Capital and Wealth in the 21st Century

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December 1, 2014

Thomas Piketty's *Capital in the 21st Century* is many things, among them an engaging historical narrative, a well-deserved scolding of his fellow economists for their intellectual narrowness, a dystopian forecast about the future path of inequality, and a political call to arms. Above all, however, the book (along with the papers by Piketty and co-authors on which it draws) is an exercise in measurement. It is on a foundation of new facts, wrested from a multitude of historical and contemporary data sources, that the other elements of Piketty's intellectual edifice rest.

In turn, the central element of Piketty's approach to measurement is the interchangeable use of the terms "capital" and "wealth." In simple models, e.g. Solow or Cass-Ramsey, capital and wealth are the same thing. In real life, however, complications intrude. The author is aware of the differences between these two concepts, and spends a good deal of time discussing them. Nonetheless, the thrust of the book is that, for the purposes in which he is interested, the two are sufficiently close conceptually that it is acceptable to switch back and forth between them, and he generally refers to them by the single name "capital." The measurement of capital -- both the aggregate quantity and its distribution among the population -- is the book's driving force.

Piketty defines capital as "the total market value of everything owned by the residents and government of a given country at a given point in time, provided that it can be traded on some market." (p. 48). Among the items included in this total are the structures, equipment, and infrastructure that make up more conventional definitions of physical capital; land (both underlying residential real estate and farmland); mineral deposits; precious objects such as gold and paintings; and the value of intellectual property, brand recognition, and market power that are captured in market valuations of corporate equity.

There are many advantages to the approach that Piketty takes.   Market valuations capture past value-creating expenditures that are not measured as part of investment in the National Income and Product Accounts. Compared to the alternative of cumulating past investment flows via a perpetual inventory method, the approach of looking at market valuations also incorporates the effects of technological changes, price changes, or other shocks that may have rendered past investment more or less productive (Pritchett, 2000).   Above all, the definition of capital allows for consistent measurement, both over time and across countries. And of course, the privately owned part of capital, in Piketty's definition, also corresponds to things that could be taxed.

But the identification of capital in wealth in the book also imposes a number of limitations. Important components of both capital and wealth are excluded because they do not trade on markets, and asset price revaluations that are unrelated to changes in the value marginal product of capital end up being counted as changes in the capital stock.

Market Wealth as a Measure of Productive Capital

In our simple models of growth, capital is a good thing. It raises both output and the marginal product of labor. More sophisticated growth models have included human capital, technological progress, the efficiency of institutions, and so on in a broader set of determinants of income growth. Research using the tools of development accounting line (See Caselli, 2005, for a summary) finds that differences in physical capital accumulation explain only a fraction of income differences among countries. And Easterly (2001) has shown that rapid capital accumulation is neither necessary nor sufficient for economic growth. All that being said, it is hard to come away from the growth literature without the idea that *ceteris paribus* more physical capital is good for economic growth.

From this perspective, the fluctuations in the capital/income ratio that Piketty documents should have had a large effect on output. In France, where his data are best, the K/Y ratio was remarkably stable, in the neighborhood of 6-7, for most of the last 300 years. The middle of the 20th century stands out as aberrant period, with K/Y plummeting and then, in the last 40 years, climbing back toward its old levels. K/Y rose from 3.68 to 6.05 over the period 1990-2010.

The impact of these fluctuations on output can be analyzed using a simple growth accounting framework (here following Jones, 1992). Start with the production function in Cobb Douglas form:

$$Y = AK^\alpha(hL)^{1-\alpha} \tag{1}$$

where h is human capital per worker and L is the size of the labor force. Re-writing the production function so that the capital/output ratio is on the right hand side, then taking logs and differentiating with respect to time, the growth rate of output per capita is

$$\hat{y} = \frac{1}{1-\alpha}\hat{A} + \frac{\alpha}{1-\alpha}\widehat{(K/Y)} + \hat{h} \tag{2}$$

Between 1990 and 2010, K/Y grew at an annual growth rate of 2.5%. If we take α to be 0.25 (the average of capital's share of national income for the period 1990-2010, from Appendix table S6.2), then the contribution to growth of output per worker from capital deepening is 0.83% annually.[1] Over this period, the actual growth rate of output per working age adult was 1.1% per

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[1] It is worth pointing out that the growth being attributed to capital in this calculation does not include the accumulation of capital that one would see along a balanced growth path, where the underlying source of growth was technological progress or improvement in human capital. This sort of growth would hold the K/Y ratio constant.

year.[2] In other words, capital accumulation was responsible for a huge fraction of actual growth in this period.

