The Rise and Fall of General Laws of Capitalism*

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Abstract

Thomas Piketty's recent book, *Capital in the Twenty First Century,* follows in the tradition of the great classical economists, Malthus, Ricardo and Marx, in formulating "general laws" to diagnose and predict the dynamics of inequality. We argue that all of these general laws are unhelpful as a guide to understand the past or predict the future, because they ignore the central role of political and economic institutions in shaping the evolution of technology and the distribution of resources in a society. Using the economic and political histories of South Africa and Sweden, we illustrate not only that the focus on the share of top incomes gives a misleading characterization of the key determinants of societal inequality, but also that inequality dynamics are closely linked to institutional factors and there are endogenous evolution, much more than the forces emphasized in Piketty's book, such as the gap between the interest rate and the growth rate.

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We should all be delighted with the huge interest in the economics of inequality that Thomas Piketty's weighty tome, *Capital in the 21st Century,* has generated. Piketty's works with Emmanuel Saez (Piketty and Saez, 2003) and with Tony Atkinson (Atkinson, Piketty and Saez, 2011) have opened new horizons for economists by showing how tax returns data can be used to assess trends in income and wealth inequality, especially at the top of the distribution. They have also provided some of the striking numbers about the evolution of the income of the top 1% (or the top 0.1%) of US tax-payers that have caught the attention of the media and the Occupy Wall Street movement alike.

Whether one agrees with the tenor or even the arguments of Piketty's book, it is hard not to be impressed by the ambition. Like many great thinkers—including Thomas Malthus, David Ricardo and particularly Karl Marx, whom he emulates in his title, in his style, and in his powerful critique of the capitalist system—Piketty is after "general laws" which will both demystify our modern economy and elucidate the inherent problems of the system (and their solutions).

But like Marx, Piketty goes wrong for a very simple reason. The quest for general laws of capitalism—or any economic system—is misguided because it is a-institutional.[1] It ignores that it is the institutions and the political equilibrium of a society that determine how technology evolves, how markets function, and how the gains from various different economic arrangements are distributed. Despite his erudition, ambition, and creativity, Marx was ultimately led astray because of his disregard of institutions and politics. The same is true of Piketty.

In the next section, we review Marx's conceptualization of capitalism and some of his general laws. We then turn to Piketty's approach to capitalism and his version of the general laws. We argue that even though there are various problems in Piketty's interpretation of the economic relationships underpinning inequality, the most important shortcoming is his omission of the role of institutions and political factors in the formation of inequality. We illustrate this using the examples of South African and Swedish paths of institutions and inequality over the 20th century, which also suggest that measures such as the top 1%'s share of national income may miss the big picture about inequality. We conclude by outlining an alternative approach to inequality that eschews general laws in favor of a conceptualization in which both technology and factor prices are shaped by the evolution of institutions and

[1] We also find the term "capitalism" not a useful one for the purposes of comparative economic or political analysis. By putting the focus on the ownership of capital, this term distracts from the characteristics of societies which are more important in determining their economic development and extent of inequality. Though both Egypt under Mubarak and Switzerland have private ownership of capital, there is little in common between these societies (and there is in fact more in common between Egypt and non-capitalist North Korea as we argued in Acemoglu and Robinson, 2012) because the inclusivity of their economic and political institutions are so sharply different. That being said, given the emphasis on capitalism as an economic system both in Marx and Piketty, we have opted to bear with this terminology.

political equilibria, and the institutions themselves are endogenous and are partly influenced by, among other things, inequality. We then apply this framework to the evolution of inequality and institutions in South Africa and Sweden.

Capital Failures...

Though many important ideas in social science can be traced to Marx's oeuvre, his defining approach, arguably, was to identify certain hard-wired features of capitalism—what Marx called *general laws of capitalist accumulation.* This approach was heavily shaped by the historical context of the middle 19th century in which Marx lived. Marx experienced first-hand both the bewildering transformation of society with the rise of industrial production, and the associated huge social dislocations. He developed a theory of history to understand this and make predictions the future. This theory, which he christened *historical materialism,* emphasized how material aspects of economic life, and what Marx called '*productive forces*'—particularly technology—shaped all other aspects of social, economic and political life, including the '*relations of production*'. For example, Marx famously argued in his book *The Poverty of Philosophy*, that

> "the hand-mill gives you society with the feudal lord; the steam-mill society with the industrial capitalist." (McLellan, 2000, pp. 219-220)

Here the hand-mill represents the forces of production while feudalism represents the relations of production as well as a specific set of social and political arrangements. When productive forces—in particular, technology—changed, this destabilized the relations of production and led to social and institutional changes that were often revolutionary in nature. As he put it in 1859 in *A Contribution to the Critique of Political Economy,*

> "...the sum total of these relations of production constitutes the economic structure of society – the real foundation, on which rise legal and political superstructures and to which correspond definite forms of social consciousness. The mode of production of material life conditions the general character of the social, political and spiritual processes of life ... At a certain state of their development the material forces of production in society come into conflict with the existing relations of production or – what is but a legal expression of the same thing – with the property relations within which they had been at work before. From forms of development of the forces of production these relations turn into fetters. Then comes the epoch of social revolution. With the change of the economic foundation

the entire immense superstructure is more or less rapidly transformed." (McLellan, 2000, p. 425)

Marx hypothesized that technology, sometimes in conjunction with the ownership of the means of production, determined all other aspects of economic and political institutions—the de jure and de facto laws, regulations and arrangements shaping social life. Armed with this theory of history, Marx made very strong predictions about the dynamics of capitalism based just on economic fundamentals—without any reference to institutions or politics, which he often viewed as derivative of the powerful impulses unleashed by productive forces.[2]

Most relevant for our focus are three of these predictions concerning inequality. In Volume 1, Chapter 25 of *Capital*, Marx developed the idea that the "reserve army" of the unemployed would keep wages at subsistence level, making capitalism inconsistent with steady improvements in the welfare of workers. His exact prediction here is open to different interpretations, motivating us to state this law in a strong and a weak form.[3]

1: *The General Law of Capitalist Accumulation.* **Strong Form**: Real wages are stagnant under capitalism. **Weak Form**: The share of national income accruing to labor would fall under capitalism.

Under its either strong or weak form, this law implies that any economic growth under capitalism would almost automatically translate into greater inequality—as capitalists benefit and workers fail to do so, be it due to simple capital accumulation or in addition technological change.

In Volume III of *Capital*, Marx proposed another general law:[4]

[2] We should note that there is no consensus on Marx's exact formulation of the relationship between the "base," comprising productive forces and sometimes the relations of production, and the "superstructure" which includes what we call political institutions and most aspects of economic institutions. In Chapter I of the *Communist Manifesto*, Marx and Engels wrote that "The history of all hitherto existing society is the history of class struggles". But the idea here, so far as we understand, is not that "class struggle" represents some autonomous historical dynamic, but rather that it is an outcome of the contradictions between the forces of production and the ownership of the means of production.

In some writings, such as *The Eighteenth Brumaire of Louis Napoleon*, Marx also allowed for feedback from politics and other aspects of society to the forces of production. But it is clear from his work that he regraded this as second order (see Singer, 2000, Chapter 7 for a discussion of this) and he never formulated an approach in which institutions play the central role and themselves endogenously change.

[3] Though Marx viewed capitalism as the harbinger of "misery, agony of toil, slavery, ignorance, brutality, mental degradation" for working men, it is less clear whether this meant to rule out real wage growth. Blaug (1997) states definitively that Marx never claimed that real wages would be stagnant but that the share of labor in national income would fall since Marx says "real wages ... never rise proportionately to the productive power of labor." Foley (2008, Chapter 3), on the other hand, argues that Marx did start by asserting that real wages would not rise under capitalism but then weakened this claim to a falling labor share when he became aware that wages were indeed increasing in England. Kaldor (1955, p. 87) writes that "... the 'reserve army' of labour... prevents wages from rising above the minimum that must be paid to enable the labourers to perform the work."

[4] Kaldor (1955) suggests that this is because capital accumulation ultimately increases the demand for labor above the supply, triggering a crisis of capitalism until the reserve army of the unemployed is restored.

2: *The General Law of Declining Profit*: as capital accumulates, whatever the path of technology, the rate of profits falls.

These two laws came along with a third, less often stressed but highly relevant, law presented in Volume I of *Capital*:

3: *The General Law of Decreasing Competition*: capital accumulation leads to increased industrial concentration.

Marx's general laws did not fare well, however. This was for the same reason that other previous general laws by Malthus and Ricardo performed so poorly: all of these laws were formulated in an effort to compress the facts and events of their times into a grand theory, supposedly applicable at all times and places—with little reference to institutions and the (largely institutionally-determined) changing nature of technology.

At the time Malthus wrote he had witnessed technological innovations and the start of the Industrial Revolution accompanied by stagnant real wages. His explanation related these two things to the large increase in population which had taken place in Britain in the 18th century. From this he deduced that increased fertility would always drive wages back to subsistence. When Ricardo wrote of the rising share of national income accruing to land, he had indeed been living through a period of rapidly rising land rents in Britain. When Marx formulated his first general law, the data were again quite consistent with it. Nominal wages were certainly flat and though there is a debate about real wages, the consensus is that British real wages were constant until about 1840, and the share of labor in national income was falling until 1860.[5]

But after Mathus predicted that population would eat up productivity gains leading to subsistence wages, real wages began to rise, and the demographic transition subsequently destroyed his theory of the connection between income and fertility. Following the rapidly rising real rents that had motivated Ricardo's theory, the share of national income accruing to agriculture fell monotonically throughout the 19th century, and by the 1870s real rents started a rapid fall which would last for the next 60 years.

History cooperated no better with Marx's general laws. As Marx was writing, real wages had already been rising, probably for about two decades (Allen, 2009a). Marx's other general laws also seem to receive little support in the British case.[6]

[5] On wages in the 18th and 19th centuries, see Feinstein (1998), Allen (2001, 2007) and Clark (2005). On land rents, see Beckett, Turner and Afton (1999) and Clark (2002).

[6] Allen's (2009a) calculation of the real rate of profit suggests that "the profit rate was comparatively low at the end of the 18th century and rose until the middle of the 19th century when it stabilized until the First World War," at just over 20%. Matthews, Feinstein and Odling-Smee (1982, pp. 187–188) suggest that these rates did not fall in the 20th century (though there is a lot of heterogeneity across sectors).

Why did these predictions fail? We think for a very simple reason: they all ignored institutions, which affect markets, prices, and the evolution of technology. The increase in real wages in Britain, for example, was in part a consequence of the technological changes unleashed by the Industrial Revolution (see Crafts, 1985, Allen, 2009b, Mokyr, 2012). This itself was the outcome of a path-dependent process of institutional change involving the rationalization of property rights, dismantling of monopolies, investment in infrastructure, and the creation of a legal framework for industrial development, including the patent system (Acemoglu and Robinson, 2012, Mokyr, 2012). The distribution of the gains from new technologies were also shaped by an evolving institutional equilibrium. For example, the Industrial Revolution went hand-in-hand with major political changes, including the development of the state and the Reform Acts, which changed British political institutions and the distribution of political power. The economic consequences of these political changes were no less profound. In 1833 a professional factory inspectorate was set up, which brought the real implementation of legislation on the regulation of factory employment. The Factory Act of 1847 was much more radical than previous measures and it came at a time of intense social mobilization in the form of the Chartist movement.[7] The political fallout of the 1832 democratization also led to the repeal of the Corn Laws in 1846, lowering the price of bread, raising real wages and simultaneously undermining land rents (Schonhart-Bailey, 2006). The dynamics of wages, factor prices and inequality should therefore be seen as part of a political economy equilibrium where technology interacts with the endogenous determination of political institutions and policies (e.g., Acemoglu and Robinson, 2000)

Another telling example is the failure of Marx's third general law. After the end of the US Civil War came the age of the robber barons and the huge concentration of economic power. By the end of the 1890s, companies such as Du Pont, Eastman Kodak, Standard Oil and International Harvester came to dominate the economy, in several cases capturing more than 70% of their respective markets (Lamoreaux, 1986, pp. 3-4). It all looks like a Marxian prediction come true.

Except that this situation was only transitory and was duly reversed in part because of the political and institutional responses it stimulated. Popular mobilization, first with the Populists and subsequently the Progressives, profoundly changed the political equilibrium and the regulation of industry (Sanders, 1999). The power of large corporations started being curtailed with the Interstate Commerce Act of 1887 and then the Sherman Anti-Trust Act of 1890 (which were used during Teddy Roosevelt's presidency's trust-busting efforts against Du Pont, the American Tobacco Company, the Standard Oil Company and the Northern Securities

[7] See Naidu and Yuchtman (2013) for evidence that pro-worker labor market legislation, the abolition of the Masters and Servants Laws in 1875, increased real wages.

