciles and percentiles of the wage distribution). This suggests that the supply and demand for skills have increased approximately at the same pace in Europe

Could the particularly large increase in U.S. labor income inequality in recent decades be explained by insufficient educational investment for large segments of the U.S. labor force? In that case, massive investment in higher education would be the right policy to curb rising income inequality (*30*). Although this view is very appealing, it cannot account for all of the facts. In particular, the race between education and technology fails to explain the unprecedented rise of very top labor incomes that has occurred in the United States over the past few decades. A very large part of the rise in the top 10% income share comes from the top 1% (or even the top 0.1%). This is largely due to the rise of top executive compensation in large U.S. corporations (both financial and nonfinancial). We discuss in the supplementary online material how changes in tax policy, as well as social norms regarding pay equality, likely play a key role in shaping labor income inequality.

To summarize: Inequality does not follow a deterministic process. In a sense, both Marx and Kuznets were wrong. There are powerful forces pushing alternately in the direction

Box 1. Income and wealth: definitions

Income is a flow. It corresponds to the quantity of goods and services produced and distributed each year. Income can be decomposed as the sum of labor income (wages, salaries, bonuses, earnings from nonwage labor, and other remuneration for labor services) and capital income (rent, dividends, interest, business profits, capital gains, royalties, and other income derived from owning capital assets). In this Review, we focus on the long-run evolution of the inequality of primary income, defined as income before taxes and government transfers. In contrast, disposable income is defined as income after taxes and government transfers. Although we do not analyze disposable income in this article, comparing inequality of primary income and inequality of disposable income is useful to assess the role of the government in reducing income inequality.

Wealth (or capital) is a stock. It corresponds to the total wealth owned at a given point in time. This stock comes from the wealth appropriated or accumulated in the past. In the context of this article, wealth is defined as nonhuman net worth, i.e., the sum of nonfinancial and financial assets, net of financial liabilities (debt). National wealth is the sum of private wealth (net worth owned by private individuals) and public wealth (net worth owned by the government and other public agencies). In this article, we focus on the level and distribution of private wealth. More details on these definitions, concepts, and corresponding series are provided in (*23*, *24*).

of rising or shrinking inequality. Which one dominates depends on the institutions and policies that societies choose to adopt.

REFERENCES

1. S. Kuznets, *Shares of Upper Income Groups in Income and Savings* (National Bureau of Economic Research, Cambridge, MA, 1953).
2. R. J. Lampman, *The Share of Top Wealth holders in National Wealth, 1922-1956* (Princeton Univ. Press, Princeton, NJ, 1962).
3. A. B. Atkinson, A. J. Harrison, *Distribution of Personal Wealth in Britain, 1923-1972* (Cambridge Univ. Press, Cambridge, 1978).
4. A. Daumard, *Les fortunes françaises au 19e siècle. Enquête sur la répartition et la composition des capitaux privés à Paris, Lyon, Lille, Bordeaux et Toulouse d'après l'enregistrement des déclarations de successions* (Mouton, Paris, 1973).
5. A. H. Jones, *American Colonial Wealth: Documents and Methods* (Arno Press, New York, 1977).
6. P. Lindert, *J. Polit. Econ.* **94**, 1127–1162 (1986).
7. L. Soltow, *Distribution of Wealth and Income in the United States in 1798* (Univ. of Pittsburgh Press, Pittsburgh, PA, 1989).
8. T. Piketty, *Les hauts revenus en France au 20e siècle—Inégalités et redistributions, 1901–1998* (Grasset, Paris, 2001).
9. T. Piketty, *J. Polit. Econ.* **111**, 1004–1042 (2003).
10. A. B. Atkinson, *J. R. Stat. Soc. Ser. A Stat. Soc.* **168**, 325–343 (2005).
11. T. Piketty, E. Saez, *Q. J. Econ.* **118**, 1–41(2003).
12. A. B. Atkinson, T. Piketty, Eds., *Top Incomes over the 20th Century—A Contrast Between Continental European and English Speaking Countries* (Oxford Univ. Press, New York, 2007).
13. A. B. Atkinson, T. Piketty, Eds., *Top Incomes—A Global Perspective* (Oxford Univ. Press, New York, 2010).
14. A. B. Atkinson, T. Piketty, E. Saez, *J. Econ. Lit.* **49**, 3–71 (2011).
15. F. Alvaredo, A. B. Atkinson, T. Piketty, E. Saez, *J. Econ. Perspect.* **27**, 3–21 (2013).
16. W. Kopczuk, E. Saez, *Natl. Tax J.* **57**, 445–487 (2004).
17. T. Piketty, G. Postel-Vinay, J. L. Rosenthal, *Am. Econ. Rev.* **96**, 236–256 (2006).
18. J. Roine, D. Waldenstrom, *Scand. J. Econ.* **111**, 151–187 (2009).
19. H. Ohlson, J. Roine, D. Waldenstrom, in J. B. Davies, Ed., *Personal Wealth from a Global Perspective* (Oxford Univ. Press, Oxford, 2008), pp. 42–63.
20. D. Waldenstrom, *Lifting all Boats? The Evolution of Income and Wealth Inequality Over the Path of Development* (Lund University, Sweden, 2009)
21. T. Piketty, *Q. J. Econ.* **126**, 1071–1131 (2011).
22. R. Goldsmith, *Comparative National Balance Sheets: A Study of Twenty Countries, 1688-1978* (Univ. of Chicago Press, Chicago, IL, 1985)
23. T. Piketty, G. Zucman, *Q. J. Econ.* **129**, in press (2014); http://piketty.pse.ens.fr/files/PikettyZucman2013WP.pdf.
24. T. Piketty, *Capital in the Twenty-first Century* (Harvard Univ. Press, Cambridge, MA, 2014).
25. J. Stiglitz, *Econometrica* **37**, 382–397 (1969).
26. M. Nirei, "Pareto Distributions in Economics Growth Models," Institute of Innovation Research Working Paper No. 09-05, Hitotsubashi University, Tokyo (2009)
27. T. Piketty, G. Postel-Vinay, J. L. Rosenthal, *Explor. Econ. Hist.* **51**, 21–40 (2014).
28. J. Davies, S. Sandstrom, T. Shorrocks, E. Wolff, *Econ. J.* **121**, 223–254 (2011).
29. G. Zucman, *Q. J. Econ.* **128**, 1321–1364 (2013).
30. C. Goldin, L. Katz, *The Race Between Education and Technology* (Harvard Univ. Press, Cambridge, MA, 2008).

SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/344/6186/838/suppl/DC1
Supplementary Text
Figs. S1 and S2
References (*31*, *32*)

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REVIEW

Skills, education, and the rise of earnings inequality among the "other 99 percent"

David H. Autor

The singular focus of public debate on the "top 1 percent" of households overlooks the component of earnings inequality that is arguably most consequential for the "other 99 percent" of citizens: the dramatic growth in the wage premium associated with higher education and cognitive ability. This Review documents the central role of both the supply and demand for skills in shaping inequality, discusses why skill demands have persistently risen in industrialized countries, and considers the economic value of inequality alongside its potential social costs. I conclude by highlighting the constructive role for public policy in fostering skills formation and preserving economic mobility.

Public debate has recently focused on a subject that economists have been analyzing for at least two decades: the steep, persistent rise of earnings inequality in the U.S. labor market and in developed countries more broadly. Much popular discussion of inequality concerns the "top 1 percent," referring to the increasing share of national income accruing to the top percentile of households. Although this phenomenon is undeniably important, an exclusive focus on the concentration of top incomes ignores the component of rising inequality that is arguably even more consequential for the "other 99 percent" of citizens: the dramatic growth in the wage premium associated with higher education and, more broadly, cognitive ability. This paper considers the role of the rising skill premium in the evolution of earnings inequality.

There are three reasons to focus a discussion of rising inequality on the economic payoff to skills and education. First, the earnings premium for education has risen across a large number of advanced countries in recent decades, and this rise contributes substantially to the net growth of earnings inequality. In the United States, for example, about two-thirds of the overall rise of earnings dispersion between 1980 and 2005 is proximately accounted for by the increased premium associated with schooling in general and postsecondary education in particular (*1*, *2*). Second, despite a lack of consensus among economists regarding the primary causes of the rise of very top incomes (*3*–*6*), an influential literature finds that the interplay between the supply and demand for skills provides substantial insight into why the skill premium has risen and fallen over time—and, specifically, why the earnings gap between college and high school graduates has more than doubled in the United States over the past three decades. A third reason for focusing on the skill premium is that it offers broad insight into the evolution of inequality within a market economy, highlighting the social value of inequality alongside its potential social costs and illuminating the constructive role for public policy in maximizing the benefits and minimizing the costs of inequality.