Before going too far in analyzing the implications of this finding, one important thread to pull is to break out the housing sector from the rest of the economy. The reason is that the growth of capital in Piketty's data is dominated by the growth of housing. Housing capital / national income rose from 1.78 to 3.71 between 1990 and 2010, while non-housing capital (specifically national wealth less the values of land, housing, and net foreign assets) went from 1.76 to 2.37 over the same period. In Piketty and Zucman, (2014, Appendix table A41) we can see that the ratio of housing product to domestic product rose from 6.7% to 8.7% between 1990 and 2010, implying that for housing, K/Y rose from 26.6 to 42.6. This would suggest that much of the newly accumulated housing capital was not very productive. For example, if the value of r for housing was 3% (since Piketty does allow for lower r in this case than for other types of capital), then an extra 200% of national income in the form of housing capital should produce an extra 6 percentage points of housing product relative to national product, rather than the 2 percentage points observed. This calculation suggests that to the extent that the growth of housing capital was really due to investment, there has been a massive misallocation (un mis-measurement of housing services).

Breaking out of the housing sector does not undo the observation that capital deepening should have produced a large fraction of observed growth. Using the information above, I can calculate K/Y for the non-housing sector.   This rose from 1.88 to 2.60, a growth rate of 1.6 percent per year. Taking capital's share in income (for this sector) as the same 0.25 used above, this

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[2] GDP in constant local currency units and population aged 15-64 from the World Development Indicators database.

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implies that capital deepening contributed 0.53% per year to growth in the non-housing sector, which is almost half of actual growth observed.

This calculation suggests that that things are really going to go very poorly for France once the K/Y ratio stabilizes -- and things will be even worse if it declines. It is possible that this calculation is correct, and that capital accumulation did indeed induce rapid growth in France over the last two decades, offset by deficiencies somewhere else (institutions getting worse, perhaps). If so, then it seems like an alternative title to Piketty's book would be *Thank You, Rich People, for Propping Up Our Economy with Your Avarice.*   If that is not correct, then there are two possibilities: either capital is not as productive as the standard model says it is, or there wasn't as much capital accumulated as Piketty's calculation suggests.

Piketty seems to favor the former theory, at least at some points in the book. His primary hostility is directed toward the means by which capital is accumulated (the avarice of rich people) as well as distortions of the political, economic, and social systems occasioned by the accumulation of large concentrations of wealth. Such a hostile view toward capital owners is not inconsistent with an appreciation for the productivity of the stuff itself, but Piketty does not seem inclined that way.   The greatest indication of this attitude is what is *not* in the book. Famously, Piketty calls for a global progressive tax on capital in order to eliminate large personal fortunes, both by taxing them away directly and by disincentivizing their accumulation. But nowhere in the book is there any discussion of an alternative mechanism to encourage someone to hold the wealth that is no longer held by the very wealthy -- either something mundane, like funded pensions or a reduction in government debt, or something that would really get them excited at the *Wall Street Journal*, like direct government ownership of part of the capital stock. Evidently, a developed world with less capital would not be significantly worse off.

At the same time, at other points in the book Piketty scolds those who would believe that capital is no longer important for producing output   A reconciliation of these views would be, I suppose, if capital is still productive, but does not have great complementarity with labor -- for example, if production were CES with an elasticity of substitution significantly greater than one. In this case, however, we would expect capital share of income to have risen much more than what has been observed as K/Y rose.