Company, then controlled by of J.P. Morgan). The reforms continued under William Taft, especially with the completion of the break-up of Standard Oil in 1911 and the ratification of the Sixteenth Amendment in 1913, which introduced the income tax, and under Woodrow Wilson, particularly with the Clayton Anti-Trust Act in 1914 and the founding of the Federal Trade Commission. These changes not only stopped further concentration but reversed it. Examining the evolution of concentration in US manufacturing, mining and distribution between 1909 and 1958, Collins and Preston (1961) find a substantial downward trend in the shares of the largest four or eight firms, and significant churning among the largest firms (see Edwards, 1975, for more on this). White (1981) shows that concentration in the post World War II period changed little.

The failures of these general laws is related to Marx's emphasis on technology and the productive forces as the engine of history while institutions played a marginal role and the central role of political factors, such as who has political power, how it is constrained and exercised, and how this shapes technology and society, was entirely ignored.[8] This theoretical lapse also meant that his interpretation of history was off-target.[9]

... in the 21st Century

Like Marx, Piketty is an economist of his milieu, his thinking heavily colored by increasing inequality in the Anglo-Saxon world and also more recently in continental Europe—and in particular compared to the more equal distribution of labor and total incomes seen in France in the 1980s and 90s. A large literature in labor economics had already done much to document and dissect the increase in inequality that started sometime in the 1970s in the United States.[10] Piketty and Saez brought a new and fruitful perspective to this literature by using data from tax returns (and confirming and extending the patterns the previous literature had uncovered).

In *Capital in the 21st Century*—henceforth *Capital*—Piketty goes beyond this empirical and historical approach to provide a theory of long-run tendencies of capitalism. While his data confirm the previous literature's conclusion of an increase in inequality driven by inequality of labor incomes, at least in the United States, *Capital* paints a future dominated by capital income, inherited wealth and rentier billionaires. The theoretical framework used to reach this

[8] Again the exception to this is Marx's discussion in the *Eighteenth Brumaire.*

[9] The faultlines of Marx's theory are made clear by his discussion of the hand-mill, which is contradicted by history. Bloch (1967), for instance, shows that it was not the hand-mill that determined the nature of feudal society anymore than it was the steam-mill that stamped the character of the post-feudal world.

[10] See, for example, Bound and Johnson (1992), Katz and Murphy (1992), Goldin and Margo (1992), Juhn, Murphy and Pierce (1993), and Autor, Katz and Krueger (1998) on US wage inequality; Blau and Kahn (1996) on the international evidence; and Abowd and Bognanno (1995) and Hall and Leibman (1998) on CEO pay and inequality at the top. A recent survey can be found in Acemoglu and Autor (2011). This literature has demonstrated that the increase in inequality has taken place throughout the income distribution, and can be explained reasonably well by changes in the supply and demand for skills and in labor market institutions.

conclusion is a mix of Marx with Harrod, Domar and Solow's growth models. Piketty defines capitalism in the same way that Marx does, and has a similarly materialist approach to it: what we need to understand the dynamics of capitalism, its implications, its limitations and its future, according to *Capital*, are the ownership of the means of production (in particular capital) and the iron-clad nature of technology and production functions inherited from Solow. Institutions do not come into it.

This approach shapes the analysis and predictions about the nature of capitalism. *Capital* starts by introducing two "fundamental laws" (which we next describe), but the more major predictions flow from what the book calls a "fundamental force of divergence" (p. 351) or sometimes the "fundamental inequality" (p. 25) comparing the (real) interest rate of the economy to the growth rate. We distill these into three general laws.

Capital's first fundamental law is just a definition:

$$\text{capital share of national income} = r \times \frac{K}{Y},$$

where r is net real rate of return on capital (the real interest rate), K as capital stock, and Y is GDP or national income (since the economy is taken to be closed).

The second fundamental law is slightly more substantial. It states that

$$\frac{K}{Y} = \frac{s}{g},$$

where s is the saving rate and g is the growth rate of GDP. As we explain in the Appendix, a version of this law does indeed follow readily from the steady state of a Solow-type model of economic growth (but see Krusell and Smith, 2014).

Let us follow Piketty here and combine these two fundamental laws to obtain

$$\text{capital share of national income} = r \times \frac{s}{g}.$$

Capital's first general law follows from this equation by positing that, even as g changes, r and s can be taken to be approximate constants (or not change as much as g). Under this assumption, the first general law is that when growth is lower, capital share of national income will be higher. This first law is not as compelling as one might first think, however. To start with, when the growth rate g changes, the saving rate might also change. But more importantly, the interest rate r will tend to react to changes in the growth rate.[11] Piketty argues that r should not change much in response to changes in g because the elasticity of

[11] There are two reasons for this. First, the interest rate and the growth rate are linked from the household side. For example, with a representative household, we have that $r = \theta g + \rho$, where θ is the inverse of the intertemporal elasticity of substitution and ρ is the discount rate. The fact that the representative household assumption may not be a good approximation to reality does not imply that r is independent of g. Second, g affects r from the production side, through its impact on the capital stock, and it is the second channel that depends on the elasticity of substitution between capital and labor.

substitution between capital and labor is high. However, this flies in the face of what the empirical evidence in this area suggests.[12] Moreover, though it is true that there has been a rise in the capital share of national income as Piketty has documented, this does not seem to be related to the forces emphasized in *Capital*. In particular, Bonnet, Bono, Chapelle and Wasmer (2014) demonstrate that this rise in the capital share is due to housing and the increased price of real estate, shedding doubt on the mechanism emphasized in *Capital.*

Next comes the second general law, formulated as

$$r > g,$$

stating that the (real) interest rate exceeds the growth rate of the economy. Theoretically, in an economy with an exogenous saving rate, or with overlapping generations (e.g., Samuelson, 1958, Diamond, 1965), or with incomplete markets (e.g., Bewley, 1983, Aiyagari, 1994), the interest rate need not exceed the growth rate (see, e.g., Acemoglu, 2009). It will do so in an economy that is *dynamically efficient*, but whether an economy is dynamically efficient is an empirical matter, and dynamic inefficiency becomes more likely when the capital-output ratio is very high as *Capital* predicts it to be in the future.[13]

Finally, *Capital*'s third general law is that whenever $r > g$, there will be a tendency for inequality to diverge. This is because capital income will tend to increase roughly at the rate of interest rate, r, while national income (and income of non-capitalists) increases at the rate g. Because capital income is unequally distributed, this will translate into a capital-driven increase in inequality, taking us back to the age of Jane Austen and Honoré Balzac. In the words of Piketty:

> "This fundamental inequality [$r > g$]... will play a crucial role in this book. In a sense, it sums up the overall logic of my conclusions.
>
> When the rate of return on capital significantly exceeds the growth rate of the

[12] The vast majority of existing estimates indicate a short-run elasticity of substitution significantly less than one (e.g., Hamermesh, 1993, Mairesse, Hall and Mulkay, 1999, Chirinko, Fazzari and Mayer, 1999, Krusell, Ohanian, Rios-Rull, and Violante, 2000, Chirinko, 2003, Antras, 2004, Klump, McAdam and Willman, 2007, Oberfield and Raval, 2014). This is also the plausible case on intuitive grounds: given technology, the ability to substitute capital for labor would be limited (for example, if you reduce labor to zero, for a given production process, one would expect output to fall to zero also). Piketty sometimes refers to the long-run elasticity, and this could clearly be different from the short-run elasticity. But Chirinko (2008) and Chirinko and Mallick (2014) also report estimates of the long-run elasticity of substitution that are significantly less than 1. One reason why one type of long-run elasticity of substitution might be greater than 1 is the endogeneity of technology (e.g., Acemoglu, 2002, 2003). In this context, it is worth noting that the only recent paper estimating an elasticity of substitution greater than 1, Karabarbounis and Neiman (2014), uses long-run cross-country variation related to changes in investment prices, making their estimates much more likely to correspond to endogenous-technology elasticities. Piketty is unclear as to whether he has in mind some process of adjustment of technology. In addition, as Rognlie (2014) points out, even an elasticity of substitution significantly greater than 1 would not be sufficient to yield of the conclusions that *Capital* reaches.

[13] Geerolf (2013) suggests that several OECD economies might be dynamically inefficient.

economy..., then it logically follows that inherited wealth grows faster than output and income." (pp. 25-26).

He elaborates this later, writing:

> "The primary reason for the hyperconcentration of wealth in traditional agrarian societies and to a large extent in all societies prior to World War I... is that these very low-growth societies in which [sic] the rate of return on capital was markedly and durably higher than the rate of growth," (p. 351)

and proposing an explanation for the rise in inequality over the next several decades:

> "... The reason why wealth today is not as unequally distributed as in the past is simply that not enough time has passed since 1945" (p. 372).[14]

Capital also takes a page from Marx, dismissing the importance of institutions against the crushing force of the fundamental inequality $r > g$:

> "... the fundamental inequality $r > g$ can explain the very high level of capital inequality observed in the nineteenth century, and thus in a sense the failure of the French revolution.... The formal nature of the regime was of little moment compared with the inequality $r > g$." (p. 365).[15]

As with *Capital*'s first two general laws, there are things to quibble with in the pure economics of the third general law. First, as already mentioned, the emphasis on $r - g$ sits somewhat uneasily with the central role that labor income has played in the rise in inequality. Second, $r - g$ cannot be taken as a primitive on which to make future forecasts, as both the interest rate and the growth rate will adjust to changes in policy, technology and the capital stock. Moreover, we show in the Appendix that, in the presence of modest amounts of social mobility, even very large values of $r - g$ may fail to create a powerful force towards divergence at the top of the distribution.

[14] *Capital* is not always clear about the reach of this fundamental force (or general law). For example, the last sentence is immediately followed by "This is no doubt part of the explanation, but by itself it is not enough," leaving the reader to ponder what else is required for the claim to be true.

More importantly, it is unclear whether $r > g$ is a force towards divergence of incomes or towards convergence to a new and more unequal distribution of income. In many places, including those we have already quoted, Piketty talks of divergence. But elsewhere, the prediction is formulated differently, for example, when he writes: "With the aid of a fairly simple mathematical model, one can show that for a given structure of ... [economic and demographic shocks]..., the distribution of wealth tends towards a long-run equilibrium and that the equilibrium level of inequality is an increasing function of the $r - g$ between the rate of return on capital and the growth rate." (p. 364). In the Appendix, we discuss a variety of economic models linking $r - g$ to inequality.

[15] This despite the fact that there is in fact empirical evidence that the French Revolution led to a decrease in inequality, see Morrisson and Snyder (2000) and had other very consequential institutional and economic legacies in Europe (see Acemoglu, Cantoni, Johnson and Robinson, 2011).

More important is the empirical success of the fundamental force of $r-g$ in explaining top inequality. The reader may come away from the huge amount of interesting data presented in *Capital* with the impression that the evidence supporting these claims is overwhelming. But Piketty does not engage in hypothesis testing, statistical analysis of causation or even correlation. Even when there are arguments about inequality increasing *because* r exceeds g, this is not supported by standard econometric or even correlational work. In fact, as we discuss in the next section, the evidence that inequality is strongly linked to $r-g$ does not seem to jump out from the data—to say the least.

But our major argument is about what the emphasis on $r-g$ leaves out—institutions and politics. If history repeats itself—perhaps first as tragedy and then farce as Marx colorfully put it—then we may expect the same sort of frustration with these sweeping predictions as they fail to come true, as those of Mathus, Ricardo and Marx did in the past. This is not just because *Capital*'s interpretations do not seem to provide a satisfactory account of observed inequality dynamics and their causes as we next document, but even more so because economy, society and institutions will continue to evolve, so it is unlikely that such general laws can be reliable guides for the future of inequality.

Before turning to this historical discussion, it is also useful to comment on a final aspect of *Capital*'s conceptual framework—the focus on top inequality, in particular, the top 0.1% or top 1% share of national income. Though there are many reasons to care about top inequality, this is not a sufficient statistic for understanding the nature of inequality, its implications or its future. While *Capital* is sometimes careful to emphasize this, the focus on top inequality inevitably leads to an insufficient focus on what is taking place in the middle of the income distribution or at the bottom. This is not without consequences as we will now see.

A Tale of Two Inequalities: Sweden and South Africa

In this section, we first use the history of inequality over the 20th century in Sweden and South Africa—as well as data from a larger sample of countries—to illustrate how different inequality dynamics have little to do with the forces that *Capital* emphasizes. Rather, the dynamics of inequality in Sweden and South Africa appear linked to the institutional paths of these societies. We then show that in a cross-country panel with available data, there is no evidence that $r-g$ has a significant impact on top inequality.