The rising skill premium is not, of course, the sole cause of growing inequality. The decades-long decline in the real value of the U.S. minimum wage (*7*), the sharp drops in non-college employment opportunities in production, clerical, and administrative support positions stemming from automation, the steep rise in international competition from the developing world, the secularly declining membership and bargaining power of U.S. labor unions, and the successive enactment of multiple reductions in top federal marginal tax rates, have all served to magnify inequality and erode real wages among less educated workers. As I discuss below, the foremost concern raised by these multiple forces is not their impact on inequality per se, but rather their adverse effect on the real earnings and employment of less educated workers.

I begin by documenting the centrality of the rising skill premium to the overall growth of earnings inequality. I next consider why skills are heavily rewarded in advanced economies and why the demand for them has risen over time. I then demonstrate the substantial explanatory power of a simple framework that embeds both the demand and supply for skills in interpreting the evolution of the inequality over five decades. The final section considers the productive role that inequality plays in a market economy and the potential risks attending very high and rising inequality; evidence on whether those risks have been realized; and the role of policy and governance in encouraging skills formation, fostering opportunity,

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Supplementary Materials for

Inequality in the long run

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This PDF file includes:

Supplementary Online Material: The role of top tax rates in explaining income inequality.

Labor income inequality. As discussed in the main text, the race between technology and education (*30*) is not sufficient to account for the differential increase in labor income inequality between the United States and continental Europe. Therefore, it is valuable to investigate whether other factors such as taxation of high incomes play a role in this evolution.

One imperfect but simple measure of the income tax burden on high incomes is the top marginal income tax rate, i.e., the rate of tax that high income earners in the top tax bracket have to pay on each additional dollar of income. Since 2013, it is 39.6% in the United States. Figure S1 depicts the top marginal tax rate in the United States, the United Kingdom, France, and Germany. The United States and the United Kingdom had strikingly high top tax rates (in the 70-90% range and much higher than in continental Europe) from the 1930s till 1980 when the Reagan and Thatcher administrations dramatically lowered the top tax rates. Since the 1980s, top tax rates have been lower in the United States and the United Kingdom than in continental Europe.

This reversal in top tax rates between the United States vs. continental Europe is the mirror image of the reversal in income inequality that we discussed in the text (Figure 1), suggesting that top tax rate policy played a role in this evolution. Indeed, a comprehensive empirical analysis shows that there is a systematic and strong negative correlation between the evolution of top tax rates and the evolution of the pre-tax top percentile income share (*31*). In the United States, top income shares are high when top tax rates are low (before the Great Depression and after the Reagan administrations) while top income shares are low when top tax rates are high (from the New Deal to the beginning of the Reagan administration). Across countries, there is a tight correlation between the cut in top marginal tax rates since the 1960s and the increase in the top percentile income share: The United States and the United Kingdom cut their top tax rates the most, and experienced the largest increases in top percentile income shares. In contrast, France or Germany saw very little change in both their top tax rates and their top percentile income shares during the same period.

Importantly, these correlations consider pre-tax (and not post-tax) top income shares. Hence, they are not due to the mechanical effect of taxes on disposable income and must reflect responses of high-income earners to changes in top tax rates. Two scenarios can explain the strong response of top pre-tax incomes to changes in top tax rates. They have very different policy implications and can be tested in the data.

First, higher top tax rates may discourage work effort and business creation among the most talented –the 'supply-side' effect. In this scenario, lower top tax rates would lead to more economic activity by the rich and hence more economic growth. In that case, high top tax rates are not a desirable policy. Second, while standard economic models assume that pay reflects productivity, there are strong reasons to be skeptical, especially at the top of the income distribution where the actual economic contribution of managers working in complex organizations is particularly difficult to measure. In this scenario, top earners might be able to partly set their own pay by bargaining harder or influencing compensation committees. Naturally, the incentives for such 'rent-seeking' are much stronger when top tax rates are low. In this scenario, cuts in top tax rates can still increase top 1% income shares but this increase in top

1% incomes now come at the expense of the remaining 99%. In other words, top rate cuts stimulate rent-seeking at the top but not overall economic growth – the key difference with the first, supply-side, scenario. In the 'rent-seeking' scenario, very high top tax rates, such as those in place in the United States or United Kingdom in the middle of the twentieth century, are desirable.