Some evidence of possible mismeasurement in capital comes from comparing Piketty's data to the Penn World Tables (version 8.0), where capital stock are created using the perpetual inventory method with depreciation rates varying by asset type (Inklaar and Timmer, 2013).   In that data, the K/Y ratio in France rose from 3.26 in 1990 to 3.59 in 2010, an annual growth rate of 0.48%, or one-fifth of Piketty's. [3]

An obvious candidate for the source of measurement error is changes in asset prices. Data from Piketty (2011, table A17) provide some evidence that this is an important part of the story. In that paper, he examines the ratios of private saving and wealth to income.   Over the period 1989-2009, the ratio of private wealth to income rose from 3.11 to 5.52. This annual growth of 2.91% can be decomposed into pieces due to "savings induced real wealth growth rate," capital gains, and income growth as follows:

Growth of K/Y = Savings Induced Wealth Growth - income growth + capital gains

   2.91%   =   2.80%   -   1.47%   + 1.58%

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[3] The specific variables are *rkna*, Capital stock at constant 2005 national prices, and *rgdpna*, real GDP at constant 2005 national prices.

Were there no capital gains, K/Y would have risen by 30% over this period, rather than 78%. A significant run-up in house prices during this period is in turn a natural explanation for much of this capital appreciation.

As mentioned above, the fact that growth of the ratio of market wealth to income was due to capital gains does not rule out the desirability of saying that it represents an increase in the capital stock. The question is whether the increase in capital prices represented a rise in expected future productivity (due to a technology change, for example) or a change in the discount associated with a specific stream of productive services (due to a decline in the market discount rate or in perceptions of risk). Looking at the broad inflation in asset values that took place in many developed countries over the last several decades, a good case can be made for the latter view.

The most obvious contributor to the rise in asset prices was simply the long-term decline in the safe real interest rates. Beyond this, Piketty's narrative itself makes a strong case that the revaluation of capital was due in part to growing security of capital holders that their assets were safe from the sorts of *de facto* and *de jure* confiscations that plagued them in the middle of the 20th century. The defeats of Communism and inflation, as well as the triumphs of Reagan and Thatcher, surely raised the multiple of current earnings that people were willing to pay for a piece of capital.

The observation that asset prices reflect possibilities of future capital confiscations is a useful jumping off point to talk about a broader difficulty with using market valuation to measure the quantity of capital. Consider the example of imposition of rent control, which is one of the policies that Piketty discusses in the context of reduced capital valuations in the middle of the 20th century. Mandating a below-market rent lowers the value of the stream of rental payments

that a landlord can expect, and thus lowers the market valuation of a piece of rental property.

But of course, rent control doesn't really destroy capital (at least in the short run).

Corresponding to the landlord's loss, there is a gain to the tenant in terms of lower rents. That

benefit is generally not capitalized and priced in markets, but it is very valuable nonetheless.

While market wealth indeed declines due to rent control, a broader measure of wealth would be

stable. The problem, then, is that the border between market and non-market forms of capital

may be more porous than we would like.

Market Wealth as a Measure of Wealth

Most of Piketty's focus is not on the implications of capital accumulation for aggregate output, as

discussed above, but rather on the implications of wealth accumulation and wealth inequality.

Unfortunately, limiting his focus to wealth in the form of ownership of physical capital leaves out

many wealth-like objects. Here I discuss what are likely to be the two most quantitatively

important.

Human Capital

One of the central objects of Piketty's concern is the split in national income between payments

to capital and payments to labor. The missing piece of this story is the change in the nature of

payments to labor, and in particular, the increase in the fraction of such payment that represent

payments to human capital. In the world of 1700, most wages were compensation for the raw

labor that workers supplied; today, a large fraction of the wage bill represents payment for skills acquired through education and training.

Although experience, on the job training, and health all contribute to human capital, I will restrict my focus here to schooling. One way to measure the quantity of human capital from schooling is from the investment side, analogously with estimating the stock of physical capital via the perpetual inventory method. In 2010, expenditure on educational institutions was 6.3% of GDP in France.[4] In addition, one should include the opportunity cost of human capital investment. Kendrick's (1976) estimate for the US in 1969 was that slightly less than half of total gross investment in education was made up of imputed wages of students, implying that the expenditure share should be roughly double the figure just reported. Putting these together, the level of gross investment in human capital is about half the size of gross fixed capital formation as measured in French National Income and Product Accounts (21.4%, averaged over the period 1990-2010). Thus the stock of human capital would be about half of the stock of physical capital if the two depreciated at the same rates, which seems like a conservative assumption (human capital probably depreciates more slowly than all types of physical capital except structures).