Figure 1 shows the evolution of the top 1% inequality—the share of top 1% in national income—in Sweden and South Africa since early 20th century.[16] Top 1% inequality behaves very similarly in the two countries, starting out high and then falling almost monotonically

[16] The data are from Atkinson and Piketty's World Top Incomes Database; see also Alvaredo and Atkinson (2010) and Roine and Waldenström (2008).

until the 1980s, and then turning up.[17]

Such common dynamics for top 1% inequality in two such different countries—a former colonial society with a history of coerced labor and land expropriation, ruled for much of the 20th century by a racist white minority, on the one hand, and the birth place of European social democracy, on the other—would seem to bolster Piketty's case that some general laws of capitalism explain the big swings of inequality. Perhaps one could even claim that, just like the French Revolution, Apartheid and social democracy are trifling details against the fundamental force of $r > g$.

Except that the reality is rather different. First, the top 1% inequality seems to give a very one-sided picture of inequality dynamics in some settings—and in ways which depend on institutions. Figure 2 shows the top 1% inequality together with other measures of inequality in South Africa, which behave quite differently than the top 1% measure. To start with, Wilson's (1972) series for real wages of black gold miners, a key engine of the South African economy at the time, shows that during the first half of the 20th century, inequality between black workers and whites was massively widening. This is confirmed by the white-to-black per capita income ratio from census data, which does have some ups and downs but exhibits a fairly large increase from about 10-fold to 14-fold until 1970. Thereafter, it shows a rapid decline. Even the top 5% share behaves somewhat differently than the top 1% share, without the same decline (though available data for this variable start only in the 1950s). In summary, the story of inequality in South Africa through the lenses of the top 1% inequality appears incomplete at best.

Second, if one wanted to understand the behavior of inequality in South Africa, changes in labor market institutions and political equilibria appear much more relevant than Piketty's general laws. Early inequality dynamics were shaped by the foundation of the Apartheid regime in 1910.[18] Shortly after its inception, the Apartheid state passed the Native Land Act in 1913, allocating 93% of the land to the 'white economy' while the blacks (around 80% of the population), got 7% of the land. In the white economy it became illegal for blacks to own property or a business, and many types of contractual relations for blacks were explicitly banned. In the 1920s the 'Color Bar,' a law blocking blacks from practically all skilled and professional occupations, was spread from mining to the rest of the white economy. Blacks could only work as unskilled laborers in mines and farms (van der Horst, 1942, Feinstein, 2005, Chapters 2-4).

[17] There are of course some differences. Sweden started out with a higher top 1% share than South Africa, but its top 1% inequality fell faster, especially following World War I. The recent increase in the top 1% also starts earlier in Sweden and is also less pronounced than what we see in South Africa in the 1990s and 2000s.

[18] Though existing evidence (e.g. de Zwart, 2011) suggests that during the 19th-century prelude to Apartheid, black incomes were already falling relative to that of whites.

The Apartheid state was further intensified when the National Party came to power in 1948 (O'Meara, 1997), and introduced the full panoply of 'social Apartheid'. This included the Population Registration Act of 1950, which formalized racial classification and introduced an identity card for all persons over the age of 18; the Group Areas Act of 1950, which, in combination with the Prevention of Illegal Squatting Act of 1951, put an end to settlements where blacks lived close to whites, like Sophiatown in Johannesburg or District Six in Cape Town, and led to mass displacements and the demolition of black towns; the Prohibition of Mixed Marriages Act of 1949, which prohibited marriage between persons of different races; and the Immorality Act of 1950 which made sexual relations with a person of a different race a criminal offence. These and other legislation created separate beaches, buses, hospitals, schools and universities for black and white people. Education was segregated by the 1953 Bantu Education Act, which fashioned a separate system of education for African students, designed to prepare black people for lives as workers for the whites.

All of these economic institutions were structured to keep black wages low, and benefit white workers as well as farmers and white mineowners. Figure 2 shows that they succeeded. South Africa became one of the most unequal countries in the world (and all this while the top 1% share is steadily decreasing). As we discuss in the next section, the rise in black wages in the 1970s also had institutional and political roots.

Top 1% inequality shows a steep rise after 1994, coinciding with the overthrow of the formidable extractive institutions of South Africa collapsed. Though there is no consensus on why this is, the answer is likely related to the fact that after the end of Apartheid, the artificially compressed income distribution among blacks started widening as some portion of this population started to benefit from business opportunities, education and aggressive new affirmative action programs such as Black Economic Empowerment (see Leibbrandt, Woolard, Finn and Argent, 2010). Whatever the details, it is hard to see the post-1994 rise in top 1% share as the demise of egalitarian South Africa.

Unlike what happened in South Africa, the falling top 1% share in Sweden does actually indicate a much more pervasive fall in inequality. Figure 3 shows that for Sweden, other measures of inequality, including two series for the Gini index, have similar trends to the top 1% and the top 5% inequality.

In the Swedish case as well, the story of inequality is related not to the general laws proposed in *Capital*, but to institutional changes. The initial fall in the top 1% share coincides with large changes in government policy, for example a rapid increase in redistribution in the 1920s from practically nothing in the 1910s (Lindert, 1994), and an increase in marginal tax rates from around 10% in 1910, to 40% by 1930 and 60% by 1930 (Roine, Valchos and Waldenström, 2009, p. 982). The expanding role of the government and of redistributive taxation plausibly had a negative impact on the top 1% share.[19] There were also dramatic changes in labor market institutions during this period. Union density rose rapidly from around 10% of the labor force during World War I to 35% by 1930 and over 50% by 1940, and centralized wage bargaining with a high degree of wage compression was instituted (see Donado and Wälde, 2012).

Capital emphasizes the role of the destruction of the capital stock and asset price falls in the aftermath of the world wars as key factors explaining the decline of top inequality during much of the 20th century. But this can hardly explain the trends in Sweden or South Africa. The former was neutral in both wars, and though South Africa provided troops and resources for the Allied powers in both, neither experienced any direct destruction of their capital stock.

One might still argue that top 1% share is just one facet of inequality, and perhaps $r - g$ explains this aspect of inequality. But as we show in Table 1, this does not seem to be the case either. Here, we report regressions using the data from The World Top Income Database, combined with GDP data from Madisson's dataset for an unbalanced panel spanning 1870-2012.[20] We use three different measures of $r - g$. First, we assume that all capital markets are open and all of the countries in the sample have the same (possibly time-varying) interest rate. Under this assumption, variation in $r - g$ will come only because of variation in the growth rate, g. The first three columns in Panel A of this table then simply exploit variation in g using annual data (that is, we set $r - g = -g$ by normalizing $r = 0$).[21] In column 1, we look at the relationship between annual top 1% inequality and annual growth in a specification that includes a full set of year dummies and country dummies—so that pure time-series variation at the world level is purged by year dummies and none of the results rely on cross-country comparisons. *Capital*'s theory would suggest a positive and significant coefficient on this measure of $r - g$. Instead, we find a negative estimate that is statistically insignificant.

In column 2, we include five annual lags of top 1% inequality on the right-hand side to model the significant amount of persistence in inequality.[22] The test at the bottom of the

[19] These data are for pre-tax inequality, but these are likely to be impacted by taxes, which influence effort and investment; see Roine, Valchos and Waldenström (2009) for econometric evidence consistent with this.

[20] The number of countries varies depending on the measure of the interest rate used. In columns 1 and 7, we have 28 countries, Argentina, Australia, Canada, China, Colombia, Denmark, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mauritius, Netherlands, New Zealand, Norway, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States and Uruguay. When we include lags, we lose Germany because of the gaps in its data. In column 4, we have 19 countries, the same 28 minus Argentina, China, Colombia, India, Indonesia, Malaysia, Mauritius, Singapore and Uruguay. In columns 5 and 6, we again lose Germany because of gaps.

[21] With returns to capital income determined in the global economy, i.e., $r_{it} = r_t$ (where i refers to country and t the time period), variation in r_t is fully absorbed by the time effects in the regression models, making the $r = 0$ normalization without any loss of generality.

Note, however, that what is relevant for growth dynamics in a country is that country's growth rate, supporting the methodology here, which exploits country-specific variation in growth rates (conditional on country and time fixed effects).

[22] Though specifications that include the lagged dependent variable on the right-hand side are potentially subject to the Nickel (1981) bias, given the length of the panel here this is unlikely to be an issue.

table shows that lagged top 1% inequality is indeed highly significant. In this case, the impact of $r - g$ is negative and significant at 5%, the very opposite of *Capital*'s prediction. Column 3 includes five annual lags of GDP as well as five lags of top 1% inequality simultaneously. There is once more no evidence of a positive impact of $r - g$ on top inequality. On the contrary, the relationship is again negative, as shown by the first lag and also by the long-run, cumulative effect reported at the bottom.

What matters for inequality may not be annual or five-year variations exploited in Panel A but longer-term swings in $r - g$. Panel B turns to investigate this possibility by looking at 10-year (columns 1 and 2) and 20-year data (column 3).[23] We again find a negative point estimate (but this time statistically insignificant) of the relationship between this measure of $r - g$ and top 1% inequality.

In columns 4-6 in Panel A, we work with a different measure of $r - g$ based on the realized interest rate constructed from data on nominal yields of long-term government bonds and inflation rates from the OECD. The relationship is again negative and now statistically significant in all three columns. In Panel B, when we use 10- and 20-year panels, the relationship continues to be negative, and is also statistically significant with 20-year observations in column 6.

One concern with the results in columns 4-6 is that the relevant interest rate for the very rich may not be the one for long-term government bonds. Motivated by this, columns 7-9 utilize the procedure proposed by Caselli and Feyrer (2007) to estimate the economy-wide marginal product of capital minus the depreciation rate using data on aggregate factors of production, and construct $r - g$ using these estimates. Now the relationship, in both panels, is more unstable. In some specifications, it becomes positive, but is never statistically significant.

Appendix Tables A1 and A2 show that these results are robust to including, additionally, GDP per capita (as another control for business cycles and their impact on top 1% inequality), population growth, and country-specific trends, and to the use of the top 5% measure of inequality.

Though this evidence is tentative and obviously we are not pretending to estimate any sort of causal relationship between $r - g$ and the top 1% share, it is quite striking that such basic conditional correlations provide no support for the central emphasis of *Capital*.[24] This is not to say that a higher r is not a force towards greater inequality in society—it very probably is.

[23] To avoid the mechanical serial correlation that would arise from averaging the dependent variable, we take the top 1% share observations every 10 or 20 years. If an observation is missing at those dates and there exists an observation within plus or minus two years, we use these neighboring observations. The results are very similar with averaging.

[24] One important caveat is that the ex post negative returns that may have resulted from stock market crashes and wars that *Capital* sometimes emphasizes are not in our sample, because our estimates for r are from the post-World War II sample. Nevertheless, if $r - g$ is indeed a fundamental force towards greater inequality, we should see its impact during the last 60 years also.

It is just that there are many other forces promoting inequality and our regressions suggest that, at least in a correlational sense, these are quantitatively more important than $r - g$.

Towards an Institutional Framework

We have already argued that any satisfactory framework for the analysis of inequality should take into account both the impact of different types of institutions on the distribution of resources and the endogenous evolution of these institutions. We now flesh out such a framework and then apply it to the evolution of inequality—and institutions—in Sweden and South Africa.

The framework we present is an extension of the one we proposed for the analysis of long-run economic development in Acemoglu, Johnson and Robinson (2005). Adapting Figure 1 from that paper, some major pillars of such a framework can be represented schematically as follows:

$$\left.\begin{array}{ccc} \text{political institutions}_t & \Longrightarrow & \text{de jure political power}_t \\ & & \& \\ \text{inequality}_t & \Longrightarrow & \text{de facto political power}_t \end{array}\right\} \begin{array}{l} \Longrightarrow \text{economic institutions}_t \Longrightarrow \left.\begin{array}{c}\text{technology}_t,\\ \text{skills}_t, \&\\ \text{prices}_t\end{array}\right\} \Longrightarrow \left\{\begin{array}{c}\text{economic performance}_t\\ \&\\ \text{inequality}_{t+1}\end{array}\right. \\ \\ \Longrightarrow \text{political institutions}_{t+1}\end{array}$$

This figure makes it clear that political institutions determine the distribution of de jure political power (e.g., which groups are disenfranchised, how power is contested, and how constrained the power of elites is, etc.), and they also impact, together with inequality in society, the distribution of de facto political power. For instance, de facto power depends on whether various different social and economic groups are organized and how judicial institutions deal with protests, but also on which groups have the resources to organize and how they resolve their collective action problem.[25] De facto and de jure power together determine economic institutions, and also the stability and change of political institutions (and hence, political institutions tomorrow, i.e., political institutions$_{t+1}$). Economic institutions shape technology (whether and how efficiently existing technologies are utilized, as well as the evolution of technology through endogenous innovations and learning by doing). They also impact the supply of skills—a crucial determinant of inequality throughout history and even more so today (see footnote 10). Finally, economic institutions influence economic performance and inequality

[25] In this respect, we make the same simplification as in Acemoglu, Johnson and Robinson (2005): we include informal institutions and social norms as part of the de facto power and do not explicitly highlight stochastic events in this figure

through their joint impact on technology, the supply of skills and prices (meaning that economic institutions, for a given set of supply and demand, also influence prices, for example through regulation, by taxation or by influencing the bargaining power of different factors of production and individuals).[26]

The timing emphasizes that political institutions and inequality are the 'state variables' that will be inherited as the initial conditions for tomorrow's dynamics.[27] We should also emphasize that, as already hinted by our discussion in the previous section, inequality should not be thought of as always summarized by a single index, such as the Gini index or the top 1% share. Rather, the economic and political factors stressed here determine the distribution of resources more generally—for example, between the mass of black workers, the black middle class, white middle class and white industrialists in South Africa.