To tell these two scenarios apart, we need to analyze to what extent top tax rate cuts lead to higher economic growth. This is a difficult empirical problem as it is challenging to trace the causal effects of top tax rates on economic growth. Let us mention two simple facts discussed in detail in (*31*). First, there is no correlation between cuts in top tax rates and average annual real GDP-per-capita growth since the 1960s. For example, countries that made large cuts in top tax rates such as the United Kingdom or the United States have not grown significantly faster than countries that did not, such as Germany. Second, in the United States, the path of growth of bottom 99% and top 1% incomes has been very different. When top tax rates were high from 1933 to 1980, bottom 99% incomes grew fast while top 1% incomes grew slowly. In contrast, after 1980, when top tax rates were low, bottom 99% incomes grew slowly while top 1% incomes grew fast. These two facts are consistent with the 'rent-seeking' scenario where a substantial fraction of the response of pre-tax top incomes to top tax rates may be due to increased rent-seeking effort at the top rather than increased productive effort.

Capital income and wealth inequality. In this main text, we have discussed the dynamics of wealth accumulation and concentration. When the rate of return to capital r is larger than the growth rate of the economy g, we expect wealth to become highly concentrated and inheritance to play a large role in wealth accumulation. Naturally, capital taxation, in the form of taxation of capital income through the income tax, or taxation of inheritances through the estate tax, mechanically reduces the net rate of return to capital that wealth holders obtain after tax. Indeed, a major factor in the drop of r in the twentieth century documented in Figure 4 is due to the development of capital taxation through corporate profits taxation, progressive income taxation, and inheritance taxation. Figure S1 showed the evolution of top income tax rates that also used to apply to capital income. Figure S2 shows that top inheritance tax rates have evolved in a similar way in the United States, United Kingdom, France, and Germany (*32*). Top inheritance tax rates were particularly high in the United States and the United Kingdom from the late 1930s to the 1980s (and much higher than in France or Germany) but have declined substantially afterwards. The tax rate on capital has also declined due to the development of lower preferred income tax rates on capital income, as well as tax competition across countries to attract corporate profits of multinational companies through lower corporate tax rates (*24*).

The lowering of capital tax rates combined with the lowering of the economy growth rate g widens the gap r-g and could lead to high wealth concentration and the return to patrimonial capital in the future (*24*). Naturally, it is possible that democratic societies will resist such an evolution by drastically changing policy. In our view, the most powerful policy to curb wealth concentration would be a properly calibrated progressive tax on individual net worth, based upon automatic exchange of bank information at the global level (or at least at the Europe-US level). It would also produce financial transparency and statistical information on wealth that could be used by economists to accurately measure wealth inequality.

In sum, this discussion on the role of taxation shows that policy plays a major factor in the distribution of income and wealth. Many other aspects of policy can affect inequality: the minimum wage, government policy towards Unions, economic regulation such as financial regulations, etc. In democracies, policies reflect society's view. Therefore, the ultimate driver of inequality and policy might well be social norms regarding fairness of the distribution of income and wealth.

Supplemental Online Material Figures

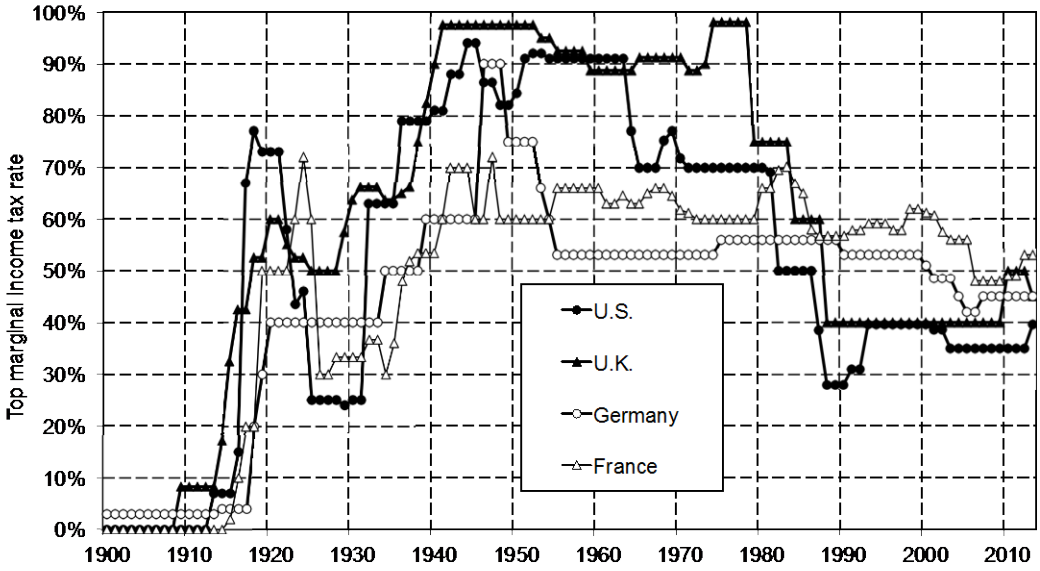

Figure S1. Top income tax rates, 1900-2013.
The top marginal tax rate of the income tax (applying to the highest incomes) has been higher historically in English speaking countries than in Continental Europe before the 1980s and lower afterwards. In the United States, it dropped from 70% in 1980 to 28% in 1988. The series constructed using country tax laws. See (*24*), chapter 14, figure 14.1. Series available on-line at piketty.pse.ens.fr/capital21c.