Measuring the stock of human capital in terms of future income flows yields a larger figure. How much larger depends on which parts of the money and effort spent on raising and maintaining human beings get counted as human capital investments. In the extreme, Jorgensen and Fraumeni (1989) view all such expenditures as investment in human capital, and correspondingly view all payments to labor as being returns to human capital. As Piketty points

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[4] OECD (2013), Education at a Glance 2013: OECD Indicators, OECD Publishing. http://dx.doi.org/10.1787/eag-2013-en, Table B2.1

out, such an approach yields enormous capitalized values of human capital -- basically labor's share of national income times the discounted value of all future output. A more modest strategy, which I follow here, is to simply look at the parts of future labor income that are attributable to education, although even here it is hard to know what year of education to start with. Somewhat arbitrarily letting available data be a guide, I consider only the period 1870-2010. In the data of Morrison and Murtin (2009), average years of schooling among working age adults in France increased from 4.0 to 12.6 years over this period. To get a value for this increment to human capital, I apply the standard development accounting techniques (Caselli, 2005). These imply that of total labor income in 2010, just over half was due to education beyond what people had in 1870. If labor earns ¾ of national income, that in turn implies that ⅜ of national income is payment to this education. Finally, capitalizing this ⅜ flow, assuming a 40 year working life, population spread evenly among age groups, and a gap between the interest rate and growth rate equal to 4%, would yield a value of this human capital relative to current national income of roughly 4.7 times national income -- very similar to Piketty's ratio of market wealth to income.

Piketty dislikes the idea of education being primarily values in terms of the market returns it produces, looking instead to its value in increasing fulfillment in life via the acquisition of knowledge and culture. But as Jorgensen and Fraumeni (1989) point out, in such a case, we should nonetheless value these non-market services as a component of income, and the human capital that produces them as a component of wealth.

Measured either way, then, the value of human capital relative to GDP is clearly much higher than it was during most of the 300 years over which Piketty measures the ratio of market wealth to GDP. Thus the ratio of *total wealth* to GDP was far from constant. More importantly, from

the perspective of the subjects that Piketty addresses in his book, the distribution of human capital is very different from the distribution of market wealth.

Although there is certainly inequality in the distribution of human capital, it is far smaller than the inequality in market wealth, and the two are not perfectly correlated. While there are many reasons for this difference in distributions, the most obvious is that there is a limit to how much human capital even the richest parent can cram into the head of his or her child. Further, because the early years of human capital investments pay especially high returns, households with only a small amount of investable funds will put all of them into children's human capital, while wealthy households will put the vast bulk of their investment in non-human forms.

Thus a broader measure of wealth will look less unequal than market wealth. Further, the rising share of total wealth made up of human capital will be a strong force pushing the trend in inequality in total wealth downward over time. Finally, with regard to inequality in human capital itself, Morrison and Murtin (2013) find that this has roughly halved in Western countries between 1870 and 2010.

Of course, human capital is not just a form of wealth, but also an input into production. To see its importance in that regard, we can return the analysis of equation (2) and ask how much of the growth in output per worker can be attributed to human capital deepening. Using data from Barro and Lee (2013, Version 2.0), average years of schooling for males and females aged 25-65 rose from 8.08 in 1990 to 11.49 in 2010, an increase of 0.17 years of education per year. Following Jones (2002), I apply a Mincerian return to schooling of 7% (on the argument that most of the extra years of schooling were at secondary and tertiary levels, where the return is lower than for primary schooling), implying that $\hat{h}$ in equation (2) was 1.19% per year. In other words, accumulation of human capital contributed significantly more to income growth than did

accumulation of physical capital. This is another reason that the total value of assets that can be traded on markets is a poor measure of the capital stock.