Let us now apply this framework to South Africa. As already noted, key turning points of inequality in South Africa seem to have come after the formation of the South African Union in 1910, in the 1940s, the 1970s and again in the 1990s. After 1910, blacks, who could previously vote in the Cape and Natal as long as they fulfilled certain wealth, income or property restrictions, were disenfranchised (and this was later extended to 'coloureds' and Indians). It was this white dominance over South African politics that led to the Native Land Act and the spread of the Color Bar from mining (where it started in the old Boer Republics) into the whole of the economy, with their significant inequality consequences. However, political dynamics in the South African case are more complex and cannot simply be represented as a conflict between monolithic groups of whites and blacks. Rather, Apartheid can be viewed as a coalition between white workers, farmers and mine-owners—at the expense of blacks, but also white industrialists who had to pay very high wages for skilled workers (Lundahl, 1982, Lipton, 1985).

The formal institutions of the Apartheid state cemented the political power of the white minority, and Apartheid laws and other aspects of the regime created economic institutions such as the distribution of land and the 'Color Bar' aimed at furthering the white minority's interests. These economic institutions determined inequality in society—to the disadvantage of the blacks and the advantage of whites, especially white workers and farmers. But by depriving industrialists of a larger pool of skilled workers, and tilting the price of white labor higher (because the supply of labor was artificially restricted), they further stunted South

[26] In terms of *Capital*'s main focus, this framework emphasizes how $r - g$ as well as other, potentially more important factors shaping inequality are themselves determined by economic institutions, both directly and also indirectly through their impact on technology.

[27] This framework is developed further (without formal modeling) in Acemoglu and Robinson (2012), and aspects of it are modeled formally in Acemoglu and Robinson (2000, 2008), Acemoglu (2008), and Acemoglu, Egorov and Sonin (2012, 2014).

African economic development.[28] Why then did the top 1% share fall? This was not just because profits were squeezed by high skilled wages, but also because there were forces within Apartheid for redistribution from the very rich towards poorer whites. Indeed, the spread of the Colour Bar and the victory of the National Party in 1948 were both related to what was called the 'poor white problem,' highlighting the importance of the specific coalition underpinning Apartheid (see Alvaredo and Atkinson, 2010, for discussion of other factors such as the gold price).

The compression of the huge gaps between whites and blacks starting in the 1970s should be viewed within the context of the political weakening of the Apartheid regime. The domestic turning point was the ability of black workers to organize protests and riots, and exercise their de facto power, particularly after the Soweto uprising of 1976, which led to the recognition of Black trade unions. This process was aided by mounting international pressure (which induced British and US firms to stop workplace discrimination). Ultimately, this de facto power forced the collapse of the Apartheid regime, leading to a new set of political institutions, and enfranchising black South Africans. The new set of economic institutions, such as Black Economic Empowerment, and their consequences for inequality, flowed from these institutional changes.

Our framework also suggests that the institutions of Apartheid fed back into the evolution of technology, for example in impeding the mechanization of gold mining (Spandau, 1980). As Apartheid started its collapse in the 1970s, white businessmen responded rapidly by substituting capital for labor and moving technology in a labor saving direction (Seekings and Nattrass, 2005, p. 403).

Turning to Sweden, though the story is very different, the role of de facto and de jure political power in shaping political and economic institutions once again appears central. In the Swedish case, the important turning point was the creation of democracy. Adult male suffrage came in 1909, but true parliamentary democracy developed only after the Reform Act of 1918, with significant curbs on the power of the monarchy and more competitive elections. Both the 1909 reform and the emergence of parliamentary democracy in 1918 were responses to unrest, strikes and the de facto power of disenfranchised workers, especially in the atmosphere of uncertainty and social unrest following World War I (Tilton, 1974). Collier (1999, p. 83) explains this as

> "...it was only after the economic crisis of 1918 and ensuing worker protests

[28] The consequences of these policies for South African growth were well understood by their proponents. For example, Feinstein (2005, p. 158) quotes the Minister of Labour of Apartheid South Africa in 1957 stating this as: "The European worker in this country must be protected or else European civilization will go under. Even though it might intrude upon certain economic laws, I would still rather see European civilization in South Africa being maintained and not being swallowed up than to comply scrupulously and to the letter with the economic laws".

> for democracy led by Social Democrats that the Reform Act was passed. Indeed, in November 1918, labor protests reached such a point as to be perceived as a revolutionary threat by Sweden's Conservative Party and upper classes."

Swedish democracy then laid the foundations of modern labor market institutions and the welfare state,[29] and created powerful downward pressure on inequality including the top 1%.[30]

Finally, as with South African institutions, Swedish labor market institutions also likely impacted the path of technology. For instance, Moene and Wallerstein (1997) emphasize that wage compression acted as a tax on inefficient plants and stimulated new entry and rapid technological upgrading.

We of course do not mean to suggest that our simple framework can fully capture the dynamics of all dimensions of inequality—let alone the dynamics of political and economic institutions. Nevertheless, the basic forces that it stresses appear to be important in a number of instances (not just in the context of Sweden and South Africa, but much more generally as argued in Acemoglu and Robinson, 2006, 2012).

Our framework also suggests some clues about why we should particularly care about top 1% inequality. Depending on the social welfare function that one posits, top 1% inequality could be very deleterious, but this may not be the most fruitful way of thinking about the societal and welfare consequences of inequality. More relevant might be the lack of equality of opportunity—a level playing field—that inequality creates or that is created by the same factors that undergird a high top 1% share. Extending the framework presented above, we have tried to argue in Acemoglu and Robinson (2012) that lack of a level playing field is likely to hold back countries in their investments, innovation and the efficiency with which resources are allocated. But top 1% inequality may not be the most relevant dimension of the distribution of income for evaluating equality of opportunity and barriers to the efficient allocation of talent and resources in society. For example, if Bill Gates and Warren Buffett became twice as wealthy, would that make US society less meritocractic? This seems unlikely,

[29] Just as the black-white conflict in South Africa does not capture all of the political dynamics, post-democratic politics in Sweden was not a simple conflict between monolithic groups of workers and businesses. As Moene and Wallerstein (1995) characterize it, social democracy was a coalition of the ends of the income distribution, businessmen and unskilled workers, against the middle class and skilled workers (see also Saint-Paul, 2000 and Gourevitch, 1986, Luebbert, 1991, for theories about the emergence of such political coalitions). In consequence, Swedish economic institutions strongly compressed skilled wages relative to unskilled wages, underpinning the rapid decline in broad-based measures of inequality. As a result, some businesses benefitted from these arrangements, particularly those in sectors exposed to international competition who used centralized wage bargaining as a tool to stop wage push from non-traded sectors, such as construction (see Swenson, 1991, 2002). In the face of high unskilled wages and the institutions of the Swedish welfare state, it is probably not a surprise that top 1% inequality also declined in Sweden, even if businessmen also did well out of some aspects of Swedish labor market institutions.

[30] Sheve and Stasavage (2009) find a significant and negative relationship between the extent of democracy and the top 1% share. See also Moene and Wallerstein (2006) on the economic and political consequences of the political settlement of the 1920s and 1930s.

and evidence from Chetty, Hendren, Kline and Saez (2014), showing that US social mobility has stayed the same even as top 1% inequality has increased rapidly over the last several decades, corroborates this intuition. Other types of inequality, such as the gap between whites and blacks as in South Africa or between the bottom and the middle class in the United States, may be more relevant for the level playing field.

But one dimension of political economy for which top 1% inequality may be central is the health of political institutions. In a society in which a small number of families and individuals have become disproportionately rich, it may be difficult to maintain political institutions that create a dispersed distribution of political power and political access for a wide cross-section of society. A cautionary tale about the dangers created by this type of inequality is discussed in Acemoglu and Robinson (2012) building on Puga and Trefler (2014): the story of late medieval Venice. Here, the economic power of the most prosperous and well-established families ultimately made it possible for them to block the access of others to political power, and once they thus monopolized political power, they could change economic institutions for their benefit by blocking the entry of other families into lucrative businesses and banning contracts that had made it possible for individuals with limited capital to enter into partnerships for long distance trade. This change in political institutions, feeding into a deterioration of economic institutions, heralded the decline of Venice. But if the main threat from top 1% inequality is political, then it suggests that the focus should be on monitoring and containing the political implications of the increase in top inequality, and any policy should be explicitly related to the institutional faultlines of the society and be put in the context of strengthening institutional checks against this type of power grab.

Conclusion

Piketty's ambitious work, fashioning itself after Marx's *Capital*, has focused a great deal of new attention on inequality. Piketty proffers a bold, sweeping theory of inequality applicable to all capitalist economies. Though we believe that the focus on inequality and the ensuing debates are very healthy and constructive, we have argued that Piketty goes wrong for exactly the same reasons that Marx, and before him Malthus and Ricardo, went astray: his approach and general laws ignore both institutions and the flexible and multifaceted nature of technology shaped by institutions. We have further suggested that the history of inequality over 20th century in economies such as South Africa and Sweden shows why the focus on top 1% inequality is unsatisfactory and why any plausible theory of inequality has to include political and economic institutions at the center stage. We have also provided a brief outline of a framework that squarely puts the spotlight on institutions, their nature and evolution in the study of inequality.

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Online Appendix

In this Appendix, we discuss the core theoretical claims of Piketty's *Capital*, with an effort to clarify the relationship between $r - g$ and inequality. The emphasis will be on four issues: (1) what types of models and economic forces lead to a divergence of inequality when $r > g$; (2) the role of social mobility in this process; (3) what types of models instead to a relationship between $r - g$ and the (right) tail of the stationary distribution of income and wealth; (4) how $r - g$ responds to policies and capital accumulation.

Divergence of Inequality when $r - g > 0$ (without Social Mobility)

The first possible reading of the theoretical core of *Capital* is that $r - g$ is positive (or sufficiently large) will lead to a divergence of wealth between the very rich and the rest of population. The approach of *Capital* here builds on ideas proposed by Nicholas Kaldor, in particular, Kaldor (1955). As we will see, this model gives a formalization of the various intuitions and statements made in *Capital* in a rather straightforward manner, but also shows what the limitations of some of these intuitions and claims are.

The prototypical Kaldor-type economy consists of "capitalists" and workers (and no land), and an important dimension of inequality is between these two groups and is fueled by the assumption that capitalists have a high savings rate (and workers have a savings rate of zero), and all of the income of the capitalists come from capital. As we will see, there is no need to assume that workers do not have any capital income; it is sufficient to allow different saving rates between these two groups.

Suppose that the economy comprises a single good, so that there is no relative price for installed capital (relative to final output and consumption). We also focus on a continuous-time economy for notational convenience. Let us denote the capital stock held by capitalists by K_C. For future reference, we also denote the fraction of capitalists in the population by m, and thus the fraction of workers is $1 - m$, and without loss of generality, we take these to be the numbers of capitalists and workers (thus normalizing total population to 1). For now, there is no social mobility between capitalists and workers, but we will relax this below.

Since all of the income of the capitalists comes from capital, their total income is simply given by the capital stock times the rental price of capital. Assuming that capital depreciates at the rate δ and the interest rate is r, total income accruing to capitalists can be written as

$$I_C = (r + \delta)K_C, \qquad \text{(A1)}$$

where we are suppressing time indices.[31]

[31] Piketty specifies everything, including the saving rate in net of depreciation units. But as Krusell and

Now supposing that capitalists have a constant saving rate of s_C out of their income, the evolution of the capital stock held by capitalists can be written as

$$\begin{aligned} \dot{K}_C &= s_C I_C - \delta K_C \\ &= [s_C(r+\delta) - \delta]K_C, \end{aligned}$$

where the first line simply uses the fact that a constant fraction s_C of capitalists' income, I_C, is saved, but then a fraction δ of their existing capital stock depreciates. The second line simply substitutes for I_C from (A1).