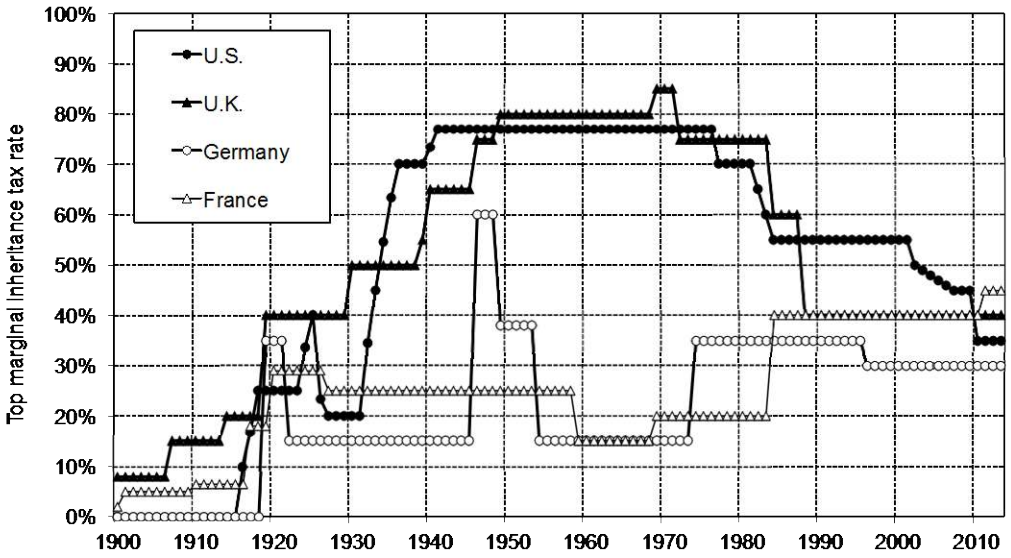

Figure S2. Top inheritance tax rates, 1900-2013.
The top marginal tax rate of the inheritance tax (applying to the highest inheritances) has been higher historically in English speaking countries than in Continental Europe. In the United States, it dropped from 70% in 1980 to 35% in 2012. Series constructed using country tax laws. See (*24*), chapter 14, figure 14.2. Series available on-line at piketty.pse.ens.fr/capital21c.

References and Notes

1. S. Kuznets, *Shares of Upper Income Groups in Income and Savings* (National Bureau of Economic Research, Cambridge, MA, 1953)

2. R. J. Lampman, *The Share of Top Wealth holders in National Wealth, 1922-1956* (Princeton Univ. Press, Princeton, NJ, 1962)

3. A. B. Atkinson, A. J. Harrison, *Distribution of Personal Wealth in Britain, 1923-1972* (Cambridge Univ. Press, Cambridge, 1978)

4. A. Daumard, *Les fortunes françaises au 19^{e} siècle. Enquête sur la répartition et la composition des capitaux privés à Paris, Lyon, Lille, Bordeaux et Toulouse d'après l'enregistrement des déclarations de successions* (Mouton, Paris, 1973)

5. A. H. Jones, *American Colonial Wealth: Documents and Methods* (Arno Press, New York, 1977)

6. P. Lindert, Unequal English Wealth since 1670. *J. Polit. Econ.* **94**, 1127–1162 (1986). doi:10.1086/261427

7. L. Soltow, *Distribution of Wealth and Income in the United States in 1798* (Univ. of Pittsburgh Press, Pittsburgh, PA, 1989).

8. T. Piketty, *Les hauts revenus en France au 20^{e} siècle—Inégalités et redistributions, 1901–1998* (Grasset, Paris. 2001).