Retirement, Life Cycle Saving, and Transfer Wealth

The relative constancy of the wealth/income ratio over most of the 300 year period that Piketty examines, with the middle of the 20th century being an apparent exception, is striking in light of the many changes in the structure of the economy over this period. A particular change that should have impacted the wealth/income ratio is the rise of retirement as a significant life stage for most people. In 2013, the labor force participation rate in France for people 65 and above was 2.3%, while life expectancy at age 65 was 23.8 years for women and 19.3 years for men.[5]

One does not have to go all the way back to 1700 to see this situation as historically unprecedented. In the data of Costa (1998), the rate of "gainful employment" for men aged over 64 in the United States fell from 78% in 1880 to less than 20% in 1990.   For the period in which French data are available, the trend is similar, and there is no reason to think that prior to the late 19th century labor force participation of the elderly was any lower. Not only did most of the elderly work historically, but most people did not reach old age to begin with. In France in 1816, life expectancy at age 20 was a further 39.1 years, and the probability of reaching age 65, conditional on living to age 20, was only 45%. By 2012, life expectancy at age 20 was 59.0 years, and the probability of a 20 year old making it to 65 was 84%.[6] Finally, among those elderly who were not working during the pre-industrial period, the most common means of

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[5] OECD (2013), "Life expectancy and healthy life expectancy at age 65", in
Health at a Glance 2013: OECD Indicators, OECD Publishing.
http://dx.doi.org/10.1787/health_glance-2013-72-en

[6] All data for males. Source: Human Mortality Database.

support was transfers from family members, often through the means of co-residence. Such transfers are far less important today.

The relevance of such a change in lifestyle for wealth is clear. Indeed, the Life Cycle model of saving and the Overlapping Generations model of growth are both based around the idea that the savings of working age adults, in order to fund their own retirements, are the main contributor to the capital stock. Even if there were additional motivations for saving in some sectors of the population, such as maintenance of dynastic fortunes, we should still expect the rise of retirement as a life stage to call forth an appreciable lump of life cycle wealth.

How big should this lump of wealth be? That depends on the particular specification of the life cycle saving problem, but to give a sense for the potential size, I consider the following simplified version: individuals start working at age 20, retire at 65, and live to 80. Wages grow at 1% per year, and the real interest rate is 4%. Rather than give individuals an explicit utility function to maximize, I assume that they simply save a fixed fraction of their wages, with the saving rate chosen such that consumption after retirement is equal to 60% of their earnings in the last period working, and that individuals die (as they are born) with zero assets. Putting this all together gives a saving rate out of wages of 7.0%, with individuals on the verge of retirement holding life cycle wealth equal to 6.6 years' wages. For simplicity, assume that in cross-section there is no variation in wage by age, and similarly, let the demographic structure be flat, i.e. an equal number of people in each age group. In this case, the aggregate ratio of wealth to wages would be 3.9. Allowing for wages to be 75% of income yields a wealth/income ratio of 2.9.

But, of course, we don't see much of this wealth in the data. The striking fact is how many people enter and live through retirement with few market assets other than housing. In the US, the median holding of financial assets outside retirement accounts for households with heads

aged 65-69 is $15,000, while the median holding of personal retirement account assets is $5,000. Further, only 12% of households in the bottom half of the total income distribution for those over 65 report receiving any private pension income (the assets of which would be included in Piketty's market wealth measure). (Poterba, 2014).

The paucity of market wealth among many of the elderly is not because the rise of retirement did not create a demand for asset holding, but rather because that demand was satisfied by the creation of a new kind of asset: claims on future public transfers, which Lee and Mason (2011) call public transfer wealth. The significance of transfer wealth can easily be seen by examining cash flows that it generates. Poterba (2014) reports that in the second quartile of the income distribution for people 65 and over, 83.5% of income comes from Social Security, vs. 6.2% from private pensions and 3.7% from assets. In the bottom quartile, Social Security is even more important, while even in the third quartile, it accounts for more than half of income.