To obtain the growth rate of capitalists' income, we also need to know how the interest rate varies over time. In particular, the growth rate of capitalists' income can be obtained by differentiating (A1) with respect to time as

$$\begin{aligned} g_C^I &= \frac{\dot{K}_C}{K_C} + \frac{\dot{r}}{r+\delta} \\ &= s_C(r+\delta) - \delta + \frac{\dot{r}}{r+\delta}. \end{aligned}$$

Now returning to workers, their income is

$$\begin{aligned} I_W &= (r+\delta)K_W + wL \\ &= (r+\delta)K_W + Y - (r+\delta)(K_C + K_W) \\ &= Y - (r+\delta)K_C, \end{aligned}$$

where the second line simply uses the fact that labor income is equal to national income minus capital income. Then, the growth rate of the income of workers can be obtained by straightforward differentiation with respect to time and by rearranging terms using the expression for the income of the capitalists from (A1):

$$g_W^I = \frac{\frac{\dot{Y}}{Y} - \frac{\dot{K}_C}{K_C}\frac{I_C}{Y} - \frac{\dot{r}}{r+\delta}\frac{I_C}{Y}}{1 - \frac{I_C}{Y}}.$$

One advantage of this expression is that it it is written without reference to the saving rate of workers, s_W, because of the national income accounting identity. But this is also a disadvantage, because, as we discuss below, it masks that comparisons of r to g are implicitly changing the growth of labor income and the saving rate of workers.

Denote the fraction of national income accruing to capitalists by ϕ $(= I_C/Y)$. If capitalists correspond to the richest 1% in the population, then ϕ is the top 1% inequality measure

Smith (2014) emphasize, this is a difficult assumption to motivate and leads to the unpleasant and untenable implication of all of national income being saved at low growth rates. In light of this, it is more appropriate to think of Piketty's results as being supported by assuming that $\delta \approx 0$.

used extensively by Piketty. Using this definition and denoting the growth rate of GDP (and national income) by g, we can then write

$$g_W^I = \frac{g - [s_C(r+\delta) - \delta]\phi - \frac{\dot{r}}{r+\delta}\phi}{1-\phi}.$$

Let us now compare this to the growth rate of the income of the capitalists. A simple rearrangement gives that

$$\begin{aligned} g_C^I &> g_W^I \text{ if and only if} \\ s_C(r+\delta) &> g + \delta - \frac{\dot{r}}{r+\delta}. \end{aligned} \tag{A2}$$

This expression thus states that there will be divergence between the incomes of the capitalists and the workers when (A2) holds.[32] Note, however, that this sort of divergence, by definition, must be temporary, because if capitalists' incomes are growing faster than the rest of the population, at some point they will make up the entire income of the economy.[33]

It is now straightforward to observe that *Capital*'s claim about $r - g > 0$ leading to expanding inequality under two additional conditions:

1. $s_C = 1$, which would follow if the very rich save a very large fraction of their incomes. In practice, though the very rich save more of their incomes than the poor, s_C is significantly less than 1, especially once one takes into account charitable contributions and donations by the very rich.

2. $\dot{r} = 0$, so that the interest rate is constant. Here, as discussed in the text, much of growth theory suggests that the interest rate is quite responsive to changes in the capital stock (and other factors of production as well as technology).

Under these two assumptions, (A2) boils down to

$$g_C^I > g_W^I \text{ if and only if } r > g,$$

as asserted by Piketty. However, the more general expression (A2) also makes it clear that without the two simplifying assumptions above, the evolution of top inequality depends on the saving rate and changes in the interest rate as well as $r > g$.

[32] See also Homburg (2014) for an explanation for why $r - g$ does not translate to divergence in overlapping generations models.

[33] In particular, when (A2) holds for an extended period of time, then all of national income will be in terms of capital income, so it is impossible for $r > g$ and thus for (A2) to be maintained forever.

Divergence of Inequality with Social Mobility

The simple Kaldor-type model presented in the previous subsection enables us to present a transparent illustration of how social mobility affects inequality. It will show that even under the assumptions enumerated above, modest amounts of social mobility can significantly change the conclusions. Though the United States is not one of the highest social mobility countries in the world, it still has a fairly sizable likelihood of those at the top of income distribution losing their position, and as mentioned in the text, recent evidence by Chetty, Hendren, Kline and Saez (2014) suggests that this rate of social mobility has not declined over time, even though overall inequality has increased sharply.

Let us now incorporate the possibility of social mobility into the simple framework. To simplify the exposition, let us suppose that $\delta = \dot{r} = 0$ for this part of the analysis.

We model social mobility as follows. We assume that at some flow rate ν, a capitalist is hit by a random shock and becomes a worker, inheriting the worker's labor income process and saving rate. At this point, he (or she) of course maintains his current income, but from then on his income dynamics follows those of other workers. Simultaneously, a worker becomes a capitalist (also at the flow rate ν), keeping the fraction of capitalists in the population constant at $m \in (0, 1)$.

We can now write the dynamics of the total income of capitalists as

$$\dot{I}_C = s_C r I_C - \nu \left[\frac{I_C}{m} - \frac{I_W}{1-m} \right], \tag{A3}$$

where we are exploiting the fact that, on average, a capitalist leaving the capitalist class has income I_C/m (total capitalists' income divided by the measure of capitalists), and a worker entering the capitalist class has, on average, income $I_W/(1-m)$. This significantly facilitates the characterization of inequality between capitalists and workers (though the determination of the exact distribution of income is more complicated because of the slow growth dynamics of the income of individuals that change economic class).[34]

Now rearranging (A3), we obtain

$$\begin{aligned} g_C^I &= s_C r - \nu \left[\frac{1}{m} - \frac{1}{1-m} \frac{I_W}{I_C} \right] \\ &= s_C r - \nu \left[\frac{1}{m} - \frac{1}{1-m} \frac{1-\phi}{\phi} \right]. \end{aligned}$$

With a similar reasoning, the growth rate of the total income of workers is

$$g_W^I = \frac{g - s_C r \phi}{1-\phi} + \nu_W \left[\frac{1}{m} \frac{\phi}{1-\phi} - \frac{1}{1-m} \right].$$

[34] This also means that the comparison of the incomes of capitalists and workers in this world with social mobility is only an approximation to the top 1% inequality measures (even when capitalists make up 1% of the population), because workers who become capitalists will join the top 1% only slowly.

Combining these expressions and rearranging terms, we can write

$$\begin{aligned} g_C^I &> g_W^I \text{ if and only if} \\ s_C r - g &> \nu \frac{\phi - m}{\phi m(1-m)}, \end{aligned} \tag{A4}$$

where the term on the right-hand side is strictly positive in view of the fact that $\phi > m$ (i.e., the share of top 1% in national income is greater than 1%). This expression thus shows that even when $s_C r - g > 0$ (or, fortiori, when $r - g > 0$), it does not follow that inequality between capitalists and workers will increase. Whether it does will depend on the extent of social mobility. In fact, the quantitative implications of social mobility could be quite substantial as we next illustrate.

From Chetty, Hendren, Kline and Saez's data, the likelihood that a child with parents in the top 1% will be in the top 1% is 9.6%.[35] If we take the gap between generations to be about 30 years, this implies an annual rate of exiting the top 1% approximately equal to 0.075 (7.5%). There are many reasons why this may be an overestimate, including the fact that children are typically younger when their incomes are measured and also that in practice, families exiting the top 1% tend to remain at the very top of the income distribution (rather than follow the income dynamics of a typical worker as in the simple model here). But there are also reasons for underestimation, including the fact that within-generation transitions in and out of the top 1% are being ignored. For our illustrative exercise, we take this number as a benchmark (without any attempt to correct it for these possible concerns). This number corresponds to ν/m in our model (the probability that a given capitalist is hit by a shock and becomes a worker), so we take $\nu = 0.00075$. Using the top 1%'s share as 20%, we can compute that the right-hand side of (A4) is approximately 0.072 (72%). This implies that for the left-hand side to exceed the right-hand side, the interest rate would have to be very high. For example, with a saving rate of 50% and a growth rate of 1%, we would need the interest rate to be greater than 15%. Alternatively, if we use the top 10% so as to reduce exits that may be caused by measurement error, the equivalent number from Chetty, Hendren, Kline (2014) is 26%, implying an annual exit rate equal to 4.4%. Using a share of 45% of income for the top 10%, the right-and side of (A4) can be computed as 0.038, again making it much more difficult for realistic values of $r - g$ to create a natural and powerful force for the top inequality to increase. For example, using again a saving rate of 50% and a growth rate of 1%, the interest rate would need to be over 8.5%. We therefore conclude that incorporating social mobility greatly reduces any "fundamental force" that may have existed from $r - g$ towards mechanically greater inequality at the top of the distribution.

[35] We thank Nathan Hendren for providing us the data.

$r - g$ and the Stationary Distribution of Income and Wealth

As discussed in the text, *Capital* sometimes posits a relationship between $r-g$ and the stationary distribution of wealth instead of the relationship between $r-g$ and divergence of incomes and wealth. Empirically the Pareto distribution (with distribution function $1 - \Gamma a^{-\lambda}$ with Pareto shape coefficient $\lambda \geq 1$) appears to be a good approximation to the tail of the income and wealth distributions. For this reason, existing models have focused on stochastic processes for wealth accumulation that generate a Pareto distribution or distributions for which the right tail can be approximated by the Pareto form. Such models have a long history in economics, and are discussed in the context of the issues raised in *Capital* in Jones (2014), and we refer the reader to this paper for more extensive references. Some recent papers that derive Pareto wealth distributions include Benhabib, Bisin and Zhu (2011), Aoki and Nirei (2013) and Jones and Kim (2014).

To give the basic idea of why the Pareto tail may emerge from certain classes of models and why it summarizes top inequality, consider an economy consisting of continuum of measure 1 of heterogeneous individuals. Suppose that each individual i is infinitely lived and consumes a constant fraction β of her wealth, A_{it}. She has a stochastic (possibly serially correlated) labor income Z_{it} (with $\mathbb{E}Z_{it} \in (0, \infty)$ and finite variance), and has a stochastic rate of return equal to $r + \varepsilon_{it}$, where ε_{it} is a stochastic, return term that is also possibly serially correlated (with the unconditional mean $\mathbb{E}\varepsilon_{it}$ equal to zero as a normalization). Thus, the law of motion of individual i assets is given by

$$A_{it+1} = (1 + r - \beta + \varepsilon_{it})A_{it} + Z_{it}.$$

Dividing both sides of this equation by GDP (also average income per capita), Y_t, we obtain

$$\tilde{a}_{it+1} = \frac{1 + r - \beta + \varepsilon_{it}}{1+g}\tilde{a}_{it} + \tilde{z}_{it},$$

where $\tilde{a}_{it} \equiv A_{it}/Y_t$ and $\tilde{z}_{it} \equiv Z_{it}/Y_t$. A further normalization is also useful. Suppose that $\tilde{a}_{it}$ converges to a stationary distribution (we verify this below). Then let $\mathbb{E}\tilde{a}$ be the average (expected) value of $\tilde{a}_{it}$ in the stationary distribution. Then dividing both sides of this equation by $\mathbb{E}\tilde{a}$, we obtain

$$a_{it+1} = \frac{1 + r - \beta + \varepsilon_{it}}{1+g}a_{it} + z_{it}, \tag{A5}$$

where $a_{it} \equiv \tilde{a}_{it}/\mathbb{E}\tilde{a}$ and $z_{it} \equiv \tilde{z}_{it}/\mathbb{E}\tilde{a}$, and of course $\mathbb{E}a_{it+1} = \mathbb{E}a_{it} = 1$ in the stationary distribution. This also implies that $\mathbb{E}z_{it} \in (0, 1)$.

Equation (A5) is an example of a Kesten process (Kesten, 1973), discussed, for example, in Gabaix (1999). Kesten shows that provided that $\frac{1+r-\beta}{1+g} < 1$, (A5) converges to a stationary distribution with a Pareto tail—meaning that the right tail of the distribution, corresponding to

$a \geq \bar{a}$ for $\bar{a}$ sufficiently large, can be approximated by $\Gamma a^{-\lambda}$ for some endogenously-determined Pareto shape parameter $\lambda \geq 0$.