9. T. Piketty, Income Inequality in France, 1901-1998. *J. Polit. Econ.* **111**, 1004–1042 (2003). doi:10.1086/376955

10. A. B. Atkinson, Top incomes in the UK over the 20th century. *J. R. Stat. Soc. Ser. A Stat. Soc.* **168**, 325–343 (2005). doi:10.1111/j.1467-985X.2005.00351.x

11. T. Piketty, E. Saez, Income inequality in the United States, 1913-1998. *Q. J. Econ.* **118**, 1–41(2003). doi:10.1162/00335530360535135

12. A. B. Atkinson, T. Piketty, Eds., *Top Incomes over the 20th Century—A Contrast Between Continental European and English Speaking Countries* (Oxford Univ. Press, New York, 2007).

13. A. B. Atkinson, T. Piketty, Eds., *Top Incomes—A Global Perspective* (Oxford Univ. Press, New York, 2010).

14. A. B. Atkinson, T. Piketty, E. Saez, Top incomes in the long-run of history. *J. Econ. Lit.* **49**, 3–71 (2011). doi:10.1257/jel.49.1.3

15. F. Alvaredo, A. B. Atkinson, T. Piketty, E. Saez, The top 1 percent in international and historical perspective. *J. Econ. Perspect.* **27**, 3–21 (2013). doi:10.1257/jep.27.3.3

16. W. Kopczuk, E. Saez, Top wealth shares in the United States, 1916-2000: Evidence from estate tax returns. *Natl. Tax J.* **57**, 445–487 (2004).

17. T. Piketty, G. Postel-Vinay, J. L. Rosenthal, Wealth concentration in a developing economy: Paris and France, 1807-1994. *Am. Econ. Rev.* **96**, 236–256 (2006). doi:10.1257/000282806776157614

18. J. Roine, D. Waldenstrom, Wealth concentration over the path of development: Sweden, 1873-2006. *Scand. J. Econ.* **111**, 151–187 (2009). doi:10.1111/j.1467-9442.2008.01558.x

19. H. Ohlson, J. Roine, D. Waldenstrom, in J. B. Davies, Ed., *Personal Wealth from a Global Perspective* (Oxford Univ. Press, Oxford, 2008), pp. 42–63.

20. D. Waldenstrom, *Lifting all Boats? The Evolution of Income and Wealth Inequality Over the Path of Development* (Lund University, Sweden, 2009)

21. T. Piketty, On the Long-Run Evolution of Inheritance: France 1820-2050. *Q. J. Econ.* **126**, 1071–1131 (2011). doi:10.1093/qje/qjr020

22. R. Goldsmith, *Comparative National Balance Sheets: A Study of Twenty Countries, 1688-1978* (Univ. of Chicago Press, Chicago, IL, 1985)

23. T. Piketty, G. Zucman, Capital is back: Wealth-income ratios in rich countries, 1700–2010. *Q. J. Econ.* **129**, in press (2014); http://piketty.pse.ens.fr/files/PikettyZucman2013WP.pdf.

24. T. Piketty, *Capital in the Twenty-first Century* (Harvard Univ. Press, Cambridge, MA, 2014).

25. J. Stiglitz, Distribution of income and wealth among individuals. *Econometrica* **37**, 382–397 (1969). doi:10.2307/1912788

26. M. Nirei, "Pareto Distributions in Economics Growth Models," Institute of Innovation Research Working Paper No. 09-05, Hitotsubashi University, Tokyo (2009)

27. T. Piketty, G. Postel-Vinay, J. L. Rosenthal, Inherited vs. self-made wealth: Theory and evidence from a rentier society (Paris 1872-1927). *Explor. Econ. Hist.* **51**, 21–40 (2014). doi:10.1016/j.eeh.2013.07.004

28. J. Davies, S. Sandstrom, T. Shorrocks, E. Wolff, The level and distribution of global household wealth. *Econ. J.* **121**, 223–254 (2011). doi:10.1111/j.1468-0297.2010.02391.x

29. G. Zucman, The missing wealth of nations. Are Europe and the US net debtors or net creditors? *Q. J. Econ.* **128**, 1321–1364 (2013). doi:10.1093/qje/qjt012

30. C. Goldin, L. Katz, *The Race Between Education and Technology* (Harvard Univ. Press, Cambridge, MA, 2008)

31. T. Piketty, E. Saez, S. Stantcheva, Optimal taxation of top labor incomes: A tale of three elasticities. *Am. Econ. J. Econ. Pol.* **6**, 230–271 (2014). doi: 10.1257/pol.6.1.230

32. T. Piketty, E. Saez, A theory of optimal inheritance taxation. *Econometrica* **81**, 1851–1886 (2013). doi:10.3982/ECTA10712