But is transfer wealth really the same as market wealth? Put differently, are public pensioners really the same as rentiers? In some ways, the answer is clearly no. Ownership of transfer wealth conveys no control rights, and it can't be sold or borrowed against, although it is not clear that these characteristics would be very valuable to those who hold it.   Because it is annuitized, transfer wealth does not pass on to heirs, and so it is certainly true it affects the dynamics of inequality differently than market wealth. Because it is only a promise from the government, transfer wealth can be taken away at the stroke of a pen, if those in power decide to change the law.   Of course, as the story of the 20th century shows, market wealth is also subject to confiscation at the stroke of a pen. At least in the US, transfer wealth actually seems more secure than market wealth. A commonly given piece of financial advice is for retired individuals of sufficient means to delay claiming Social Security benefits for several years, supporting their

consumption by running down their stock of market wealth, in order to "buy" themselves a larger stream of Social Security benefits.[7]

The gross size of these transfer claims is enormous. Among 66 year olds in the US, the average value of net Social Security wealth in 2013 was $189,799. Simply adding up all the discounted Social Security benefits expected by people alive in the US now gives a total of $36.2 trillion. Of course the *net* size of public transfer assets is much smaller. Transfers given in any year are equal to transfers received, so discounted and summed over all current and future generations, net public transfer wealth is zero. Among current cohorts, net transfer wealth is positive, because future cohorts have negative transfer wealth. Net Social Security wealth of currently living Americans in 2013 was $12.9 trillion, or three quarters of a year's GDP.[8]

More important than its impact on the aggregate wealth/income ratio is the impact of transfer wealth on the distribution of wealth. Because of the progressive structure of the typical public pension system, individuals in the lower part of the distribution of lifetime income see all of the wealth that they would otherwise hold for life cycle reasons displaced by public transfer wealth, while richer individuals do not. Thus the distribution of market wealth is far more skewed than the distribution of market plus transfer wealth. For example, among households with heads aged 65-69, the 90th percentile value of Social Security wealth is roughly twice as large as the median, while the 90th percentile value of non-annuitized wealth is almost six times as large as the median (Poterba 2014, Table 9). Further, an investigation of the right tail of the distribution

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[7] The transformation of market wealth into an annuitized stream of payments should be familiar to the reader of Balzac's *Pere Goriot*, which is one of Piketty's frequent literary touchstones. The hero of that novel at one point liquidates his holdings of market assets in order purchase for himself an annuity. Admittedly, in this case the annuity is from the private sector rather than the government.
[8] Calculations in this paragraph assume 1% per year real wage growth and a discount rate of 4%. I am grateful to Gretchen Donehower and Ron Lee.

of Social Security wealth, focusing on the top 1% or the top 0.1%, would not show anything like the extreme skewness of the distribution of market wealth.

Conclusion

The definition of capital that Piketty uses in his book -- the market value of tradeable assets - - is both problematic as a measure of the quantity of physical capital in the economy and incomplete as a measure of wealth. Given that Piketty's primary focus is on changes in the wealth/income ratio over time, as well the distribution of wealth in the cross section, it is the latter of these two problems that is particularly significant. In 1700, at the beginning of the period that he studies in his book, marketable assets were indeed pretty much the only form of wealth. But over the intervening 300 years, new types of wealth, most notably human capital and transfer wealth, have come to constitute a very significant fraction of total wealth. Thus the constancy of the wealth/income ratio as portrayed in his data is an illusion. More important, however, is the fact that the distribution of the new types of wealth that he does not measure is far more equal than, and not perfectly correlated with, wealth that falls into his analysis.

In the presence of these other forms of wealth, the case for focusing on market wealth seems to come rest most heavily on its being inheritable, and thus subject to growing inequality over time. However, this argument is circular: if market wealth is only a part of aggregate wealth, then aggregate wealth is much less unequal than he has portrayed it as being, and the role of inheritance in producing inequality in aggregate wealth is similarly reduced.

The fact that Piketty misses out on some dimensions of wealth does not undermine the value of the exercise conducted in his book and supporting articles, however. Over recent decades, the dynamics of market wealth on which he focuses probably have indeed been the biggest part of

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the story of wealth evolution.   And even if his analysis of wealth inequality over the longer

horizon is incomplete, it nonetheless represents an enormously valuable contribution to the

state of our knowledge.

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