To obtain the intuition for why (A5) generates a Pareto tail in the stationary distribution, we consider the following heuristic derivation. Let us focus on the case in which z and ε are iid. Let us also define the counter-cumulative density function of (normalize) wealth in this economy as $\mathbb{G}(a) \equiv 1 - \Pr[a_{it} \leq a]$. Then

$$\begin{aligned} \Pr[a_{it+1} \geq a] &= \mathbb{E}\left[\mathbf{1}_{\{\gamma a_{it}+z \geq a\}}\right], \\ &= \mathbb{E}\left[\mathbf{1}_{\{a_{it} \geq (a-z)/\gamma\}}\right], \end{aligned}$$

where $\mathbf{1}_{\{\mathcal{P}\}}$ is the indicator function for the event $\mathcal{P}$, we have defined $\gamma \equiv \frac{1+r+\varepsilon-\beta}{1+g}$ for notational convenience, and we have dropped the indices for z and γ since the stochastic laws for these variables do not depend on time and are identical across individuals. Then, by the definition of a stationary distribution $\mathbb{G}$, we have

$$\mathbb{G}(a) = \mathbb{E}\left[\mathbb{G}\left(\frac{a-z}{\gamma}\right)\right].$$

Now let us conjecture a Pareto tail with shape parameter λ, i.e., $\mathbb{G}(a) = \Gamma a^{-\lambda}$ for large a. Then for large a, we have

$$\Gamma a^{-\lambda} = \Gamma \mathbb{E}(a-z)^{-\lambda}\left[\gamma^{\lambda}\right],$$

or

$$1 = \mathbb{E}\left(\frac{a-z}{a}\right)^{-\lambda}\left[\gamma^{\lambda}\right].$$

Since $\mathbb{E}z < \infty$ and has finite variance, we can write $\lim_{a\to\infty} \mathbb{E}\left(\frac{a-z}{a}\right)^{-\lambda} = 1$, which confirms the conjecture and defines λ as the positive solution to

$$\mathbb{E}\left[\gamma^{\lambda}\right] = 1. \tag{A6}$$

This equation also explains why $\mathbb{E}\gamma = \frac{1+r-\beta}{1+g} < 1$ is necessary for convergence to a stationary distribution (as otherwise the wealth distribution would diverge).

Once pinned down, this Pareto shape parameter of the right tail, λ, determines top inequality. For example, if the entire distributional were Pareto, then the top k's percentile's share would be simply: $\left(\frac{k}{100}\right)^{\frac{1-\lambda}{\lambda}}$. This expression makes it clear that lower λ corresponds to a "thicker tail" of the Pareto distribution and thus to a greater share of aggregate wealth accruing to households in the higher percentiles of the distribution.

The question of interest is whether an increase in $r-g$ (or in $r-g-\beta$) corresponding to a rightward shift in the stochastic distribution of γ will reduce λ, thus leading to greater inequality in the tail of the wealth distribution. Though in general this relationship is ambiguous, in a number of important cases such rightward shifts do reduce λ and increase top inequality as we next show.

Recall that (again ε_{it} and z_{it} being iid), we have

$$a_{it+1} = \gamma_{it} a_{it} + z_{it}.$$

Taking expectations on both sides, using the fact that γ_{it} is iid and that in the stationary distribution $\mathbb{E}a_{it+1} = \mathbb{E}a_{it} = 1$, we have

$$\mathbb{E}\gamma = 1 - \bar{z},$$

where $\bar{z} = \mathbb{E}z_{it} \in (0,1)$, as noted above. This equation also implies that $\mathbb{E}\gamma \in (0,1)$.

To determine the relationship between $r-g$ and λ, we consider two special cases.

First suppose that γ (or ε) is log normally distributed. In particular, suppose that $\ln\gamma$ has a normal distribution with mean $\ln(1-\bar{z}) - \sigma^2/2$ and variance $\sigma^2 > 0$ (so that $\mathbb{E}\gamma = 1-\bar{z}$). Then we can write

$$\mathbb{E}[\gamma^\lambda] = \mathbb{E}[e^{\lambda \ln \gamma}],$$

which is simply the moment generating function of the normally distributed random variable $\ln\gamma$, which can be written as

$$\mathbb{E}[e^{\lambda \ln \gamma}] = e^{\lambda[\ln(1-\bar{z})-\sigma^2/2]+\lambda^2\sigma^2/2}.$$

Then the definition of λ, $\mathbb{E}[\gamma^\lambda] = 1$, implies that

$$\lambda[\ln(1-\bar{z}) - \sigma^2/2] + \lambda^2\sigma^2/2 = 0,$$

which has two roots, $\lambda = 0$ (which is inadmissible for the stationary distribution), and the relevant one,

$$\lambda = 1 - \frac{\ln(1-\bar{z})}{\sigma^2/2} > 1.$$

Finally, for small values of $r-g-\beta < 0$, we can write

$$\gamma \approx 1 + r - g - \beta + \varepsilon,$$

and thus from the relationship that $\mathbb{E}\gamma = 1-\bar{z}$, we have that $\bar{z} = -(r-g-\beta) > 0$, so that

$$\lambda \approx 1 - \frac{\ln(1+r-g-\beta)}{\sigma^2/2}.$$

It then readily follows that λ is decreasing in $r-g-\beta$, thus implying that higher $r-g$ and lower marginal propensity to consume out of wealth, β, lead to greater top inequality.[36]

[36] The same conclusion follows without the approximation $\gamma \approx 1+r-g-\beta+\varepsilon$. In this case, we would simply have

$$\lambda = 1 - \frac{\ln\left(1 + \frac{1+r-\beta}{1+g}\right)}{\sigma^2/2},$$

which yields the same comparative statics.

Second, a similar relationship can be derived even when γ is not log normally distributed, but only when $\bar{z}$ is small (and we will see why this may not be very attractive in the context of the stationary distribution of wealth). Let us start by taking a first-order Taylor expansion of $\mathbb{E}[\gamma^\lambda] = 1$ with respect to λ around $\lambda = 1$ (which also corresponds to making $\bar{z}$ lie close to zero). In particular, differentiating within the expectation operator, we have

$$\mathbb{E}[\gamma + \gamma \ln \gamma(\lambda - 1)] \approx 1,$$

where this approximation requires λ to be close to 1.[37] Then again exploiting the fact that $\mathbb{E}\gamma = 1 - \bar{z}$, we have

$$\lambda \approx 1 + \frac{\bar{z}}{\mathbb{E}[\gamma \ln \gamma]} > 1.$$

(where the fact that $\mathbb{E}[\gamma \ln \gamma] > 0$ follows from the fact that $\bar{z}$ is close to zero).[38] This expression clarifies why λ is close to 1 when $\bar{z}$ is close to 0.

Moreover, note that the derivative of $\gamma \ln \gamma$ is $1 + \ln \gamma$. For $\bar{z}$ small, $\ln \gamma > -1$ with sufficiently high probability, and thus $\mathbb{E}[\gamma \ln \gamma]$ increases as γ shifts to the right (in the sense of first-order stochastic dominance). Therefore, when λ is close to 1 or equivalently when $\bar{z}$ is close to 0, a higher $r - g - \beta$ increases $\mathbb{E}[\gamma \ln \gamma]$ and reduces the shape parameter λ, increasing top inequality. However, it should also be noted that this case is much less relevant for stationary wealth distributions which have Pareto tails much greater than 1.

Benhabib, Bisin and Zhu (2011) extend this result to a setup with finitely-lived agents with bequest motives. In this case, the tail of the distribution is in part driven by which individuals have been accumulating for the longest time. They also derive the consumption choices from optimization decisions, consider the equilibrium determination of the interest rate, and confirm the results derived heuristically here. In addition, they show that one type of social mobility—related to the serial correlation of ε, thus making financial returns less correlated for a household over time—tends to make the tail less thick, hence reducing top inequality. These issues are also discussed in Jones (2014).

There are several reasons why these models may not be entirely satisfactory as models of top inequality. First, to the extent that very rich individuals have diversified portfolios, variability in rates of returns as a driver of the tail of the distribution may not be the most dominant factor. Second, the structure of these models implies that labor income plays no role in the tail of the stationary wealth distribution, but this may be at odds with the importance of wages and salaries and "business income" in the top 1% or even top 0.1% share of the national income (Piketty and Saez, 2003). Third and relatedly, these models do not have a

[37] Formally, we have $\mathbb{E}[\gamma + \gamma \ln \gamma(\lambda - 1) + o(\lambda)] = 1$.

[38] In particular, by noting that $\gamma \ln \gamma$ is a convex function applying Jensen's inequality, $\mathbb{E}[\gamma \ln \gamma] > \mathbb{E}\gamma \cdot \ln \mathbb{E}\gamma = (1 - \bar{z}) \ln(1 - \bar{z})$. For $\bar{z}$ close enough to zero, $(1 - \bar{z}) \ln(1 - \bar{z}) = 0$, and thus $\mathbb{E}[\gamma \ln \gamma] > 0$.

role for entrepreneurship, which is one of the important aspects of the interplay between labor and capital income (see, for example, Jones and Kim, 2014). Fourth, and most importantly in our opinion, these models do not feature social mobility (except the limited type of social mobility related to the correlation of financial returns considered in Benhabib, Bisin and Zhu, 2011), which appears to be an important determinant of top inequality and its persistence. Finally, in more realistic versions such as Benhabib, Bisin and Zhu (2011) and Jones and Kim (2014), a key determinant of the extent of top inequality turns out to be the age or some other characteristic of the household determining for how long the household has been accumulating. But this is also at odds with the salient patterns of the tail of the income and wealth distribution in the United States, whereby successful entrepreneurs or professionals are more likely to be represented at this tale than individuals or households that have been accumulating capital for a long while.

From $r - g$ to the Implications of Low Growth

A key part of *Capital*'s argument is that the future will bring even greater inequality because it will be characterized by low economic growth (at least in growth of the developed economies). This argument relies on two pillars—in addition to the link from $r - g$ to inequality or top inequality as explicated above. The first is that the future will be characterized by low growth. This is not the place to enter into a long debate about the forecasts of future growth rates, but it suffices to note that we do not find forecasts about future growth that do not make any reference to the future of technology, innovation, and the institutions that shape them particularly convincing. Though the demographic trends Piketty emphasizes are well known, their implications for economic growth are much less well understood.

The second important point is that, even if one were to take the link between $r - g$ and inequality on faith, this does not imply that a lower g will translate into a higher $r - g$. As we noted in the text, there are two reasons for this. First, changes in g will impact r from the household side. For example, if consumption decisions are made by optimizing households, then the interest rate is pinned down as $r = \theta g + \rho$, where θ is the inverse of the intertemporal elasticity of substitution. If only some fraction of households optimize and the rest are hand-to-mouth consumers, then this equation will still apply because it will be the optimizing consumers who, at the margin, determine the equilibrium interest rate. In cases where $\theta > 1$, $r - g$ would actually decrease with declines in g.

Second, even ignoring the linkage between r and g coming from the household side, changes in g will impact r through their influence on the capital-output ratio (since r is related to the marginal product of capital). This is where Piketty asserts that the elasticity of substitution between capital and labor is very high, ensuring that changes in the capital-labor ratio in the economy do not translate into significant changes in the rate of return to capital and the interest rate. As we noted in the text, however, these strong claims are not backed by the existing evidence (see footnote 12). Therefore, we are particularly skeptical of *Capital*'s conclusion from his theoretical edifice, even with the central role assigned to $r - g$.

These considerations suggest that even if $r-g$ may be a useful statistic in the context of top inequality, it cannot be used either for comparative static type analysis (because it will respond endogenously and depending on technology and institutions to the changes being considered) or even for medium-term forecasting. In addition, the Kaldor-type model presented above highlights another difficulty of reasoning in terms of $r-g$. For this quantity to be constant, we need to specify not only what the saving rate of workers has to be but also how it is changing. In particular, given the saving rate of capitalists and other variables, g is a function of the capitalists's share of national income, ϕ, the saving rate of workers, s_W, and the rate of growth of their labor income. This implies that if $r > g$, then because ϕ is changing, the saving rate and/or the growth rate of labor income of workers must be also implicitly changing.

All of this suggests that r and g must be treated as endogenous variables, and predictions about the future or comparative statics must be conducted in terms of exogenous variables, not in terms of endogenous objects.

***Capital*'s Second Fundamental Law of Capitalism**

The final point we would like to comment on is *Capital*'s second fundamental law of capitalism, linking the capital-GDP ratio to the saving rate and the growth rate of the economy. Piketty uses this second fundamental law to assert a strong link between the size of the capital stock relative to GDP and the growth rate of the economy, and then on the basis of his forecasts of lower economic growth in the future, reaches the conclusion that the future will bring a pronounced increase in the size of the capital stock relative to GDP in advanced economies. Given a constant interest rate, r, this also implies the continuation of the recent increase in the share of in national income. Thus, while the fundamental force of $r-g$ provides an account of growing top 1% inequality, *Capital*'s second fundamental law of capitalism provides predictions about the future of capital-GDP ratio and the share of national income accruing to capital overall.

Capital's second fundamental law of capitalism is

$$g = s\frac{Y}{K},$$

where s is the aggregate saving rate. Then, combining this with his first fundamental law (which is just an identity as noted in the text), he obtains that

$$\text{capital share of national income} = \frac{r \times s}{g}.$$

Holding r and s constant, if there is a decline in the growth rate of the economy, g, then capital share of national income will increase. In particular, if the growth rate is halved, then capital's share of national income should double.

Let us start with the steady-state equilibrium of a standard Solow growth model, where there is a constant savings rate, s, and depreciation of capital at the rate δ. Then in this steady-state equilibrium, we have

$$\frac{K}{Y} = \frac{s}{g+\delta}. \tag{A7}$$

To see this, simply note that, assuming a constant savings rate, aggregate saving is

$$sY = I = \dot{K} + \delta K,$$

so that

$$s\frac{Y}{K} = \frac{\dot{K}}{K} + \delta.$$

If we also have $g = \frac{\dot{K}}{K}$, then (A7) follows.

Piketty's version is the special case of this well-known relationship when $\delta = 0$—or when things are specified in "net" units, so that what we have is not national income, but national income net of depreciation, and the saving rate is interpreted as the saving rate above the amount necessary for replenishing depreciated capital. Krusell and Smith (2014) provide a more detailed critique of Piketty's second fundamental law formulated in this way. In particular, as we noted in the text, Piketty's second fundamental law has untenable implications, particularly in the cases where the growth rate of the economy becomes low (and it is these cases on which Piketty bases his conclusions about the implications of low growth on the capital share of national income).

We should also note that the second fundamental law applies when the capital-GDP ratio is constant, and thus $g = \frac{\dot{K}}{K}$ as just noted. Out of steady state or the balance growth path, it is not exactly true. Nevertheless, the relevant conclusion—that there will be an increase in the capital-GDP ratio following a decline in g provided that r and s remain constant—still holds. This follows from the fact that the new steady state following a lower growth rate, say $g' < g$, will involve a higher capital-GDP ratio of

$$\frac{K'}{Y'} = \frac{s}{g'+\delta},$$

and convergence to this new steady state in the baseline Solow model is monotone, so over time the capital-GDP ratio will monotonically increase (though with a small saving rate, the transition can take a long time).

Observe also that because of the depreciation rate, δ, in the denominator, the impact of changes in the growth rate are less than the very large effects *Capital*'s second fundamental law of capitalism implies (see again Krusell and Smith, 2014).

In closing, we should again note that even with *Capital*'s second fundamental law of capitalism (or a modified version thereof implied by the standard Solow growth model), the conclusion strongly depends on the interest rate remaining constant as the growth rate declines. As we have already emphasized, this assumption appears quite non-standard and certainly not supported by the available data.

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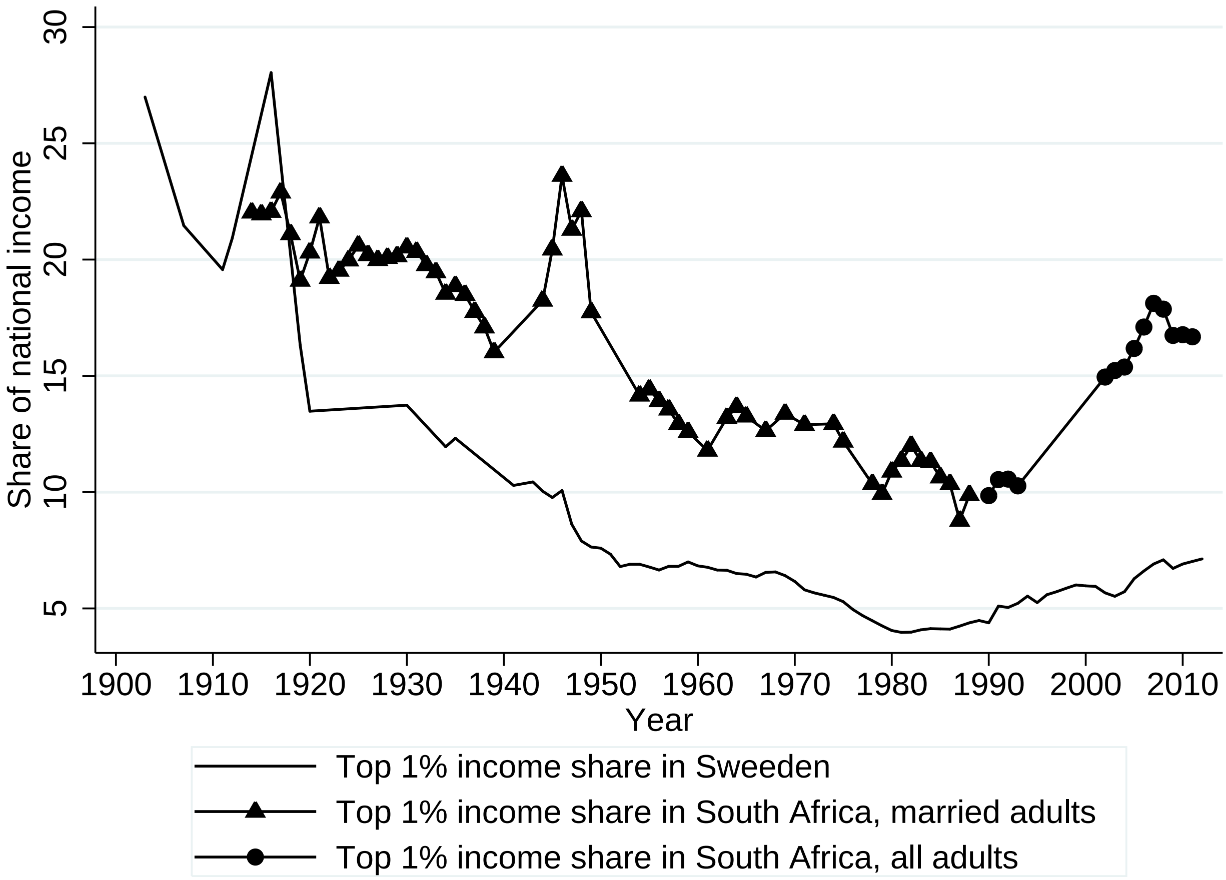

Figure 1: *Top 1% share of national income in Sweden and South Africa.* The figure plots the top 1% share of national income for South Africa and Sweden. The series for South Africa is from Alvaredo and Atkinson (2010). The series for Sweden is from Roine and Waldenström (2009). Data obtained from The World Top Incomes Database.

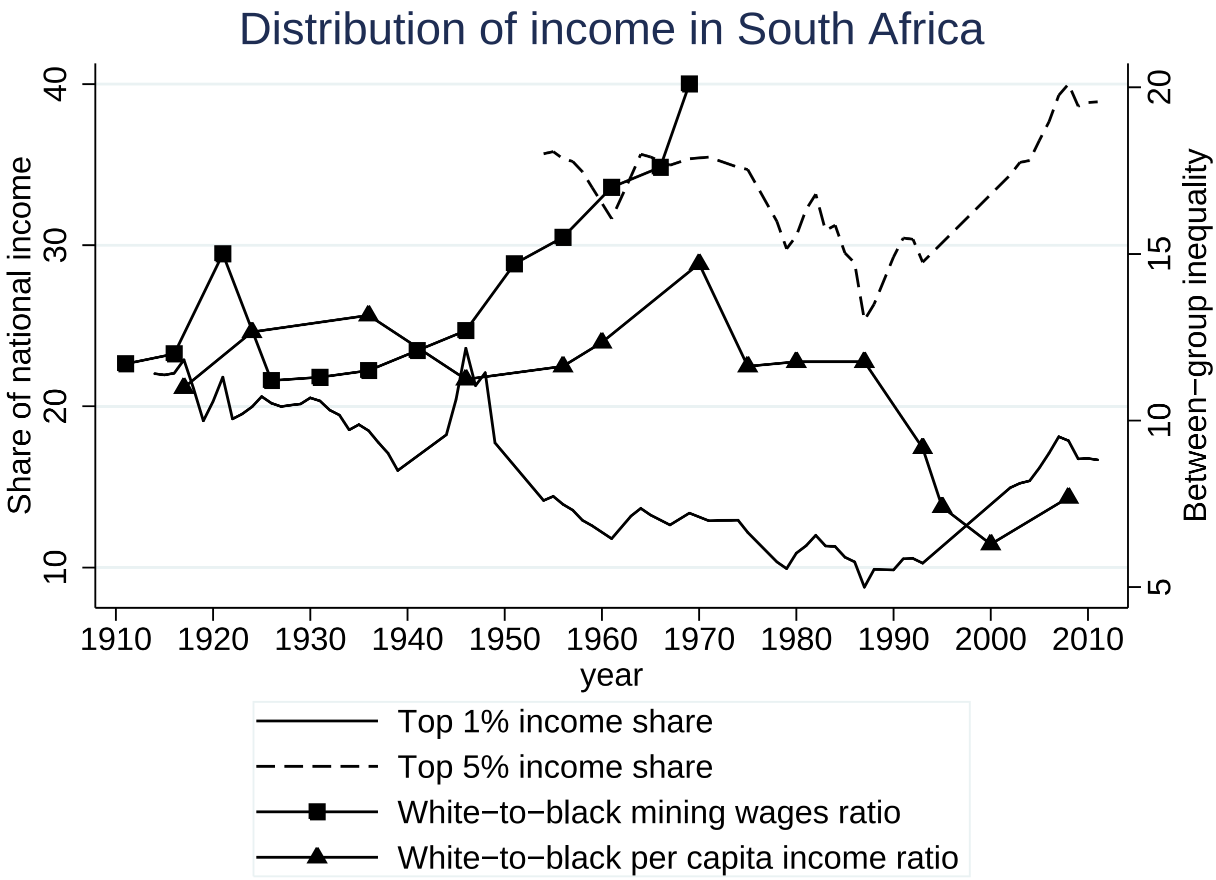

Figure 2: *Top income shares and between-group inequality in South Africa.* The figure plots the top 1% and 5% shares of national income for South Africa in the left axis, obtained from Alvaredo and Atkinson (2010). In the right axis it plots the ratio between whites' and blacks' wages in mining (obtained from Wilson, 1972). The last axis plots the white-to-black per capita income ratio, obtained from Leibbrandt et al. (2010).

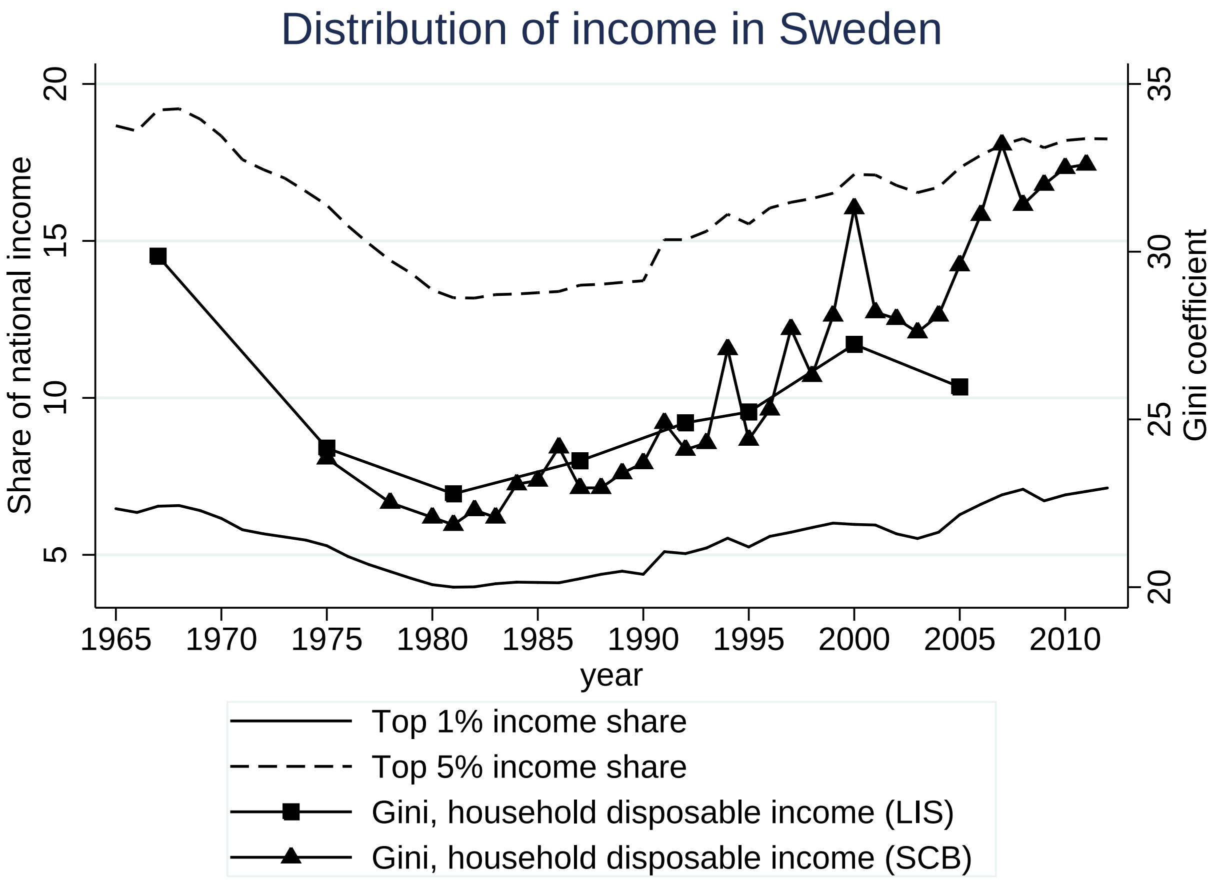

Figure 3: *Top income shares and overall inequality in Sweden.* The figure plots the top 1% and 5% shares of national income for Sweden in the left vertical axis, obtained from Roine and Waldenström (2009). In the right axis it plots series for the Gini coefficient of households' disposable income, obtained using the Luxembourg Income Study (see Milanovic, 2013), and from the website of Statistics Sweden, or SCB (see Atkinson and Morelli, 2014).

Table 1: Regression coefficients of different proxies of $r - g$. The dependent variable is the top 1% share of national income.

	No cross-country variation in r			*OECD data on interest rates*			$r = MPK - \delta$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Panel A: Estimates using annual panel					
Estimate of $r - g$ at t	-0.006	-0.018**	-0.018**	-0.055*	-0.032**	-0.033**	0.029	-0.004	-0.011
	(0.010)	(0.008)	(0.009)	(0.028)	(0.015)	(0.014)	(0.030)	(0.008)	(0.008)
Estimate of $r - g$ at $t - 1$			0.001			-0.003			0.005
			(0.008)			(0.016)			(0.013)
Estimate of $r - g$ at $t - 2$			0.005			0.010			-0.012
			(0.006)			(0.012)			(0.007)
Estimate of $r - g$ at $t - 3$			-0.002			-0.015			0.014*
			(0.007)			(0.019)			(0.007)
Estimate of $r - g$ at $t - 4$			-0.005			-0.000			0.006
			(0.006)			(0.012)			(0.009)
Joint significance of lags [p-value]			2.17 [0.09]			1.44 [0.26]			3.64 [0.01]
Long-run effect [p-value estimate> 0]		-0.16 [0.04]	-0.18 [0.03]		-0.35 [0.15]	-0.40 [0.21]		-0.04 [0.67]	0.03 [0.87]
Persistence of top 1% share [p-value estimate< 1]		0.89 [0.00]	0.89 [0.00]		0.91 [0.13]	0.90 [0.10]		0.90 [0.04]	0.92 [0.06]
Observations	1647	1233	1226	608	503	453	1162	905	860
Countries	28	27	27	19	18	18	28	26	26
Years per country	58.8	45.7	45.4	32.0	27.9	25.2	41.5	34.8	33.1
				Panel B: Estimates using 10-year and 20-year panels (columns 3,6,9)					
Average $r - g$	0.055	-0.036	0.136	-0.057	-0.070	-0.200	0.069	0.148	0.061
	(0.101)	(0.101)	(0.203)	(0.144)	(0.135)	(0.321)	(0.100)	(0.094)	(0.163)
Long-run effect [p-value estimate> 0]		-0.05 [0.73]			-0.15 [0.64]			0.29 [0.19]	
Persistence of top 1% share [p-value estimate< 1]		0.32 [0.00]			0.53 [0.02]			0.48 [0.00]	
Observations	214	183	105	83	81	39	136	126	69
Countries	28	27	27	19	19	19	28	27	27
Years per country	7.6	6.8	3.9	4.4	4.3	2.1	4.9	4.7	2.6

Notes-: The table presents estimates of different proxies of $r - g$ on the top 1% share of national income. Columns 1 to 3 use growth rates from Madisson, and assume no variation in real interest rates across countries. Columns 4 to 6 use real interest rates computed by subtracting realized inflation from nominal yields on long term government bonds. Columns 7 to 9 use $r = MPK - \delta$, constructed as explained in the text. All specifications include a full set of country and year fixed effects, and report standard errors robust against heteroskedasticity and serial correlation within countries. Panel A uses an unbalanced yearly panel from 1870 to 2012 covering up to 28 countries. Columns 2,5 and 8 add five lags of the dependent variable and report the estimated persistence of the top 1% share of national income and the estimated long run effect of $r - g$ on the dependent variable. Columns 3,6 and 9 add up to the fourth lag of $r - g$ as explanatory variables; reports the long run effect of a permanent increase of 1% in $r - g$; and a test for the joint significance of these lags. Panel B uses an unbalanced panel with observations every 10 years or 20 years (columns 3,6,9), covering up to 28 countries. Columns 1,4 and 7 present regression estimates of the average $r - g$ during the last 10 years on the top 1% share of national income in every decade in the sample (in 1870, 1890, ..., 2010). Columns 2,5, and 8 control for a lag of the dependent variable. Finally, columns 3,6 and 9, report estimates of the average $r - g$ during the last 20 years on the top 1% share of national income every 20 years (in 1880, 1900, ..., 2000).

Table A1: Regression coefficients of different proxies of $r-g$ controlling for country trends, population growth, and GDP per capita

	No variation in r		*OECD interest rates*		$r = MPK - \delta$	
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Baseline			
Estimate of $r-g$ at t	-0.006	-0.018**	-0.055*	-0.032**	0.029	-0.004
	(0.010)	(0.008)	(0.028)	(0.015)	(0.030)	(0.008)
Long-run effect [p-value estimate> 0]		-0.16 [0.04]		-0.35 [0.15]		-0.04 [0.67]
Persistence of top 1% share [p-value estimate< 1]		0.89 [0.00]		0.91 [0.13]		0.90 [0.04]
Observations	1647	1233	608	503	1162	905
Countries	28	27	19	18	28	26
Years per country	58.8	45.7	32.0	27.9	41.5	34.8
			Panel B: log of GDP per capita			
Estimate of $r-g$ at t	-0.006	-0.018**	-0.032	-0.031*	0.031	-0.008
	(0.009)	(0.008)	(0.026)	(0.015)	(0.028)	(0.008)
log GDP per capita at t	-0.169	0.022	3.396***	0.070	0.202	-0.206
	(0.691)	(0.127)	(1.057)	(0.454)	(0.780)	(0.196)
Long-run effect [p-value estimate> 0]		-0.16 [0.04]		-0.34 [0.17]		-0.08 [0.36]
Persistence of top 1% share [p-value estimate< 1]		0.89 [0.00]		0.91 [0.13]		0.90 [0.03]
Observations	1647	1233	608	503	1135	885
Countries	28	27	19	18	28	26
Years per country	58.8	45.7	32.0	27.9	40.5	34.0
			Panel C: Population growth			
Estimate of $r-g$ at t	0.004	-0.021**	-0.043	-0.008	0.071*	-0.012*
	(0.011)	(0.009)	(0.031)	(0.009)	(0.035)	(0.006)
Population growth at t	0.255	0.010	0.165	-0.043	0.493	-0.102
	(0.168)	(0.048)	(0.325)	(0.116)	(0.363)	(0.068)
Long-run effect [p-value estimate> 0]		-0.56 [0.06]		-0.23 [0.50]		-0.19 [0.22]
Persistence of top 1% share [p-value estimate< 1]		0.96 [0.00]		0.97 [0.39]		0.94 [0.03]
Observations	1647	1233	608	503	1135	885
Countries	28	27	19	18	28	26
Years per country	58.8	45.7	32.0	27.9	40.5	34.0
			Panel D: Country trends			
Estimate of $r-g$ at t	-0.002	-0.018*	-0.018	-0.020	0.015	-0.006
	(0.009)	(0.009)	(0.012)	(0.013)	(0.015)	(0.009)
Long-run effect [p-value estimate> 0]		-0.10 [0.05]		-0.05 [0.04]		-0.02 [0.51]
Persistence of top 1% share [p-value estimate< 1]		0.82 [0.00]		0.60 [0.00]		0.70 [0.00]
Observations	1647	1233	608	503	1162	905
Countries	28	27	19	18	28	26
Years per country	58.8	45.7	32.0	27.9	41.5	34.8

Notes-: The table presents estimates of different proxies of $r-g$ on the top 1% share of national income. Columns 1 and 2 use growth rates from Madisson, and assume no variation in real interest rates across countries. Columns 3 and 4 use real interest rates computed by subtracting realized inflation from nominal yields on long term government bonds. Columns 5 and 6 use $r = MPK-\delta$, constructed as explained in the text. The sample is an unbalanced yearly panel from 1870 to 2012 covering up to 28 countries. All specifications include a full set of country and year fixed effects, and report standard errors robust against heteroskedasticity and serial correlation within countries. Columns 2,4 and 6 add five lags of the dependent variable and report the estimated persistence of the top 1% share of national income and the estimated long run effect of $r-g$ on the dependent variable. Panel A presents the baseline estimates. Panel B adds the log of GDP per capita as a control. Panel C adds population growth as a control. Finally, Panel D adds country-specific trends as controls.

Table A2: Regression coefficients of different proxies of $r - g$. The dependent variable is the top 5% share of national income.

	No cross-country variation in r			*OECD data on interest rates*			$r = MPK - \delta$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Panel A: Estimates using annual panel					
Estimate of $r - g$ at t	-0.002	0.010	0.007	-0.106**	-0.034	-0.043*	0.056	0.006	-0.006
	(0.031)	(0.017)	(0.018)	(0.046)	(0.027)	(0.024)	(0.059)	(0.020)	(0.026)
Estimate of $r - g$ at $t - 1$			-0.001			0.008			0.005
			(0.016)			(0.027)			(0.021)
Estimate of $r - g$ at $t - 2$			0.035***			0.015			-0.007
			(0.011)			(0.019)			(0.015)
Estimate of $r - g$ at $t - 3$			-0.006			0.003			0.020*
			(0.010)			(0.029)			(0.012)
Estimate of $r - g$ at $t - 4$			-0.008			0.008			0.011
			(0.010)			(0.017)			(0.016)
Joint significance of lags [p-value]			7.58 [0.00]			0.86 [0.53]			1.10 [0.39]
Long-run effect [p-value estimate> 0]		0.12 [0.58]	0.34 [0.21]		-0.41 [0.21]	-0.11 [0.82]		0.08 [0.78]	0.34 [0.29]
Persistence of top 5% share [p-value estimate< 1]		0.92 [0.00]	0.92 [0.00]		0.92 [0.11]	0.91 [0.10]		0.93 [0.05]	0.93 [0.05]
Observations	1308	988	988	571	472	423	985	786	749
Countries	25	21	21	18	17	17	24	20	20
Years per country	52.3	47.0	47.0	31.7	27.8	24.9	41.0	39.3	37.5
				Panel B: Estimates using 10-year and 20-year panels (columns 3,6,9)					
Average $r - g$	-0.019	-0.147	0.261	-0.071	-0.001	-0.248	0.102	0.252**	0.165
	(0.164)	(0.165)	(0.557)	(0.194)	(0.217)	(0.442)	(0.157)	(0.107)	(0.203)
Observations	174	144	84	79	77	37	116	106	58
Countries	25	22	23	18	18	18	24	22	23
Years per country	7.0	6.5	3.7	4.4	4.3	2.1	4.8	4.8	2.5

Notes-: The table presents estimates of different proxies of $r - g$ on the top 5% share of national income. Columns 1 to 3 use growth rates from Madisson, and assume no variation in real interest rates across countries. Columns 4 to 6 use real interest rates computed by subtracting realized inflation from nominal yields on long term government bonds. Columns 7 to 9 use $r = MPK - \delta$, constructed as explained in the text. All specifications include a full set of country and year fixed effects, and report standard errors robust against heteroskedasticity and serial correlation within countries. Panel A uses an unbalanced yearly panel from 1870 to 2012 covering up to 28 countries. Columns 2,5 and 8 add five lags of the dependent variable and report the estimated persistence of the top 5% share of national income and the estimated long run effect of $r - g$ on the dependent variable. Columns 3,6 and 9 add up to the fourth lag of $r - g$ as explanatory variables; reports the long run effect of a permanent increase of 1% in $r - g$; and a test for the joint significance of these lags. Panel B uses an unbalanced panel with observations every 10 years or 20 years (columns 3,6,9), covering up to 28 countries. Columns 1, 4 and 7 present regression estimates of the average $r - g$ during the last 10 years on the top 1% share of national income in every decade in the sample (in 1870, 1890, ..., 2010). Columns 2,5, and 8 control for a lag of the dependent variable. Finally, columns 3,6 and 9, report estimates of the average $r - g$ during the last 20 years on the top 5% share of national income every 20 years (in 1880, 1900, ..., 2000).